DESCRIPTION OF A RENDZINA FROM WARIALDA, NEW SOUTH WALES

R.A. Patterson
University of New England, Armidale, N.S.W.

ABSTRACT

A rendzina at Warialda, New South Wales, is described as a shallow black to brownish black (10YR3.1) silty loam of very Fine crumb and loose consistency, overlying at depths from 200 mm a dull yellowish brown to light grey soft marl. The marl was examined to depths of 4.5 metres and varied from 7% to 80% carbonate as determined by the Rapid Titration Method. Stratification of the carbonate occurred as many distinct colour horizons, consistent with deposition in a lacustrine environment. Microscopic examination of the calcareous horizons indicated the carbonate material was not concretionary or of biological fom, but had precipitated into the pore spaces of the acid porphyritic lithic fragments,

The chocolate soils derived from Tertiary alkali-olivine basalts above the marl have a carbonate content less than 5% by weight and are not capable of producing the known deposit of marl. The fine grained sandstones, below the marl, were examined in thin section to reveal secondary deposition of carbonate in a matrix of arkose fragments. Thus evidence indicates that the soil formation was influenced by the underlying marl on the colluvium derived from upslope chocolate soils.

A reconnaissance survey revealed a similar rendzina 6 km to the North at the same altitude of 630 m A.S.L. while other deposits are known to exist to the East. Rendzinas of the Darling Downs may be similarly related.

1. INTRODUCTION

Rendzina is the term used in all countries except the United States to describe a shallow black to very dark grey soil, of medium to fine texture overlying a calcareous parent material. The term Rendoll is used in Soil Taxonomy. Rendzinas are universally distributed in the more humid areas where they appear as thin mantles of soil weathered from limestone. In Hungary and Austria they have developed from hard Tertiary limestones, whereas in England and America equivalents have formed on calcareous chalks and marls.

The Australian distribution of rendzinas has been documented for the Lower South East of South Australia (Stace, 1956), the Murray Basin Mallee soils (Prescott, 1952) and the Darling Downs of Queensland (Reeve et al., 1960). The Adelaide region has a variety of calcareous parent material including Miocene marine limestones, loessial limestones, weathered calcareous slates and colluvium enriched by solution and redeposition of loessial lime, Groundwater rendzinas are also promoted by contact with calcareous groundwaters and water logging conditions,

In the Kurrawa area of the Darling Downs of Queensland, Beckman and Thompson described Yargullen Clay as a rendzina. It is a very dark brownish grey soil with a 200 mm very fine granular surface overlying a marly clay of up to 60% carbonate. The marl continues to a depth of 3 metres without apparent change,

Rendzinas have developed on soft calcareous parent materal as a result of the weathering processes, although the calcareous horizon has a chemical buffering effect which slows down the rate of weathering, No complete Peaching is possible because of the flocculation of the clay and humus colloids by the calcium ions. The development of differentiated A and B horizons has not been possible. A granular to crumb structure and stable aggregates are also imparted due to the saturation influence of the colloids by calcium, hence the overall stability of the profile.

Stace (1956) considers the presence of a shallow black soil overlying a calcareous horizon as a rendzina, whether the calcareous horizon is the parent material or not. He emphasised "associated with" as implying that there may not be a pedogenic association between the shallow soil and the marl. This is contrary to the overseas descriptions.

From an agricultural point of view, the rendzina represents the period when soil and vegetation are in optimal conditions, The organic matter content is high (4-6%) and the soil microflora populations numerous. The structure of the soil (crumb to granular) aids the infiltration of moisture and enhances cultivation operations. The shallow profile, however, limits the available moisture reserves. The disadvantages of such highly calcareous soils are that they require large quantities of single superphosphate (300 kg ha^{-1}) to overcome the loss through complexing of P with Ca, and micronutrient problems with Mn, Cu and Zn are a serious concern because of the high pH (8.5-9.0).

2. THE STUDY AREA

Warialda is situated on the Gwydir Highway between Inverell and Moree, and 100 km south of the Queensland-New South Wales border town of Goondiwindi. At an altitude of 400 metres (A.S.L.) it is on the North West Slopes of the New England Tablelands. Warialda experiences cold winters and warm to hot summers with variation from -8" to *44°C* throughout the year. The average annual rainfall is 680 mm with a definite summer dominance. The rendzina described in this report was located on the McMaster Research Station, a property owned by the University of New England, approximately 30 km North of Warialda on the North Star Road. This is represented in Figure 1 below. The survey site was on an eastern-facing slope of three percent grade, midway up the slope between a lower Black Earth and ridge capping of Chocolate soil. The land was under cultivation for a summer crop of oats and had been extensively contoured to allow continual cropping.

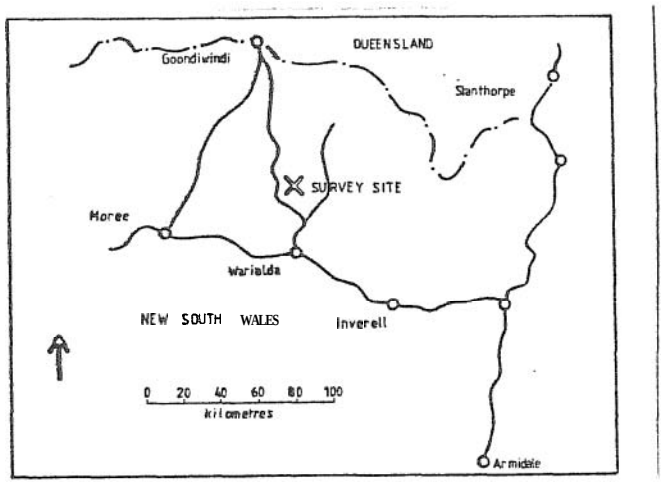

Figure 1: Locality map of Warialda, N.S.W.

The geology of the area consists of a basement of Palaeozoic rocks and the New England granitoids, intersected under Warialda by the North South Peel Fault. Overlying are the sediments of the Jurassic-Cretaceous Surat Basin. During the mid Tertiary two periods of volcanism, separated by an era of intense tropical weathering, produced basaltic outpourings. Today, the Tertiary basalts exist only as cappings to the occasional ridge. The river valleys are Quaternary alluvium typically of Black Earth,

3. METHOD OF SURVEY

A reconnaissance survey located the rendzina in areas as widely separated as six kilometres. The site chosen was considered representative of the general landscape on which the rendzinas were typically located as described above. A soil pit was dug to provide a full 1.2 metre profile description. A soil auger description was undertaken to a depth of 4.5 metres. Additionally, *27* individual 1.8 metre deep auger holes were taken at a horizontal spacing of 20 metres along a cross-section of the slope.

The field description was followed by a laboratory analysis of: pH using 1:5 soil water; rapid titration evaluation of carbonate; soil moisture using oven dry weight analysis; evaluation of organic matter using Walkley-Black method; atomic absorption spectrometer analysis of calcium and magnesium of the rapid titration supernatant and mechanical analysis of particle size by hydrometer method. The carbonate was removed from 100 grams of the soil by reacting with 1M HCL over a period of ten days, replacing the acid daily and continuing until all effervescence ceased.

Carbonate samples were examined microscopically for biological remains, The solid remains from concretions digested in hydrogen peroxide and concentrated HCL were also examined,

4. RESULTS

4.1 Soil Reaction

Soil reaction was recorded at values of 8.6 in the surface horizons, 9.0 at depths of 0.5 to 2.8 metres and returned to 8.7 at greater depths. The higher carbonate level is responsible for the higher alkaline levels.

4.2 Organic Matter

The graph below, Figure 2, illustrates the increased level of organic matter averaged over 16 samples of 2 metre deep borings. The surface soils (0-400 mm) had between 1.0 and 2.3% organic matter (Walkley-Black) with an average of 0.7 for the remainder of the soil profile.

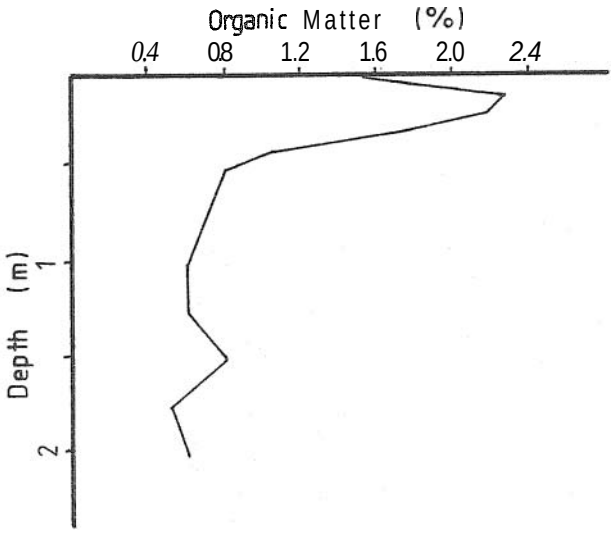

Figure 2: Organic Matter content with depth,

4.2 Colour

The Munsell colours were assigned to the 4.5 metre boring at each change in colour. Appendix 1 details the results from which it is

obvious that there is a pattern repeating itslef in the white layers at 1250 and 4250 mm. The subtle changes in colour are consistent with depositional layers,

4.3 Carbonate Content

An accuracy of 1% has been quoted by Piper (1947) in soils having up to 50% carbonate content when using the Rapid Titration Method. A cross reference was made by calculating the loss in weight of the soil sample under acid treatment. The residue in each case indicated a lower percentage carbonate by 10%. Basalt rocks, sandstone and carbonate concretions were powdered and completely digested in hydrofluoric acid. Analysis of the supernatant indicated a 5% and 13.7% carbonate level in the basalt and sandstone respectively.

Figure 3 indicates the carbonate percentages to a depth of 4.5 metres. The peaks at 1 and 4 metres coincided with a very white to light grey colour (7.5YR8.1). The method of determination was by Rapid Titration.

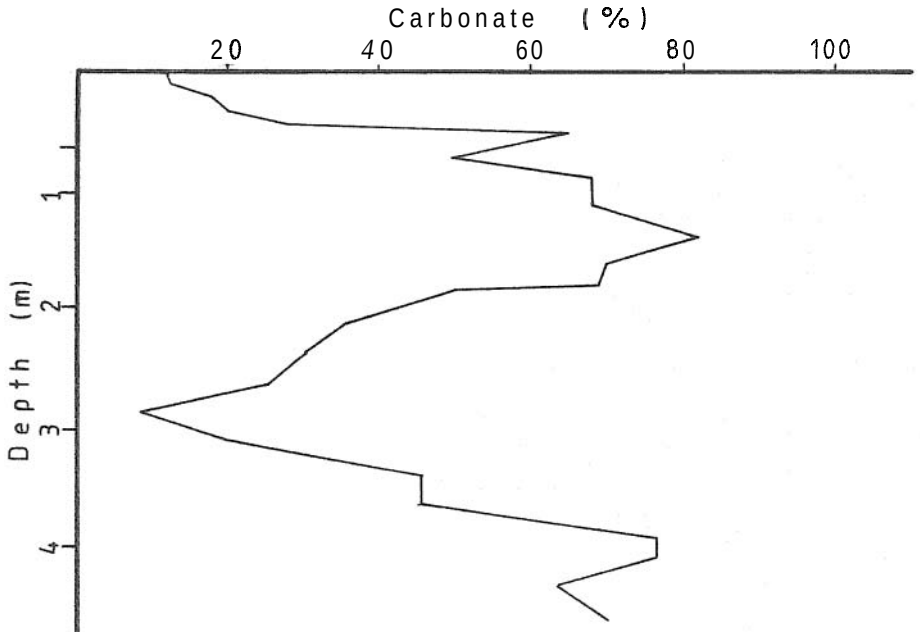

Figure 3: Carbonate content with depth.

4.4 Mechanical Analysis

Mechanical analysis of the samples taken at 250 mm intervals to a depth of 2 metres proved difficult to separate because of the problems of removal of carbonate. While the field texture indicated a medium clay surface (Ap), laboratory analysis lead to a silty loam. However, after rain, the surface soil was as sticky on the rendzina as on the black earths downslope, indicating the fineness of the texture.

4.5 Microscopic Analysis

A microscopic examination of random samples from the profile failed to identify any animal castes, remains or shells, The carbonate material was not concretionary but appeared to have filled the pore spaces without adhering to the fragments, There was no evidence of the carbonate strongly cementing the fragments together.

The sand fraction of the mechanical analysis was composed of fine grained quartz bearing lithic fragments with the appearance of acid porphyritic igneous or pyroclastic material, The possible origin of these fragments was from a volcanic source. Garnets were visible as both free grained and incorporated with the feldspathie fragments.

The results of thin section examination of the underlying sandstones indicate that the carbonates, some siderite, are secondary deposition in arkose fragments deposited after the initial sedimentation. The time of the precipitation cannot be estimated except that it was pre-basalt.

4.6 Calcium Magnesium Ratio

The Ca/Mg ratio was determined by atomic absorption methods using the supernatant from the rapid titration. The magnesium ion concentration of 0.5 mg/l in the Ap horizon was the lowest in the profile, increasing to 7.6 mg/l at 1.25 m while averaging 5.4 mg/l below 400 mm. The graph below, Figure 4 illustrates the changes with depth. The greater solubility of magnesium carbonate (10^{-5}) compared to calcium carbonate ($5x10^{-9}$) is reflected in the high surface Ca/Mg ratio.

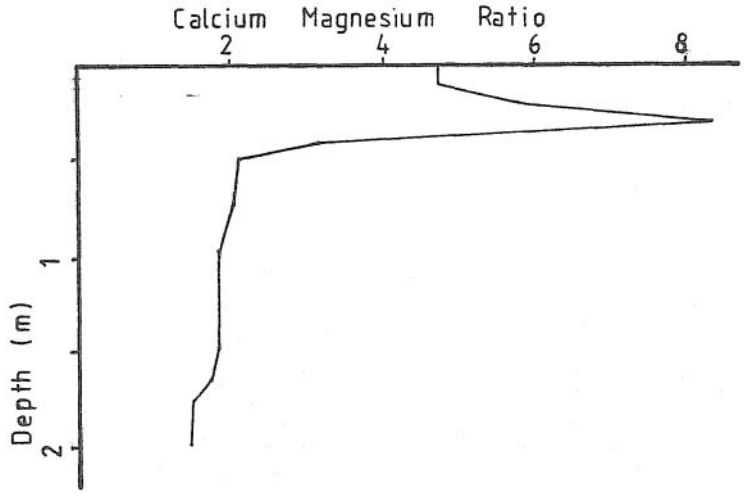

Figure 4: Calcium/Magnesium Ratio with depth.

5. DISCUSSION

The evidence suggests that while the soil may be influenced by the underlying marl, it has not been derived from it. The black to brownish black A and B horizons have originally been derived from the basaltic material upslope. Chocolate soils, both shallow and normal have resulted from the weathering processes of the Tertiary basalt capping, Erosional phases have caused. the chocolates to move downslope.

On the midslope where the rendzina occurs, there has ken a flocculation of the organic colloids (calcium saturated) due to the presence of the underlying carbonate. No carbonate exists in the chocolate.

The Tertiary basalts of Warialda are alkali-olivine with an equivalent calcium carbonate content of 5%. It is unreasonable to consider that erosion of the basalt surface could produce a calcareous material at least 19 metres thick. Further the acid porphyritic fragments of the calcareous material and the absence of basaltic minerals suggest an origin of sedimentary material before the Tertiary basalts. The lithic fragments are angular and subangular, indicating that they were produced from *a* nearby source, and not moved over a great distance as would be necessary from a basaltic source.

At some time before the Tertiary a Large lake had formed, the source of which was to the East which is consistent with the slope of the sandstones as described by Bourke (1980). The input was high in carbonate and precipitation occurred, Increasing intensities of input added silt and clays, while fluctuating inputs produced various colour Payers. These layers are visible in the material today. These colours are detailed in Appendix 1.

Not knowing the depth or attitude of the carbonate layer or its basement rock prevents further speculation. The reconnaissance survey provided evidence of a lateral extent of at least six kilometres north south and a roughly horizontal surface. From the cross-sectional survey it is estimated that the minimum depth is 19 metres made up of numerous layers of visibly different coloured sediments.

It can only be estimated that the possible genesis of the rendzina is according to the cross-section below (Figure 5). In the figure three geological strata are placed in context, the basalt and sedimentary material being separated by the carbonate layer of unknown thickness. As the weathering processes have occurred over time, the colluvial material has been subjected to the influences of the calcareous material. Thus the black earths in the alluvial valleys have a high carbonate content derived from upslope, but that the midslope soils have been subjected to and influenced by the calcareous layer but not derived from them.

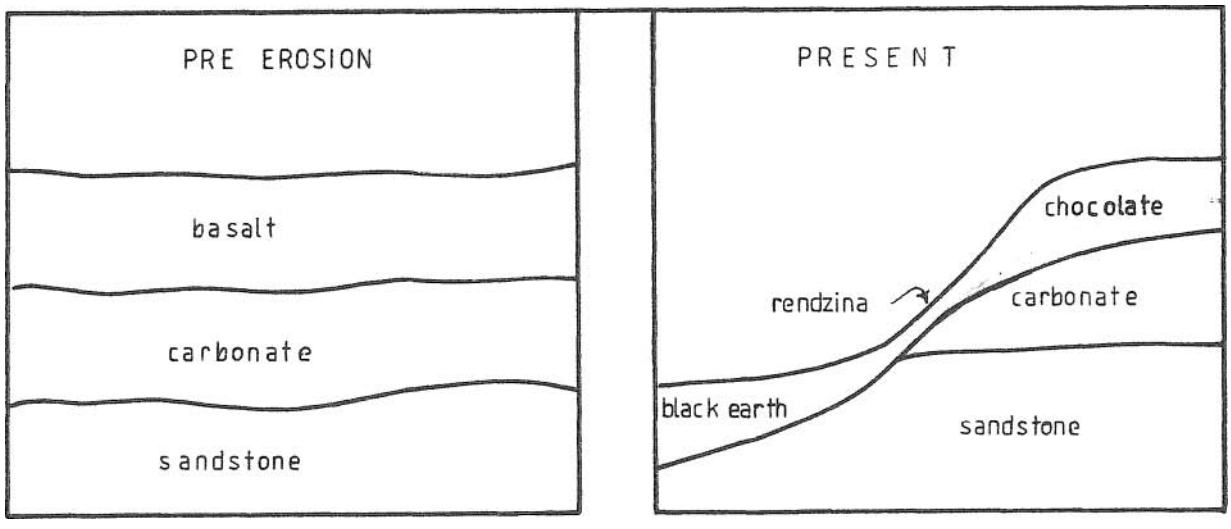

Figure 5: Suggested Weathering Cross-Section.

6. CONCLUSION

The Warialda rendzina can be described as "a shallow black to brownish black silty loam of very fine crumb and loose consistency overlying at depths from 200 mm, a dull yellowish brown to light grey soft marl. The marl is composed of up to 80% carbonate, appearing to have been deposited in a lacustrine environment, The soil reaction is alkaline throughout (8.6–9.0)." The rendzina was not formed on the calcareous material but as a result of its influence, the internal reorganisation of constituents being due to the saturation of the humus and clay colloids by the calcium.

7. ACKNOWLEDGEMENTS

I wish to acknowledge the field survey assistance given me by Associate Professor J.W. McGarity of the Division of Soil Science.

8. REFERENCES

BECKMANN, G.G. and THOMPSON, C.H. (1960). Soils and Land Use in the Kurrawa Area Darling Downs Queensland C.S.I.R.O. Soils and Land Use Series No. 37.

BOURKE, D.J. (1980). Stratigraphy of the Mesozoic Sequence in the Warialda Goondiwindi Area. Records of Geol. Surv. N.S.W. Vol. 19, pp. 1–79.

PIPER, C.S. (1947). Soil and Plant Analysis. Uni. of Adelaide,

PRESCOTT, J.A. (1952). The Soils of Australia in Relation to Vegetation and Climate, C.S.I.R.O. Bulletin No, 52.

REEVE, R., THOMPSON, C.H. and BECKMANN, G.G. (1960). The laboratory Examination of Soils from the Toowoomba and Kurrawa Areas, Darling Downs, Queensland. C.S.I.R.O. Div. Soils Div. Rep. 1/60.

STACE, H.C.T. (1956). Chemical Properties of Terra Rossas and Rendzinas in South Australia, J. Soil Sci. 7: 280–293,