SOILS

The soils in a given region are the result of the interaction over time of climate, living organisms (mainly plants and soil inhabiting animals) topography and parent rock. Often it is possible to discern relationships between soil properties and one particular soil-forming factor. Field observations in the Eildon Catchment, and analyses of soil samples, showed broad relationships with altitude which have also been observed in other studies in the mountainous parts of Victoria. In general it can be said that, as altitude increases –

- Texture becomes lighter;
- Content of organic matter in the topsoil increases;
- Profiles become porous and friable;
- Content of some nutrients, for example nitrogen and phosphorous, increases;
- Exchangeable magnesium and calcium decrease by sodium and potassium ions show no trend. All metal ions, however, are progressively more concentrated in the topsoil;
- Base saturation of the colloids decreases, with a corresponding pH decrease.

Seven soil groups are represented on the bulk of the area – solodic soils, red and yellow podsolic soils, leptopodsols, amphipodsols, cryptopodsols, acid brown earths and alpine humus soils. To facilitate comparison with soils elsewhere, the soil names used in this report have been correlated with those in other soil classification systems (Table 3).

General descriptions are based on may field observations.

The diagram (Figures 6 to 13), depicting the general chemical and physical properties of the soil groups, are based on the average of all available data from a limited number of samples. Analyses of profiles appear in Appendix II.

The distribution of the soils can be gauged from the map of land systems, because soil patterns closely parallel the vegetation patterns on which the land systems are based.

(i) ***Solodic Soils****:-* Most of the Mansfield Plain and the adjacent lower hill slopes are characterised by solodic soils. Much of the area is also gilgaied. Gilgais are alternate hummocks and hollows on the surface of the land, with a vertical interval of up to thirty centimetres, and the horizontal interval up to about six metres. On the steeper slopes fringing the solodic soils, the development of gilgais is subdued, but broad undulations of the top of the clay horizon are characteristic.

Solodic soils are formed on detritus derived largely from the purple Carboniferous mudstones and sandstones and also, in the west of the Mansfield Plain, on Silurian or Ordovician mudstone.

Texture profiles are duplex (Northcote 1971), characterised by lighter textured upper horizons which abruptly overlie a heavier, clayey horizon. The depth to clays is variable, from about one centimetre to almost a metre, over a distance of a few metres.

On gilgai hummocks, the topsoil consists typically of fifteen centimetres of grey loam, whilst in hollows, the A horizons consist of grey loam, overlying brownish clay loam, massively structured and containing small buckshot. A conspicuous line of large buckshot is usually found on top of the undulating clay surface. The A horizons are vesicular, and they set hard when dry but have little strength when wet. All the horizons, including the clayey subsoils, disperse readily in water. For this reason, when overcleaning of the land occurs, they are extremely prone to seepage sapping and thus to gully erosion. Embankments built with the material are prone to tunnelling. The clay horizon, which may be one to six metres thick, shows the features of its parent material. This may be fluviatile detritus or weathered bedrock.

Plate 7 – Gilgaied solodic soils of the Mansfield Plain

The A horizons are similar to those of the pallid leptopodsols, described later, and it is clear that at least some of these soils have had a complex origin.

Selected chemical characteristics of this group are shown in Figures 6 and 7, and are given in Appendix II, profiles 315, 316, 317, 318. These show that the pH value at the surface of the clay hummocks is about six, and that it increases with depth; at the surface in gilgai hollows, pH is about 5.5, and increases slightly with depth. Cation exchange capacities are moderately high, reaching to about thirty milliequivalents per cent in the structured clay. Calcium dominates at the surface, but magnesium is greater in the clay. Sodium increases with depth, to about fifteen per cent. As in most solidic soils encountered in south-eastern Australia, magnesium plus sodium together dominate the exchange complex of the lower subsoil.

The level of total and exchangeable potassium appears adequate for plant growth, particularly in the clayey subsoils. Total and available phosphorous values are low.

(ii) ***Black Earths:-*** There are two distinct kinds of heavy black soil in the Mansfield land system, and in some valleys of the Eildon land system. One, termed here a chernozemic soil, is a highly structured black heavy clay with calcium carbonate in the subsoil. It is restricted to a narrow zone in the drainage line of Fords Creek and its tributaries. The other, termed here as prairie soil, is a friable black clay without free carbonate in the subsoil. It occurs on lower slopes and in drainage lines, usually in the Mansfield land system. At some sites, the prairie soil overlies the chernozemic soil, with or without a layer of undifferentiated fine sediment between them.

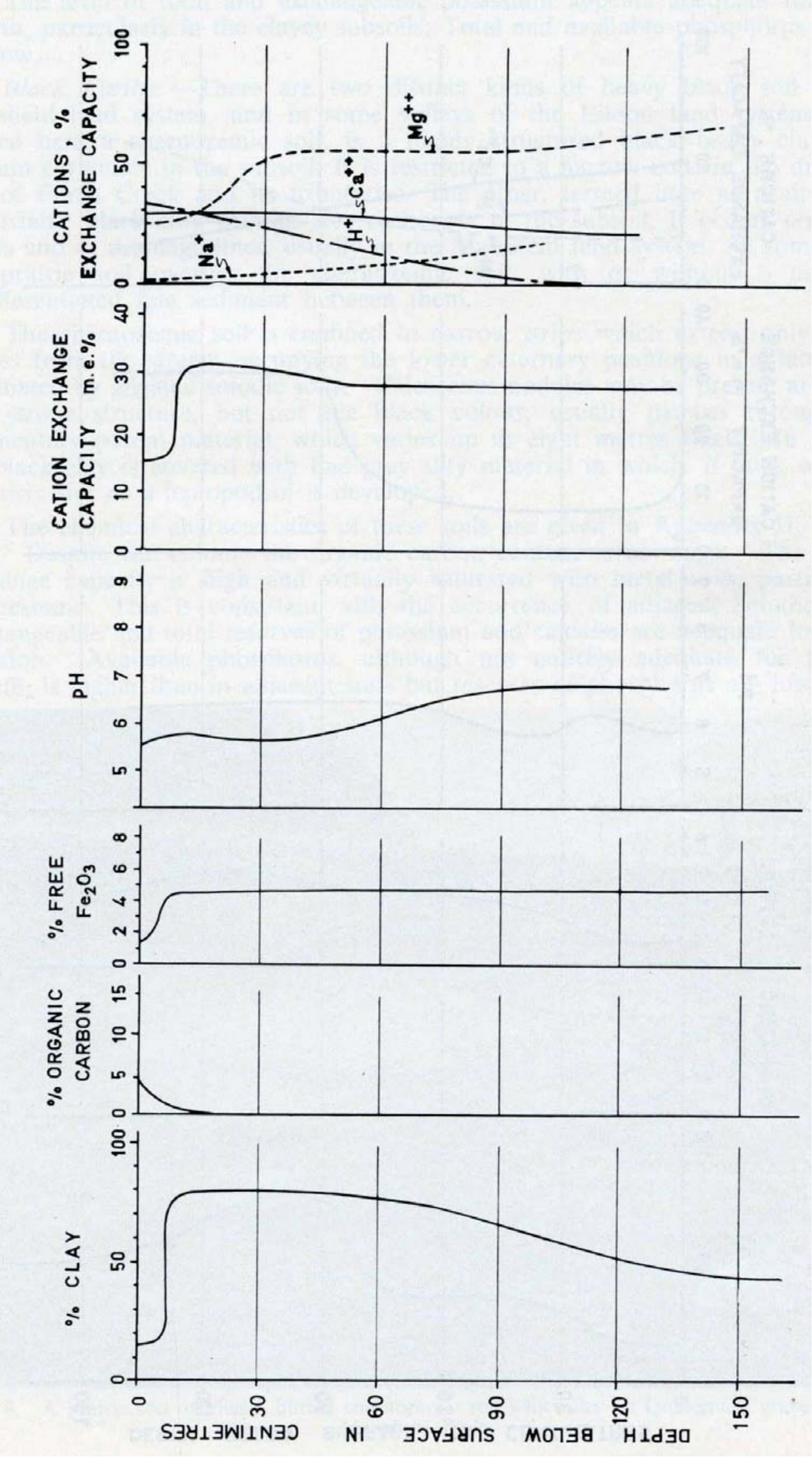

Figure 6 – Analytical Data for Solodic Soils, Gilgai Hummock (Profiles 315, 318)

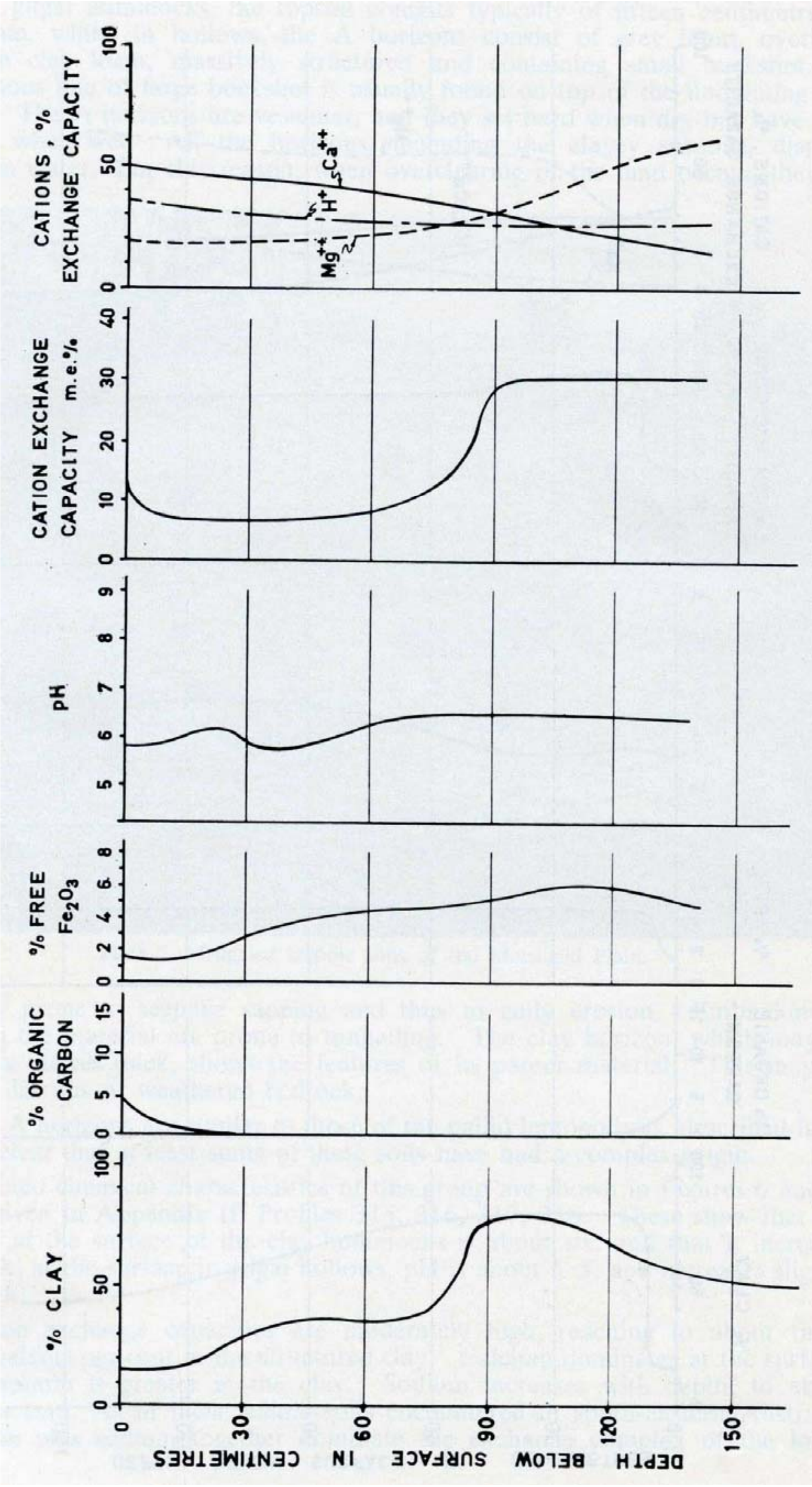

Figure 7 – Analytical Data for Solodic Soils, Gilgai Hollow (Profiles 316, 317)

The chernozemic soil is confined to narrow strips which extend only a few metres from the stream occupying the lower caternary positions in a landscape dominated by gilgaied solodic soils. Calcareous nodules may be present at depth. The strong structure, but not the black colour, usually persists through the sedimentary parent material, which varies up to eight metres thick. In places, the black clay is covered with fine grey silty material in which, it thick enough, a prairie soil or a leptopodsol is developed.

Plate 8 – A prairie soil overlies a buried chernozemic soil which lies on Quaternary gravels of the Mansfield Plain

The chemical characteristics of these soils are given in Appendix II, Profile 311. Despite the colour, the organic carbon content is not high. The cation exchange capacity is high and virtually saturated with metal ions, particularly magnesium. This is consistent with the occurrence of adjacent solodic soils. Exchangeable and total reserves of potassium and calcium are adequate for plant nutrition. Available phosphorous, although not entirely adequate for pasture growth, is higher than in adjacent soils but reserves of phosphorous are low.

The prairie soils, which occur in association with leptopodsols, are common in moist sites in the eastern, hilly portion of the Mansfield land system, Parent material are usually Carboniferous sediments. Chemically, they are distinct from the chernozemic soils (Figure 8 and Appendix II, Profiles 319, 321). The total of silt and clay generally exceeds fifty per cent, the proportion of silt is high, and there is little increase of clay or of free ferric oxide with depth. Significant features are the near neutrality of pH values, the moderately high values for organic carbon, fairly high carbon-nitrogen ratios and moderate levels of available and total phosphorous and potassium. The exchange complex has a moderately high capacity and is mainly unsaturated.

(iii) ***Brown Earths***:- These soils are found most commonly in colluvial material on the upper slopes of Carboniferous “red rock”, between the skeletal soils of the ridges and the prairie soils of the lower slopes. The profiles are of loam texture with little structural development, but good friability. There are abundant small rock chips. The profile can be two or more metres deep, with the lowest portions a little heavier in texture. The upper horizons are apparently mobile on the slope, the rock chips parallel to the surface. These chips are not cemented, and the material is liable to collapse.

Chemical characteristics (Appendix II, Profile 322), show the reaction to be mildly acidic and the organic matter content relatively low. The cation exchange capacity is low but there are adequate levels of exchangeable potassium and calcium. The proportions of both magnesium and sodium on the complex increase with depth but sodium does not reach high values.

There is a marked response of clover to superphosphate application. Possibly this can be attributed to the sulphur in this fertilizer.

Plate 9 – Yellow and red podzolic soils in the Jamieson land system

(iv) ***Red and Yellow Podsolic Soils***:- These soils occur upslope from the solodic soils of the Mansfield and Eildon land systems. There is a less abrupt boundary between topsoil and underlying clay, a strongly bleached A2 horizon and a well structured clay subsoil, with well developed clay skins.

The angular blocky peds are about thirteen millimetres across, less than those of the solodic soils. Material from any part of the profile disperses readily in water, contributing to the erosion hazard.

The upper horizons may show the complex variation found in the deeper solodic soils. Furthermore, at some sites, the upper horizons have features of leptopodsols, even though they overlie clays characteristic of red and yellow podosolic subsoils. The lateral variation can take place in a complex pattern over distances of approximately a metre.

The mechanical analyses (Figure 9 and Appendix II, Profile 329) show substantial increase in clay with depth, and an acidic reaction throughout. Organic carbon levels are moderate in the surface. Available and total phosphorous are low and are concentrated in the topsoil. Available and total phosphorous are low and are concentrated in the topsoil. Total potassium is adequate, as is exchangeable calcium is not high.

The exchange complex is predominantly base unsaturated, but the proportions of magnesium and sodium increase with depth.

(v) ***Leptopodzols***:- Soils of this group show a gradual increase of clay with depth, with a weakly structured and bleached A2 horizon. Tow variants have been recognised, the pallid and the red leptopodsols.

Pallid leptopodsols: These are found mainly in the Eildon land system. They consist of 20 to 30 centimetres of light brownish-grey loam, merging gradually with depth to light yellowish-brown clay-loam or light clay, weakly structured or massive, 15 to 30 centimetres thick. This latter horizon contains small buckshot concretions. It is often weakly mottled and, in poorly drained sites, it is gleyed.

At the base of the profile, a line of stones and buckshot is common. Beneath the profile, the upper part of which is often formed on transported materials and separated by a stone line, is a variety of other materials, including clayey horizons, normally found in podsolic soils and solodic soils, coarse alluvium and other detritus.

Mechanical analyses (Figure 10 and appendix II, Profiles 312, 313 and 314) show that clay content increases with depth. Actual clay contents vary with parent material by are usually relatively low.

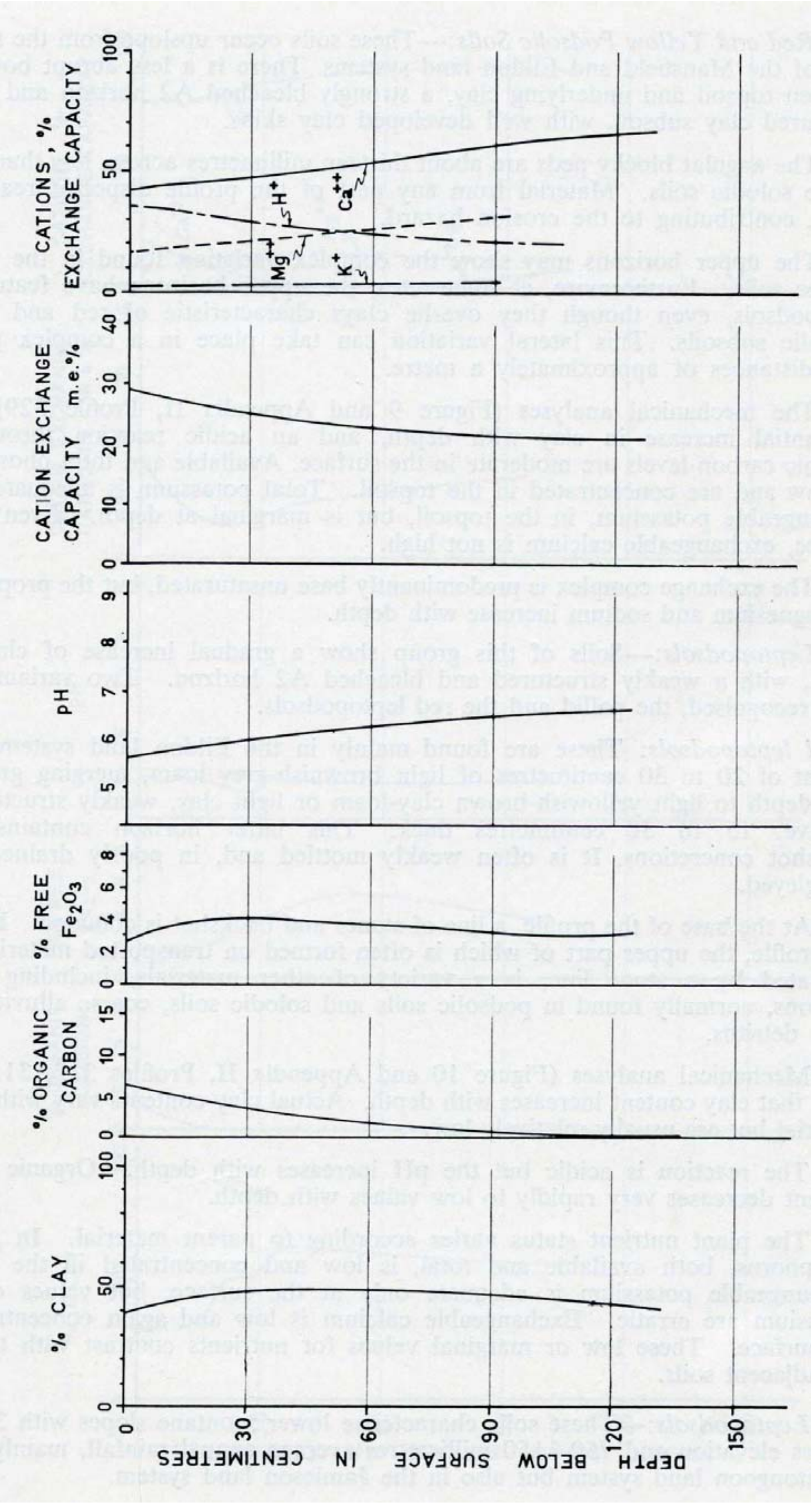

Figure 8 – Analytical Data for Chernozemic Soils (Profiles 319, 321)

The reaction is acidic but the pH increases with depth. Organic carbon content decreases very rapidly to low values with depth.

The plant nutrient status varies according to parent material. In general, phosphorous, both available and total, is low and concentrated in the topsoil. Exchangeable potassium is adequate only at the surface, but values of total potassium erratic. Exchangeable potassium is adequate only at the surface, but values of total potassium are erratic. Exchangeable calcium is low and again concentrated in the surface. These low or marginal values for nutrients contrast with those in the adjacent soils.

Red Leptopodzols:- These soils characterise lower montane slopes with 300-800 metres elevation and 750-1150 millimetres average annual rainfall, mainly in the Maintongoon land system but also in the Jamieson land system.

The progression f horizons with depth is a dark, greyish-brown loam, brown clay-loam, yellowish light clay which usually grades into reddish, moderately structured clay overlying the parent rock. The structure changes with depth from almost massive to strong, fine, subangular blocky in the red clays. Rock fragments are present, increasing with depth in their size and number.

The soils appear to be derived directly from bedrock, usually Ordovician and Silurian mudstones, whereas the leptopodosals of the flats have been developed on resedimented soil materials.

The analyses (Appendix II, Profiles 312, 314) shoe an increase in both clay and free ferric oxide with depth, but no conspicuous horizon of accumulation. The pH values are about 5 to 5.5, contents of organic carbon decline rapidly with depth, and the carbon/nitrogen ratio is high, as is usual under eucalypt litter.

Available and total phosphorous are low and concentrated in the surface; total potassium is high and exchangeable potassium is adequate.

The cation exchange capacity is high in the surface zone where organic material is concentrated; the exchange complex is partly unsaturated. Exchangeable calcium is adequate at the surface.

(iv) ***Amphipodsols***:- These soils have a gradual increase in clay from the bleached, weakly structured A2 horizon to the prominent, thick lower horizon of strongly structured red clay. The prominence of the latter horizon is the chief distinction from the red leptopodsoils, with which this group is associated at the drier end in thickness with rainfall until, in areas with more than 1020 millimetres rainfall, it usually constitutes the bulk of the profile. The soils differ from Kransnozems in having coarser bleached upper horizons.

The analytical properties (Figure 11 and Appendix II, Profiles 320, 324) are similar to those of the red leptopodsols, except for the greater clay content in the B horizon. This clay has only a moderate cation exchange capacity and a lower base saturation than the leptopodsols.

(vii) ***Cryptopodsols***:- Profiles are brown, well structured and friable, with a slight and gradual increase in clay with depth. There is only a weak bleaching of the A2 horizon because of the masking effect of the high content of organic matter.

These soils grade from the red leptopodsoils and red amphipdsols of drier areas t the acid-brown earths of wetter areas. They characterise the 1300-1400 millimetres rainfall belt in the Howqua land system.

The chemical properties parallel those of the red leptopodsols and amphipodsols, but the content of organic matter in the surface horizons is higher and the profile more leached, as indicated by the values for free ferric oxide.

(viii) ***Meadow Soils***:- Wet valley floors and areas of impeded drainage in the Eildon and Jamieson land systems may carry meadow soils. The profile is grey with ironstone concretions and greying at depth, as indicated by strong mottling of orange, brown, grey and blue. Occurrence is minor and no profiles were sampled.

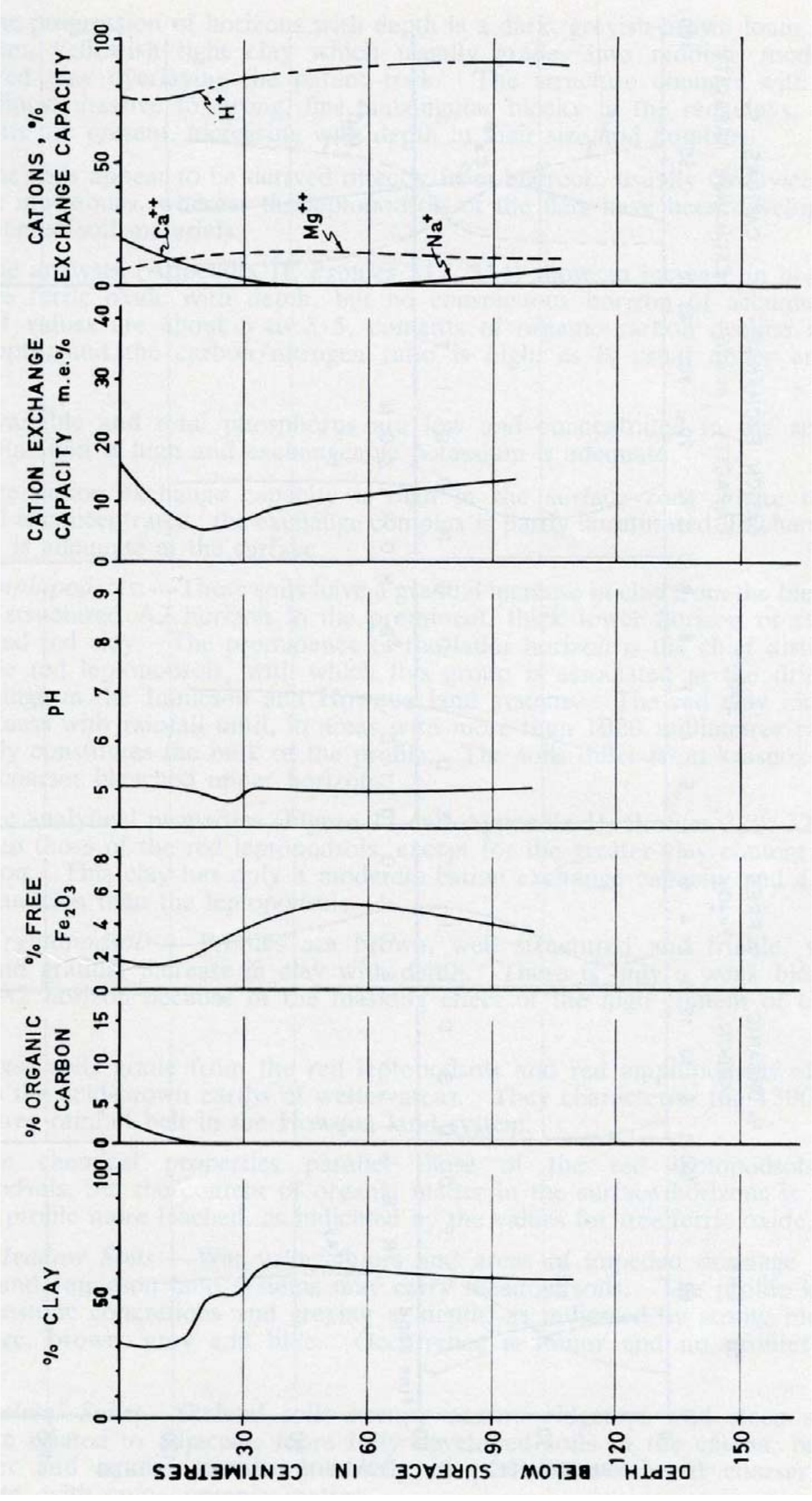

Figure 9 – Analytical Data for Yellow Podzolic Soil (Profile 329)

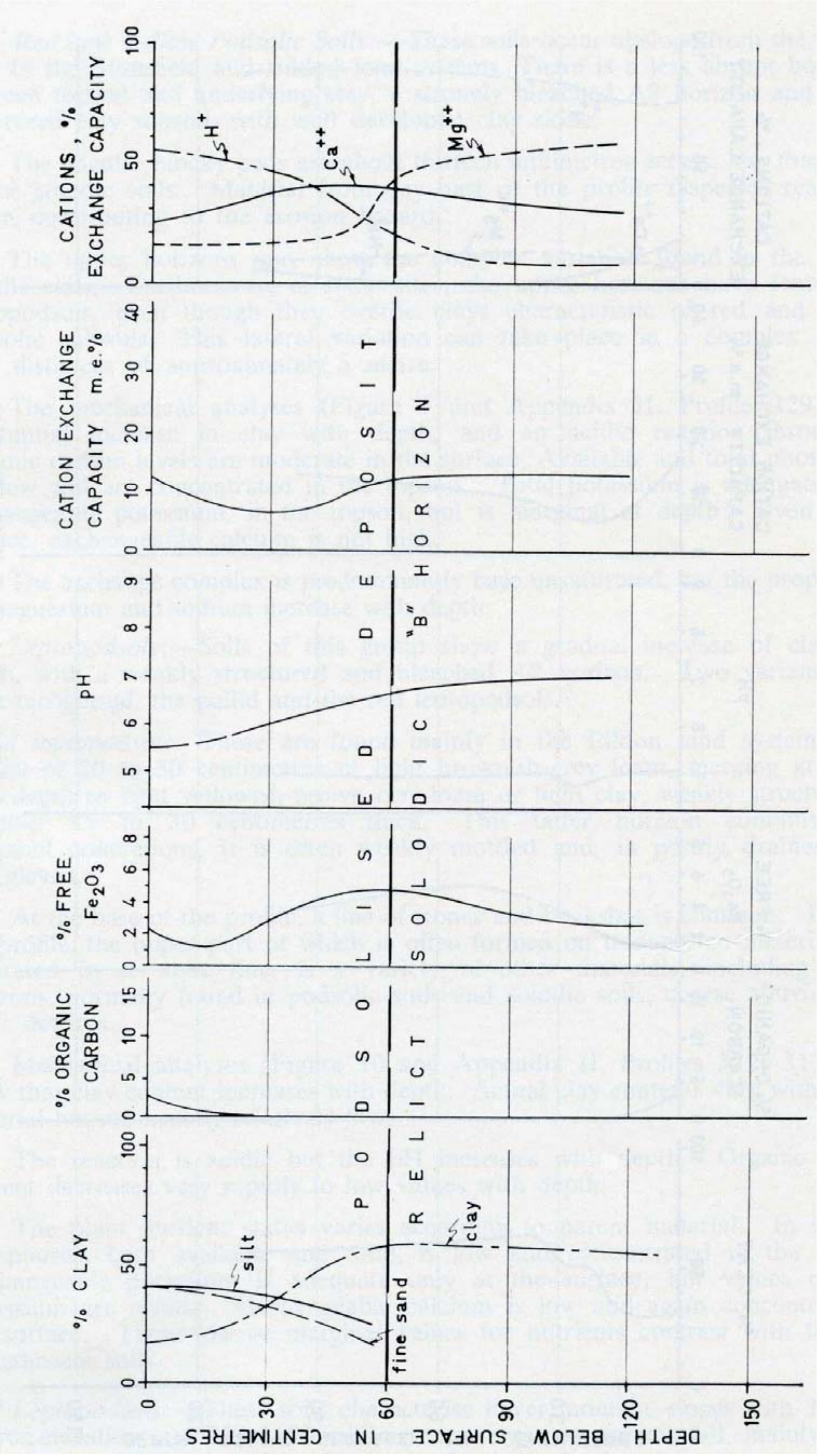

Figure 10 – Analytical Data for Leptopodzols (Profiles 312, 313, 314)

(ix) ***Skeletal Soils***:- Skeletal soils occupy narrow ridgetops and steep slopes. They are related to adjacent, more fully developed soils in the catena, but are shallower and stonier, consisting of partially weathered coarse rock fragments, with some organic matter.

(x) ***Krasnozems***:- These are deep, friable, well structured reddish soils; the texture at the surface is with loam or clay-loam or clay-loam surfaces gradually increasing with depth to light clay.

They are formed from parent materials with a high proportion of calcic plagioclase and ferromognesium minerals, such as basalt, and under rainfalls greater than about 1000 millimetres. In the catchment most areas of such rocks are at high altitude supporting alpine humus soils, but in the Howqua and Jamieson valleys there are tow belts of altered basaltic lavas of Cambrian age. On these tocks, krasnozems have formed at sites with high elevation and rainfall.

(xi) ***Regosols***:- Regosols occur to a minor extent on alluvium and colluvium and show no profile development apart from some accumulation of organic matter at the surface. The alluvial soils are found on the younger stream terraces and deposits resulting from recent erosion along creeks in forested land, consisting of stratified materials of variable texture. The colluvial sands are derived from quartzitic rocks, for example granite and porphyry.

(xii) ***Peats***:- There are no known active fen peats in the catchment. Valley bog peats and raised bog peats (Costin 1954) occur at altitudes above 1450 metres. Living moss overlies raw, undecomposed moss saturated with water, grading down into brown, and finally black, humified peat lying on fossil fen deposits. Where the peat bog is no longer active, the profile consists of brown and black humified peat lying on fossil fen deposits. Where the peat bog is no longer active, the profile consists of brown and black humified peat only.

(xiii) ***Acid Brown Earths***:- These are friable, porous, permeable and well structured brown loamy soils. At depth, the texture increases slightly because of decreasing organic matter, the structure becomes coarser and the colour lighter.

In a typical profile, the surface consists of litter and plant roots, several centimetres deep, overlying a dark brown friable loam, with a very fine crumb structure. With increasing depth, the colour lightens and becomes redder, the texture increases slightly, and eventually the structure becomes coarser. The whole profile is open friable, moist, and permeable. Soil depth is markedly affected by topographic position; on ridges, development may be restricted to 15 to 20 centimetres of fine brown loam under litter, while in deep gullies the material may have been accumulated to a depth of more than six metres above the rock.

There is a wide range of parent materials, thus chemical constitutions are variable. This is enhanced by the presence of partially weathered rock fragments. In moister sites, particularly on granitic rocks, the weathering of rock continues to great depths.

The acid brown earths are intermediate in nature, environment and position, between the drier cryptopodsols and the transitional alpine humus soils of the upper, colder fringe. They are found in areas with more than 1250 millimetres average rainfall below 1200 metres, beneath forests of narrow-leaved peppermint, mountain gum, alpine ash and mountain as (the Howqua, Taponga and Bindaree land systems). Their outstanding ability to absorb water, because of their porosity, friability and depth, is of prime importance in the hydrology of the catchment area.

Chemical features are shown in Figure 12, and in Appendix II, Profile 325. The mechanical analyses show a slight rise in clay in the first metre or so, then a fall, indicating slight clay eluviation. Organic carbon values for the surface are high (9 percent) and persist for some depth. The profile is acidic throughout. Free ferric oxide figures are moderate to high and show a slight waxing and waning, with a maximum at a depth of about one metre. The carbon/nitrogen ratio is high at the surface where partly decomposed eucalypt litter dominates, and is lowest at a depth of fifteen centimetres.

The total and available phosphorous, exchangeable potassium and exchangeable calcium are all concentrated in the topsoil but, even there, none have high values. Total potassium is moderately high throughout.

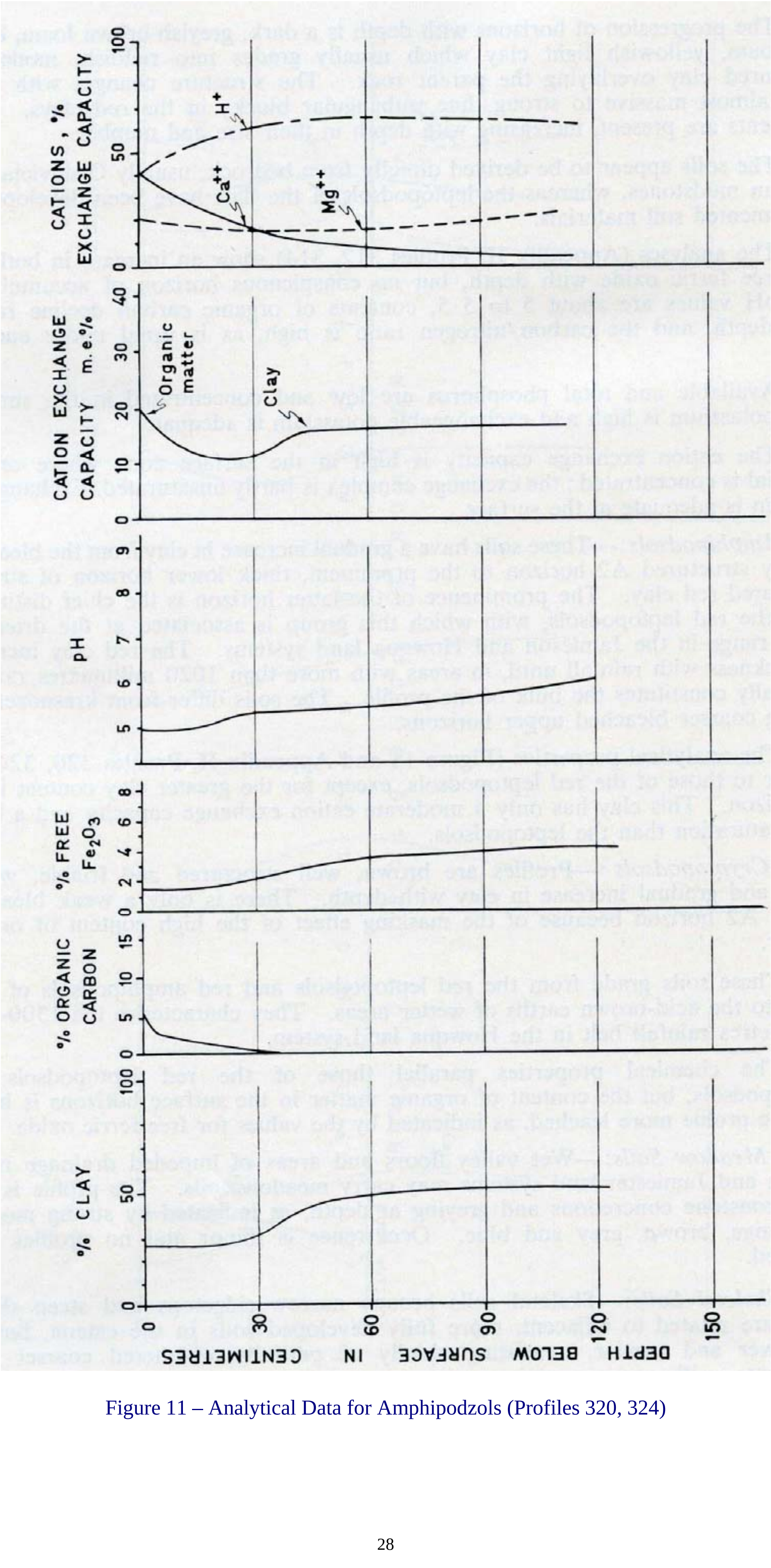

Figure 11 – Analytical Data for Amphipodzols (Profiles 320, 324)

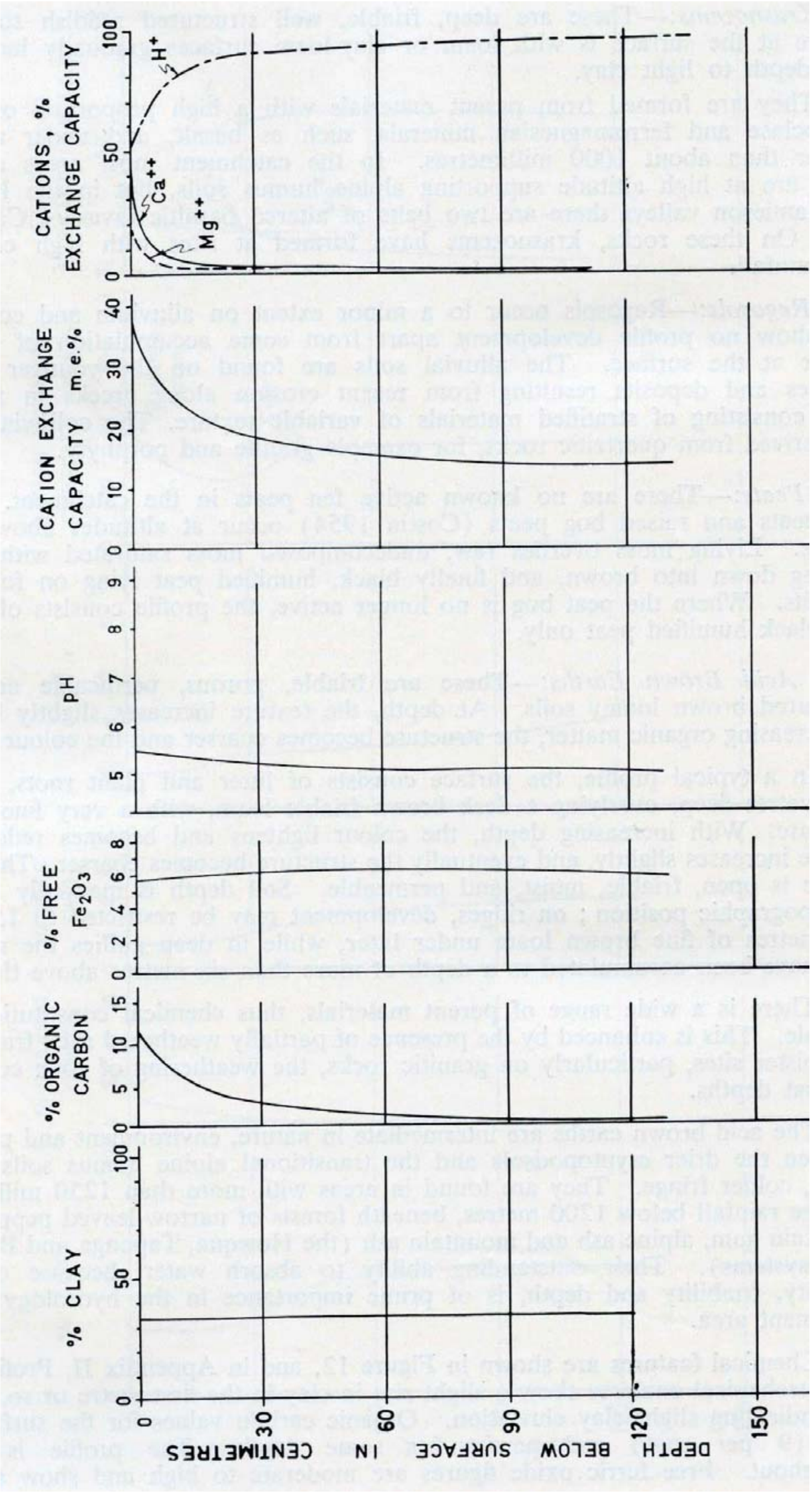

Figure 12 – Analytical Data for Acid Brown Earths (Profile 328)

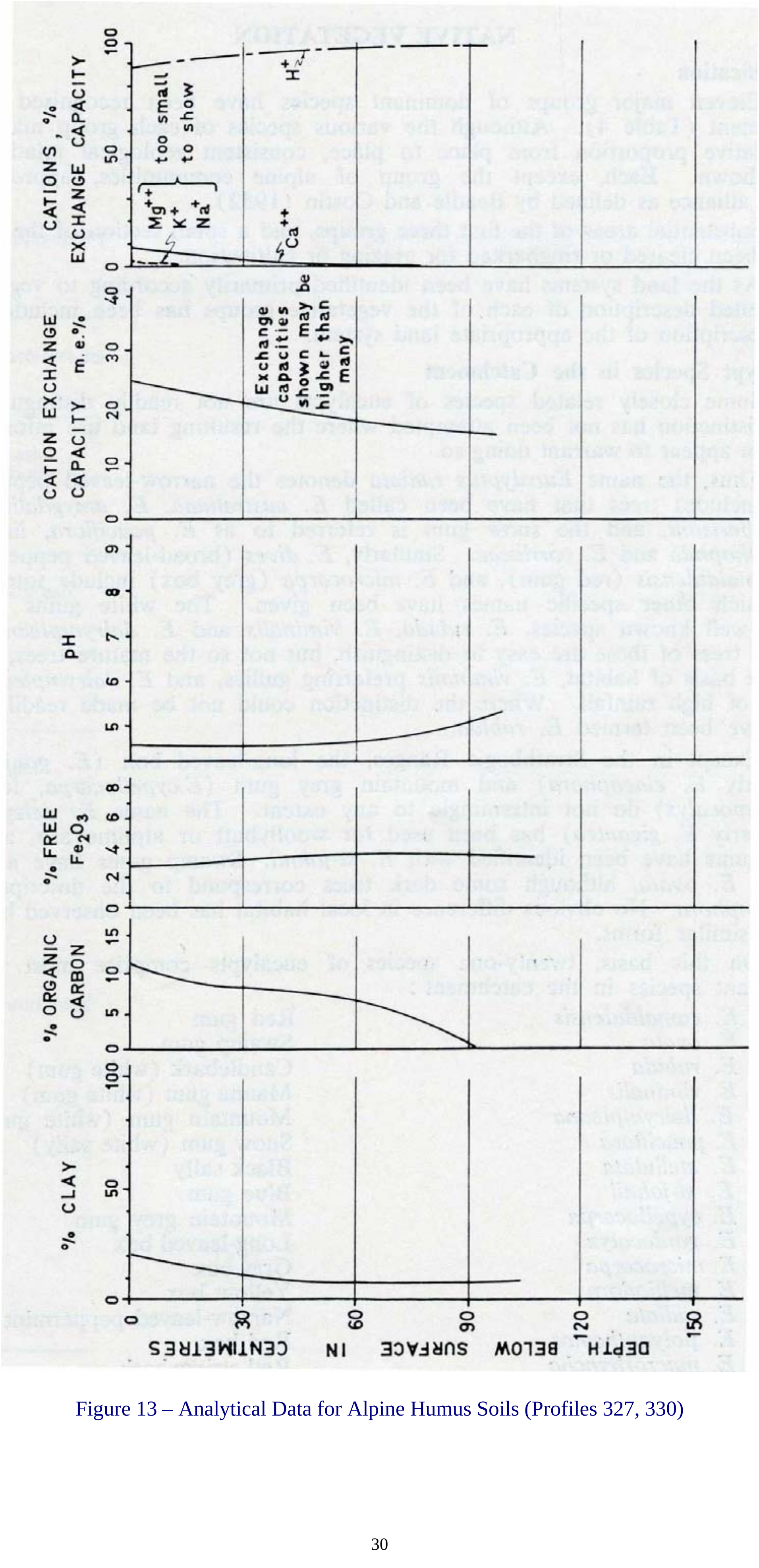

Figure 13 – Analytical Data for Alpine Humus Soils (Profiles 327, 330)

Plate 10 – Acid brown earths are friable, porous, crumbly soils in the narrow-leaved peppermint and alpine ash zones

The cation exchange capacity is high at the surface, largely attributable to organic matter. Beneath the topsoil, the exchange complex is 90 per cent unsaturated. Calcium predominates amongst the metal ions in the topsoil and magnesium at depth.

(xiv) ***Transitional Alpine Humus Soils***:- Profiles show a prominent, dark friable, organic loam with strong, fine crumb structure, thirty centimetres thick, grading with depth into fine brown loam and then into yellowish-brown clay-loam of massive structure. This overlies decomposing parent material.

The group is transitional from the soils at lower elevation to the alpine humus soils in features and environment. It is distinguished from the alpine humus soils by the significant amount of clay derived by chemical weathering of minerals in the B horizon. The chemical characteristics are also intermediate between those of the acid brown earths and the alpine humus soils (Appendix II, Profile 328).

The group characterises the land at the top of the alpine ash zone, at elevations between 1200 and 1350 metres.

(xv) ***Alpine Humus Soils***:- Above 1350 metres, transitional alpine humus soils give way gradually to alpine humus soils. These soils, considered in detail by Costin (1954), consist of a friable, very dark, organic loam topsoil with strong fine, crumb structure, merging through brown loam to yellowish-brown, lightly weathered, unconsolidated rock. Where the base of the profile is marked by a stone line, the profiles are likely to contain much rock, having been formed on detrital material. This will remain as a shingle after deflation of the friable organic and mineral layers, should the soil be eroded.

The chemical characteristics of the group (Figure 12 and Appendix II, Profiles 327, 330) show that, in contrast to other montane soils, the clay content normally decreases with depth. Profiles are very acidic, with reactions below pH 5.0, except on basic rocks. Organic content is as high as 15 per cent at the surface, and continues high to considerable depth.

Values for total phosphorous are moderate, but those for available phosphorous are low. The content of exchangeable metal ions in general is closely dependent on the underlying rock. On the sediments, the values are all quite low, moderate on granite and on basalt markedly higher. Similarly, the cation exchange capacity and degree of base saturation are higher where partially weathered granitic or sedimentary cations at the surface is less marked than in other montane soils.