The Soils in the Old Vineyard at Camden Park Estate, Camden, New South Wales

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In this paper the authors, Tony Koppi and Brian Davey from the Department of Soil Science and Judy Birmingham from the Department of Archaeology, University of Sydney, describe the disturbed soils found in the old vineyard at Camden Park Estate. By comparison with the local undisturbed soil, the vineyard soils appear to have been trenched. The topsoil and possibly organic matter were placed in the bottom of the trench and then the various layers of the subsoil were mixed together and placed on top. Calcareous sandstone fragments, from another place, were mixed into the surface and have raised the pH of some of the soils. The fragments may also have served to protect the grapes from splashed mud. The historical evidence suggests that the preparation of the vineyard was carried out by vinedressers from the Rhine.

INTRODUCTION

The aim of this paper is to describe the soils surrounding the old winery at Camden Park Estate, Camden, N.S.W., and to relate the observations to the historical record of the early settlement of the Sydney region. In particular it will be shown that the area has been trenched to a depth of about 70cm, topsoils and organic matter have often been placed at the bottom of the trench and a mixture of the subsoil layers placed on top. Nearer to the surface lime-rich sandstone has been added to the profile and has altered the reaction of acid soils to alkaline. These changes appear to have been carried out deliberately at the time of establishment of the vineyard *circa* 1821, as a result of observations made by Macarthur during his tour of Europe. The work was probably done by vinedressers who were brought to the colony to aid in the establishment of the wine industry.

We have studied the soil in the old vineyard surrounding the remains of the winery, with its stone wine vats, and have compared it with a nearby undisturbed soil and other well described soil profiles in the County of Cumberland in order to establish the changes caused by the deep trenching of the site. Some laboratory data have also been collected to enhance the picture established by field procedures.

COMPARISON OF DISTURBED AND UNDISTURBED SOILS

Field investigation

The site (Fig. 1) is located on Bringelly Shale,[1] which is the parent material of the Cumberland soil association. Walker,[2] has shown that this parent material, in topographic positions similar to the vineyard at Camden Park, gives rise to Red Podzolic soils on the crests and upper slopes and Yellow Podzolic soils in the lower slope positions.

The reference soil profile examined about 50 metres west of the old vineyard is shown in Fig. 2. The topsoil (30cm deep), is coloured dark brown (Munsell Soil Colour Chart,[3] notation 7.5YR 3/2, moist) by organic matter, has a clay loam texture, a weak blocky structure, and a crumbly consistence. The lower part of the topsoil contains some small shale fragments, and a few small concretions of iron and manganese oxides. While many of the deeper topsoils in the County of Cumberland may be paler in colour than at the surface soil, the topsoil of this profile is the same colour throughout. A marked change in colour and an increase in clay content takes place between 30 and 35cm. The subsoil from 35 to 80cm is a yellowish red (5YR 4/8) medium clay with prismatic and angular blocky structure. Deeper, the colour becomes brownish yellow (10YR 6/6), and the texture decreases to light medium clay as the soil merges into weathered shale. The pH is acid throughout the profile; being about 6.0 at the surface, decreasing to 5.5 in the subsoil and then increasing to 6.5 in the weathered shale. Lime is absent from this profile but is known to occur in the shale at some locations in the south-west of the County of Cumberland. Further descriptions of the Red Podzolic soil may be found in Walker[4] where it is referred to as the Cumberland Clay Loam.

A soil profile from Site 2 (Fig. 3) shown in Fig. 4 is markedly different from the undisturbed Red Podzolic soil. The abrupt change to weathered shale at about 70cm is unusual, as the normal pattern is for the deep subsoil to gradually merge into the weathering shale as reported for the reference profile. We interpret the abrupt change to shale as being the bottom of a deliberately dug trench. The relatively pale coloured strong brown (7.5YR 5/8) weathered shale is of sandy clay texture, has some sandier lenses, and contains more sand than the shale at the reference site. It contains no free lime, but the pH of 8.0 indicates that it is base rich. Immediately above the sharply defined shale boundary there is a thin layer of charcoal overlain by a layer of dark reddish brown (5YR 3/4) organic rich, light to medium clay. This layer is up to 30cm thick and contains pockets of red medium clay. Frequent thin roots are present in the dark reddish brown layer which has a weak polyhedral structure. The moderately moist soil is brittle requiring a moderate force to break a 2cm cube between the fingers. Lime is not visible and pH is 8.5. The 20–30cm of yellowish red (5YR 5/8) medium clay above the layer already described contains pockets of red clay and sandy lenses which may have come from the weathered shale. The structure is weak polyhedral and a 2cm cube of moist soil crumbles with moderate force. Lime is not visible and cannot be found by acid test even though the pH is 8–9. The topmost layer is about 20cm thick and is a dark reddish brown (5YR 3/6) light clay with moderately well developed polyhedral structure and some weakly developed prismatic units. When moderately moist a strong force is required to crumble a 2cm cube of soil in contrast to surface soils which break with a weak force. Frequent fragments of lime-rich sandstone rock from a few millimetres to 1.5cm in diameter, which characteristically effervesce vigorously with dilute HCl, are found throughout

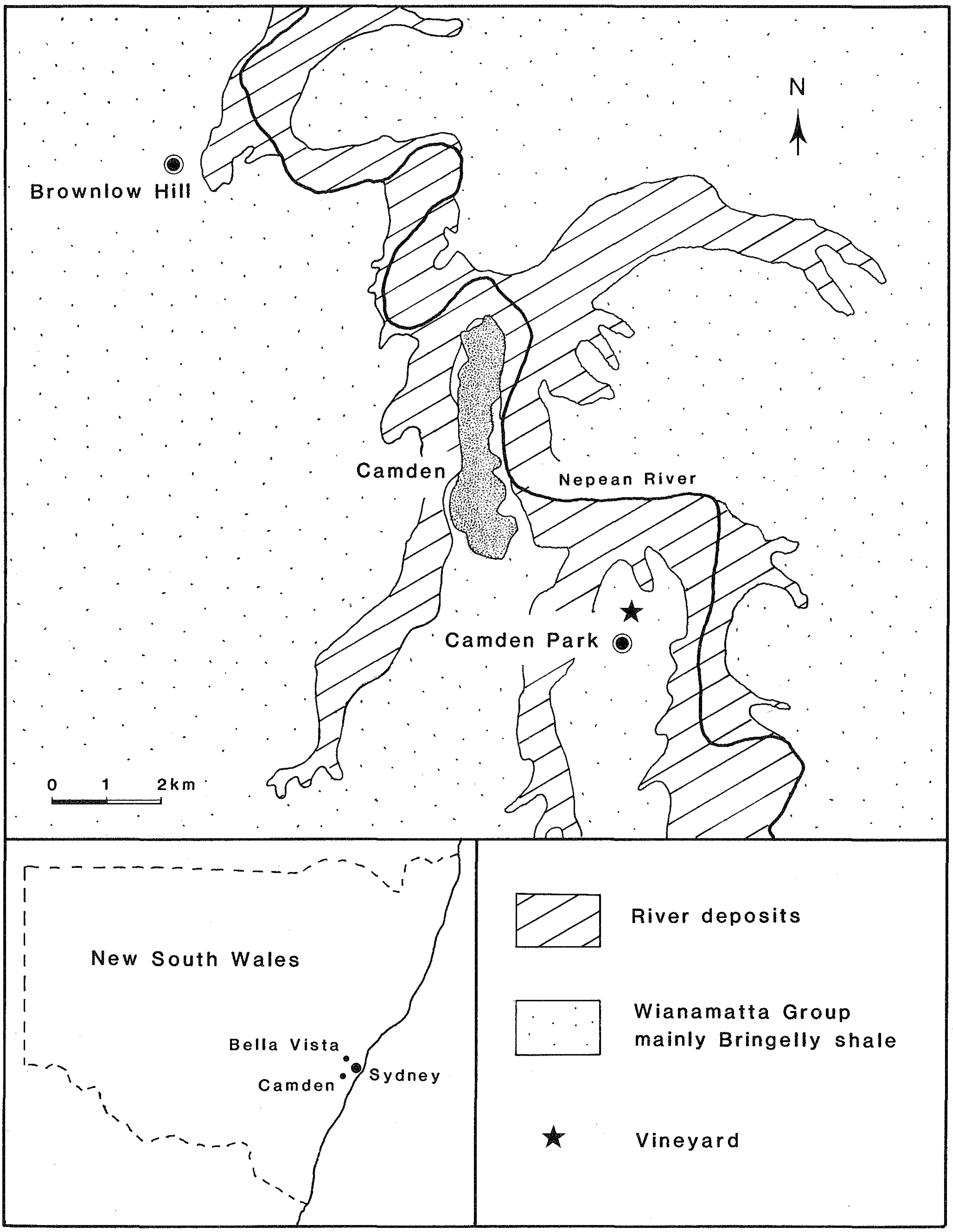


Fig. 1: Location and geology of the vineyard at Camden Park Estate and Brownlow Hill. Bella Vista is also on Bringelly Shale 42km N.N.E. of Camden.

the topmost layer. Non-calcareous rock fragments are also common near the surface and are similar to those dug from the weathered shale and to those found in an old quarry on the estate. There are many roots in the topsoil and the pH is 8–9. As Fig. 4 shows, this profile is highly heterogeneous in nature and contains materials from several of the horizons of the undisturbed soil in close conjunction to each other. This admixture of topsoil, red and yellow subsoil, weathered shale and organic matter has been produced by a deliberate mixing process. In addition lime-rich sandstone has been incorporated into the surface layer.

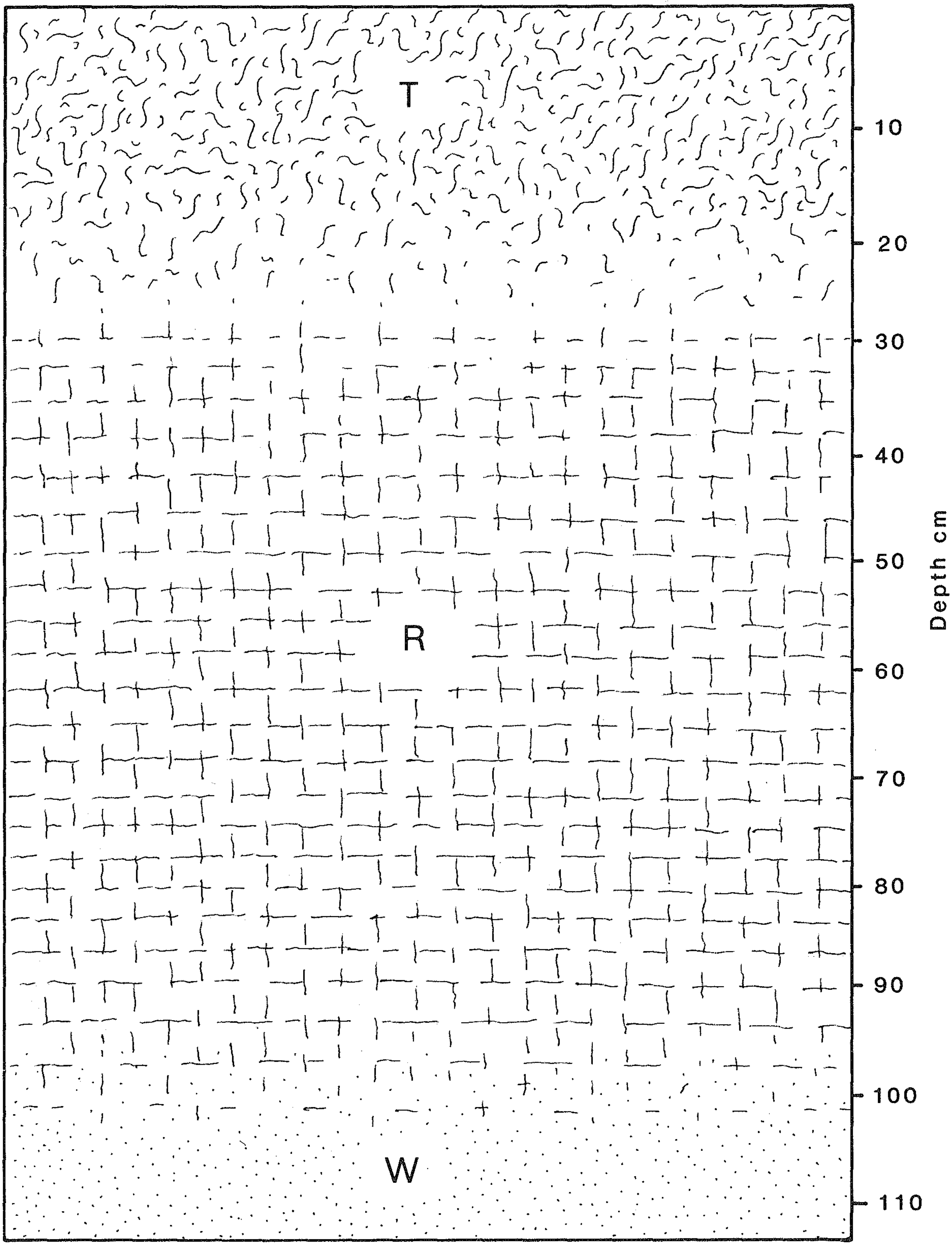
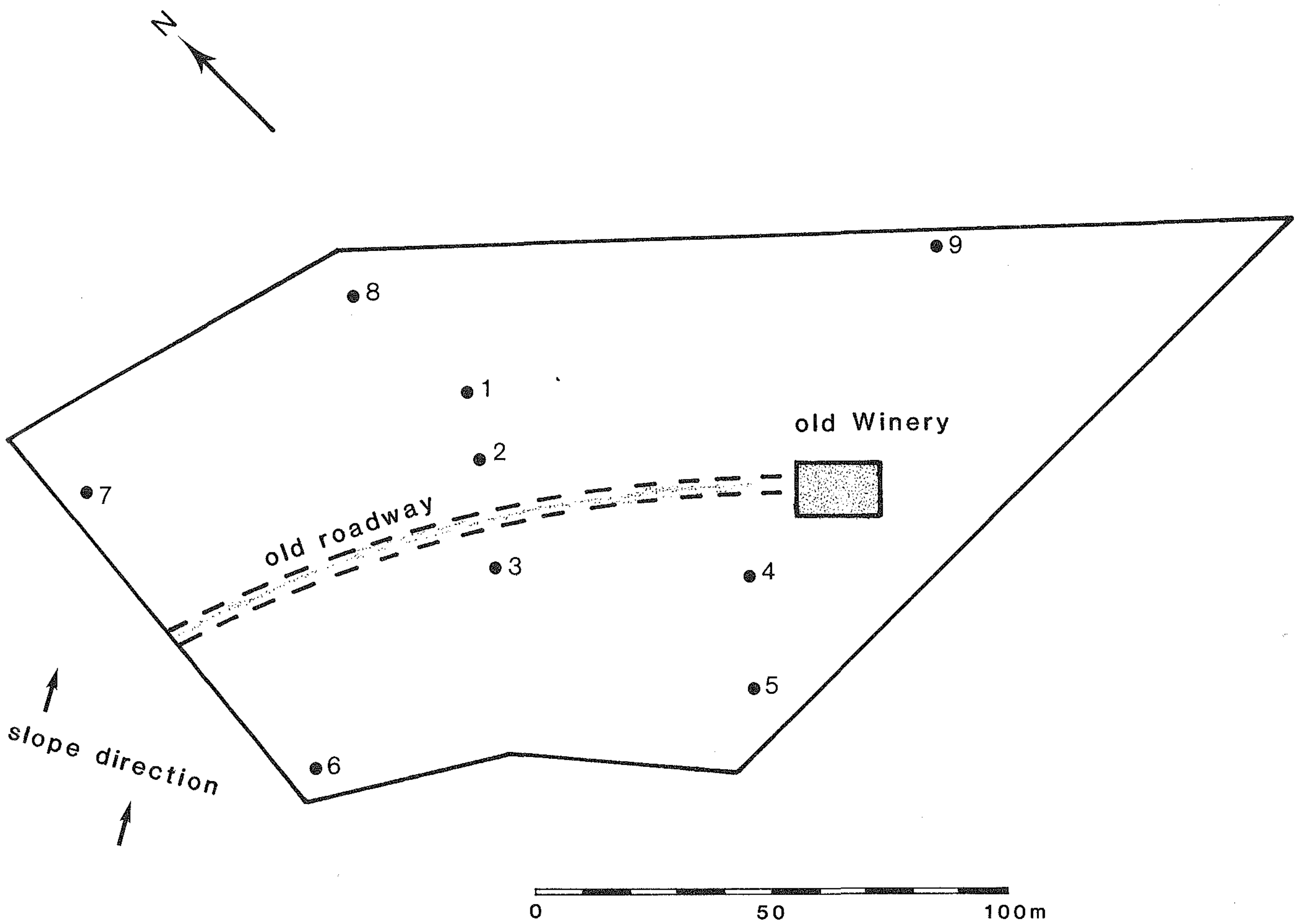


Fig. 2: A sketch of a Red Podzolic soil from Camden Park reference site, developed on Bringelly Shale. The topsoil, T, is shown to merge into the red clayey subsoil, R, which merges into weathered shale, W.

The soils within the old vineyard were examined by auger at eight other sites, as shown on Fig. 3. The material at Sites 1 and 3 generally are like those described for the pit site (Site 2). Site 4 has been trenched to 70cm depth, is light medium clay in texture at the surface with a strong brown (7.5YR 4/6) sandy clay loam between 10 and 30cm. A red (2.5YR 4/6) heavy clay with pronounced organic staining on the surface of the lumps extends to about 75cm, where a sharp boundary to a dark brown (2.5YR 3/2) organic rich, clay loam containing charcoal is found. Immediately below, undisturbed red and yellow mottled medium clay is found which changes to a light clay-textured weathering shale. Small white lumps of free calcium carbonate are found in the surface soil (pH 7.0) and the pH increases to 9 in the buried clay loam surface soil between 75 and 95cm, where rock fragments containing lime are present. The shale at this site is calcareous and effervesces with acid.

At Site 5 trenching has extended to 60cm, where an organic-stained, strong brown, medium clay is found. The pH is 6 at the surface and increases through 7.5 at 30cm to 9 at 100cm;



free calcium carbonate is found at 120cm. Trenching has extended to 70cm at Site 6, where a 25cm-thick organic rich, light clay layer, pH 5.5, overlaid an undisturbed yellowish medium clay of pH 7.0. Some free calcium carbonate is found at 10cm depth.

Rock, too hard to be augered, is found at 60cm depth at Site 7. A sharp boundary at 45cm divides a light yellowish brown (10YR 6/4) fine sandy clay loam from the layer above in which dark brown loam is mixed with lumps of red medium clay. The pH is 6.5 at the surface, 7 at the bottom of the trench and 8.5 at 60cm. The profile at Site 8 shows clear evidence of trenching to 55cm depth, where undisturbed pale white (10YR 8/1) medium clay, pH 9, was found. A 15cm layer of very dark grey organic-rich, light medium clay, pH 9, is found on the bottom of the trench with mixed yellow clay showing organic staining above. Below the white clay layer the soil is light grey and brownish yellow mottled medium clay, pH9. These colours are typical of the Yellow Podzolic soils found in the lower slope positions, as noted by Walker.[5] Trenching extends to 50cm at Site 9 and the surface soil seems to have been more thoroughly mixed through the disturbed soil than at some other sites. The pH is 5.5 at the surface and increases to 9 at 30cm and remains at this value to 120cm. Free calcium carbonate in nodular form was distributed throughout the lower part of the profile.

Stones are found in the disturbed soils at Sites 4, 5, 7, 8 and 9 and pieces of calcareous sandstone are frequently found on the surface throughout the trenched area.

The main features of the vineyard site, compared to an undisturbed soil are: sharp lower boundary; sharply defined pockets of contrasting materials in the subsoil; organic matter in the subsoil; lack of texture contrast between the topsoil and subsoil; more clayey topsoil; red or yellow clay subsoil is not adjacent to the topsoil; lime-rich sandstone rock fragments and nodules are often found in the topsoil; fragments of shale rock very close to the ground surface; soil pH of 8–9. All of these properties are consistent with a trench having been dug, topsoil being placed in the bottom, subsoil mixed with weathered shale then being added, and finally calcareous and other stones being mixed into the new topsoil. The pH values of the acid horizons of the Red Podzolic soil have been raised by the addition of lime-rich rock, and possibly by the ash which contributed the charcoal.

Fig. 3: A plan of the old vineyard at Camden Park Estate showing the location of the winery, road and sampling sites.

The vineyard site on the Camden Park Estate faces north-east with a slope of about 6–8 per cent and is high above the influence of river flooding. The small regular surface benches parallel to the contours are probably the remnants of minor terracing for each vine row. There is no evidence for terrace construction involving stone walls, except for the small wall on the western side of the roadway leading to the old winery, which is made of large pieces of the calcareous sandstone found distributed in the soil. The winery is constructed of a much harder sandstone which shows no evidence of being calcareous.

Laboratory properties

A profile representative of the undisturbed Red Podzolic soil on Bringelly Shale was chosen at Bella Vista, 42km N.N.E. (near Blacktown) of Camden Park (Fig. 1), and sampled by auger for laboratory analysis and compared with the reference profile from Camden Park. Three profiles from the Camden Park vineyard were analysed for comparison, and form a transect from the lower to the top part of the site as Fig. 3 shows.

The five profiles were analysed for particle size (clay less than 2 µm; silt 2–20 µm; fine sand 20–220 µm; coarse sand

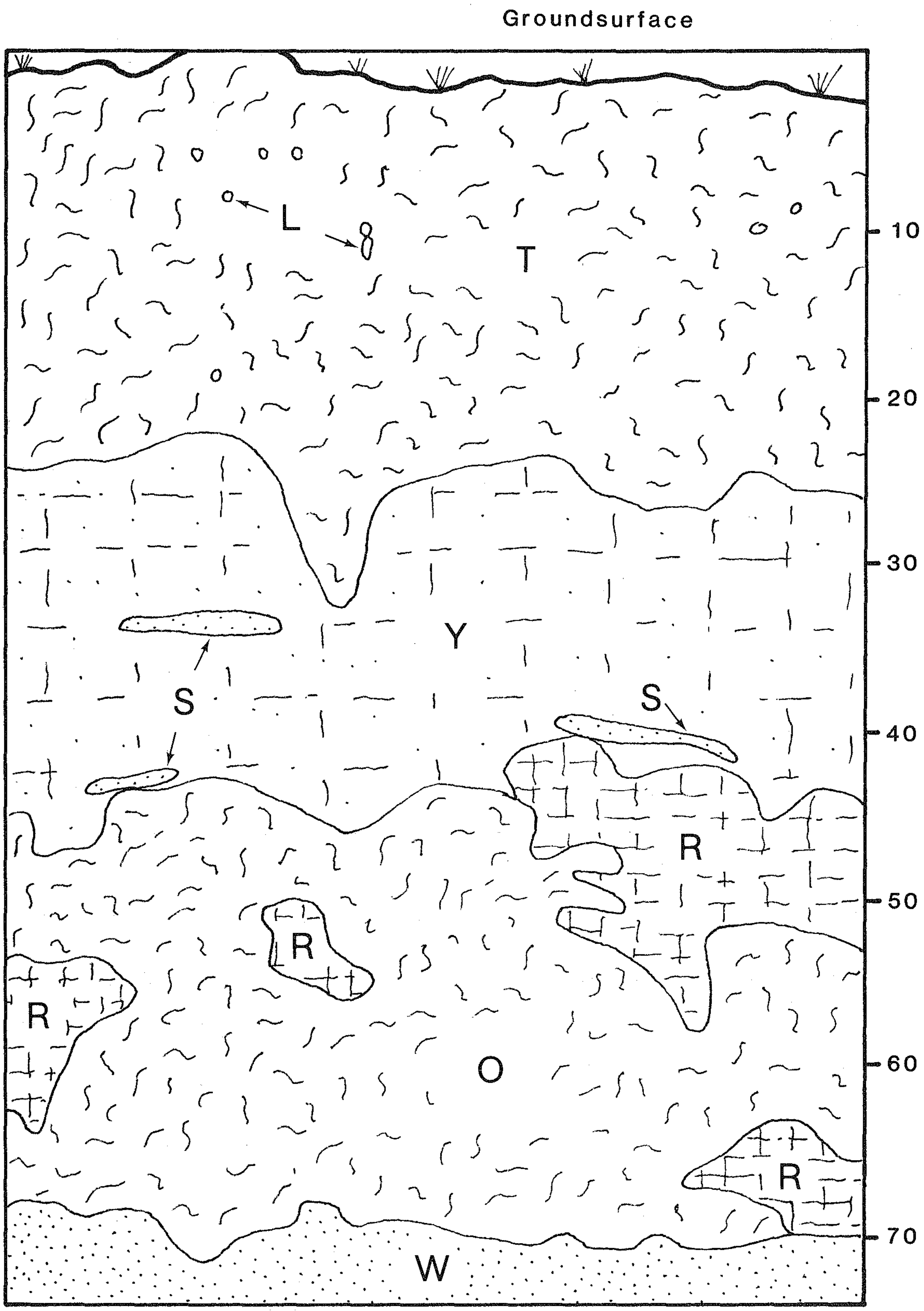


Fig. 4: A sketch of the profile at Site 2, showing: T, topsoil; L, limestone; Y, yellowish red clay layer; S, sandy lens; R, red clay; O, organic rich layer; W, weathered shale.

200–2000 μm) by a routine method based on that given in Day[6] and for organic carbon by a method based on McCleod.[7] Results are presented in Table 1. The results for Bella Vista are comparable to those given by Walker[8] for the Cumberland clay loam. The clay values for Bella Vista show a marked increase from 37 per cent to 74 per cent at about 22cm where the clay subsoil begins. A smaller increase in clay content occurs in the reference profile, and fine and coarse sand are higher. Both profiles fall within the ranges of values defined in Walker.[9] This distinction is not shown by the Camden Park profiles (Sites 1–3), although there is less clay in the three topsoils than the subsoils. A comparison of the coarse sand values of the five profiles shows that much more coarse sand is present in the topsoil of the vineyard soil. The lower and middle profiles (Sites 1 and 2), which were sampled deeper than the top profile (Site 3), have similar coarse sand values

Table 1: Analytical results from an undisturbed Red Podzolic soil and three profiles from the vineyard site.

Location	Depth (cm)	Clay (%)	Silt (%)	Fine Sand (%)	Coarse Sand (%)	Organic Carbon (%)
Bella Vista (Undisturbed)	0–8	17.1	58.9	20.4	3.25	1.53
	8–21	36.8	45.6	41.6	3.8	0.85
	22–26	73.9	7.7	16.5	17.6	0.79
	43–45	72.0	12.5	14.0	1.3	0.46
	65–68	61.8	14.2	16.8	2.1	0.29
	100–103	57.2	17.4	23.6	1.4	0.18
Camden Park Reference (Undisturbed)	0–10	19.8	23.6	44.7	12.0	5.30
	10–20	30.7	22.2	39.1	8.0	1.62
	30–40	51.9	15.6	26.0	7.4	1.00
	40–60	51.9	17.3	24.2	7.0	0.73
	60–80	51.1	17.7	23.7	7.2	0.48
	90–100	38.0	18.8	26.8	16.4	0.45
	100–110	27.6	21.5	32.7	18.7	0.32
Camden Park Site 1	0–5	32.6	9.6	22.4	35.6	6.15
	5–12	38.6	10.6	22.9	27.5	2.66
	12–30	39.6	13.5	22.9	24.0	—
	30–45	39.7	15.7	20.6	24.0	0.50
	45–60	35.2	16.0	23.2	25.8	1.84
	75–90	25.6	15.3	26.9	32.3	0.39
Camden Park Site 2	0–5	17.3	39.0	15.2	28.5	7.0
	5–20	36.9	13.4	28.6	21.1	1.3
	20–40	42.9	11.0	28.0	18.3	0.46
	40–50	40.1	27.8	28.5	3.6	0.96
	60–90	46.3	11.5	32.1	22.1	0.32
Camden Park Site 3	0–5	21.2	16.5	40.8	20.9	4.95
	5–15	38.6	11.3	24.7	20.4	1.94
	15–45	56.0	8.6	7.5	27.9	1.90
	45–50	45.3	15.7	32.3	6.7	0.69
	50–65	46.3	13.2	30.5	10.0	0.72

at depth to the topsoil. The middle and top profiles (Sites 2 and 3) have similar coarse sand values in the lower part of the soil to the topsoil of Bella Vista. The higher amounts of coarse sand at Camden Park Estate were inherited from the shale and the higher values in the surface soil of the old vineyard reflect the way in which the weathering shale has been mixed with the clay subsoils. Few differences can be seen between the four profiles for silt and fine sand, except that the topsoil at Bella Vista is more silty than the other profiles.

The organic carbon values for Bella Vista show the typical trend for Podzolic soils in that the organic matter (i.e. organic carbon × 1.7) content of the topsoil is not very high and there is a gradual decrease with depth. The disturbed and reference topsoils at Camden Park are far higher in organic matter than normal Red Podzolic soils, and this is probably due to the dense mat of roots. The organic matter values for the Site 1, 2 and 3 profiles are all higher at depth than undisturbed sites, and the middle and lower profiles (Sites 2 and 1) show a distinct increase in the lower part of profile.

These laboratory data are consistent with topsoil having been placed at depth in the profile, and the coarse textured material having been brought from depth and mixed throughout the soil.

Because the Site 2 pit at the vineyard was unusually hard to dig at the surface, bulk density was also measured. Values are compared with the soil from Brownlow Hill in Table 2. The Brownlow Hill soil shows the normal trend with the surface having the lowest density which gradually increases with depth. The vineyard soil has a high topsoil density which is similar to the subsoil. Porous soils with low density are

Table 2: Bulk density values from the vineyard profile and the Red Podzolic soil from Brownlow Hill.

Vineyard		Brownlow Hill	
Sample depth cm	Bulk density ($g\ cm^{-3}$)	Sample depth cm	Bulk density ($g\ cm^{-3}$)
3–8	1.51	0–16	1.38
25–30	1.60	16–56	1.56
65–70	1.50	56–90	1.62

normally desirable for cultivation (as advocated by Busby[10]). The treatment given to the vineyard soil has resulted in a considerable reduction in porosity at the surface, relative to undisturbed soil. It is not possible to ascertain how long this condition has existed or how it might have influenced use of the site since 1821. We now know that the deep subsoils of these Red Podzolic soils are often high in sodium, which promotes instability leading to high density. It seems that this material, initially made 'open' at the surface by trenching and mixing, has reverted to its original condition of high density, defeating the intent of Macarthur's deep cultivation programme. Soils high in sodium are rare in England and in Europe, where most of the glacial soils are of coarser texture and more freely drained, resulting in leaching of sodium. This event at Camden Park represents one of the many encounters the new settlers made with soils having properties foreign to their previous experience.

HISTORICAL SURVEY OF VINEYARD PREPARATION METHODS

This section is based on the writings of Busby[11] and Macarthur.[12] We know that prior to cultivation the soil of the vineyard site had a medium to heavy clay subsoil, like that found in the reference profile, and Busby[13] notes that soils such as these are improper for the vine. He implies that all clayey soils are the same (which is not true) and provide adverse physical conditions for root growth. Macarthur[14] also notes that wet clayey situations are unfavourable to the health of the plant and both authors note that the soil should be freely drained and porous. Modern thoughts are similar in that, for grapes, heavy poorly drained clays should be avoided.[15]

Busby[16] and Macarthur[17] comment on the importance of stones in the soil to keep it 'open' and a bed of stones on the surface to help with water infiltration (thereby controlling erosion), to retard evaporative losses, and to improve surface temperature conditions. Macarthur[18] also notes that the stones keep the low-hanging grapes from being splashed with dirt during rain. It was also thought that calcareous soils were favourable to the vine.[19]

The slope of the land is of some importance, and in general a gentle slope is better than a steep one.[20] If the slope is considered too steep then terracing was advocated by Macarthur.[21] This consisted of making wide, near level steps down the slope, with the rise of each step being supported by a stone wall. The most desirable aspect for slopes in N.S.W. was north-easterly, because as Busby[22] notes, the greatest enemy of vegetation is the hot westerly winds. The chosen aspect also favours early warming of the soil in spring and provides shelter from the cold south-westerly winds. The elevation of the site favours air drainage and would therefore limit the effect of late heavy frosts on fruit set.

When the climate, slope and aspect were favourable, a loose and open structure was thought to enable deep root penetration. If this was not the case then trenching was advocated.[23] Because of droughts in the Colony, Busby[24] stresses that in most cases trenching was indispensable to the health and longevity of the vines. Trenching was described by Busby[25] as an inversion of the soil to 2 or 3 feet (60 or 90cm) in a trench 2.5 to 3 feet (75 to 90cm) wide at the bottom. The whole soil should also undergo a thorough mixing, with a little manure being added whenever possible. Macarthur[26] adds that if the soil is clayey then stones should also be intermingled. Trenching has been a long-established practice in Europe. In the past large areas were cultivated by this method, which is now far too costly because it is so labour intensive.

CONCLUSIONS

The following sequence of events are proposed for the vineyard site.

1. The vineyard site was trenched to about 70cm depth prior to the planting of vines. This process probably involved filling an open trench with adjacent soil, organic matter and stone and resulted in partial inversion and mixing of the horizons of the undisturbed soil profile.
2. Charcoal, topsoil, and possibly manure were placed in the bottom of the trench. Often some red and yellow clay subsoil was accidentally mixed in. It is possible that the charcoal at depth in the soil originated from the initial clearing of the land.
3. The red or yellow medium clay subsoils were then mixed with the sandier weathering shale and added to the trench, on top of the topsoil, organic matter and so on.
4. Rock fragments, probably taken from the weathered shale in each trench, were mixed with calcareous sandstone fragments carted to the site, and some organic material (possibly manure and other vegetable matter) to form a new surface soil.
5. Dissolution of the calcareous rock fragments and the nodules raised the pH of the acid soil horizons to high values.
6. In time the topsoil has become relatively dense.

The source of the calcareous rock fragments is not established, but they were not obtained from the estate itself because the only known quarry is located in non-calcareous shale. It is know that the sandstone columns for the house verandah were quarried from Brownlow Hill. It is therefore possible that calcareous sandstone which crops out near Brownlow Hill was brought to the site. Calcareous sandstones are not uncommon in the south-west of the County of Cumberland.

The enterprise was certainly a success, for Hood[27] in 1843 wrote of 10 acres of the most beautiful vineyard at Camden Park Estate, managed by a colony of vinedressers from the Rhine area of Germany.

NOTES

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