

# SOIL DEVELOPMENT ON DOLOMITES OF THE CAMBRIAN NORMANVILLE GROUP AT DELAMERE, SOUTH AUSTRALIA

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## INTRODUCTION

Terra Rossa soils are widespread in areas with a Mediterranean (or xeric) climate (ie. cool, wet winters alternating with warm, dry summers), and characteristically overlie hard calcareous bedrock such as crystalline limestone or marble. The genesis of these highly structured, uniform textured, red soils has long been a matter of controversy. The 'residual theory' suggests that the development of the Terra Rossa is the result of carbonate dissolution and the subsequent accumulation of limestone residue (Bronger & Bruhn-Lobin 1997). This process has been observed by Gal (1967) and Moresi & Mongelli (1988). Another theory is that the soil is unrelated to the underlying rock and is allochthonous in origin. Aeolian dust is commonly defined as the parent material of red soils in the Mediterranean (MacLeod 1980, Yaalon 1997).

Preliminary fieldwork in the southern and central Mount Lofty Ranges has revealed a morphologically similar group of Terra Rossa soils over thin, elongate marble lenses of the lower Cambrian Normanville Group. The genesis of these soils has not yet been studied, however they provide an ideal medium in which to test the two theories stated above. First, the marbles of the Normanville Group are quite pure. Preliminary estimates suggest that for 40 cm of soil to develop, on the order of 150 m of limestone would need to be weathered. Yaalon & Ganor (1975) quote 1-2 cm per  $10^3$  years for limestone denudation in Judea and Galilee. This suggests that the time for dissolution is  $15-30 \times 10^6$  years. This is considerably older than the oldest surfaces of the region. Given the tectonic instability of the Adelaide Geosyncline it is unlikely that a soil formed during the Tertiary could survive erosion. This would imply that the residual theory is an unlikely explanation. Second, the marble lenses are found juxtaposed with shales of the Normanville Group on which yellow podzolic soils with strong texture contrast have developed. The transition between soil types is quite abrupt and seems coincident with lithology. This implies that lithology is the dominant influence on the soil type and that the accession of material from up-slope and/or aeolian deposition also seems an unlikely explanation.

In addition to this, areas where the Terra Rossa and marbles are located in the mid-slope position, and are flanked up-slope by the yellow podzolic soils; the properties of the Terra Rossa would be expected to reflect the mineralogy and particle size of the podzol. This, however, is not supported by cursory field inspection.

The aim of our project is to ascertain the origin of the Terra Rossa developed over the marbles of the Normanville Group located at Delamere on the Fleurieu Peninsula, South Australia. This includes specifically: (1) determining the degree to which weathering of the marble has occurred and its contribution to the formation of the soil; (2) determining how much material accession has added to the profile; and, (3) explaining the characteristic uniform texture of the soil and the abrupt contact between soil and bedrock.

## RESULTS

The analysis of the soils includes dissolution of the marble in acid to determine the amount of residue as well as its mineralogy and chemistry.

The measurement of the particle size allows comparison between profiles and rock residue and may indicate the degree of uniformity of the parent material as well as contributions from external sources. Preliminary results reveal that the clay fraction is larger in the Terra Rossa than in the marble. This supports the residual theory, in that over time particles must break and wear and subsequently become smaller, adding to the clay fraction.

The separation of the clay, silt and sand fraction from the rock residue and soil allows characterization of mineralogy through x-ray diffraction. Given the marked mineralogical differences between marble and shale, the mineralogy of the Terra Rossa profile should: (a) reflect the mineralogy of the marble if it has formed *in situ*; or, (b) reflect a mixed mineralogy if contributions to the profile were received from the weathering shale up-slope. Preliminary diffraction results indicate the latter. Changes in the mineralogy can often indicate the degree of weathering *in situ* as well as down-slope movement from adjacent soil types. Also the chemistry of the silt and sand gives an insight into the relative contribution of weathering and

extrinsic additions of material. Grain surface characteristics determined by scanning electron microscopy reveal the mechanisms of transport and the extent of weathering. Marble and limestone petrology by EMPA and optical microscopy define the process of weathering and the nature of structures such as stylolites which are often the sources of clay, iron oxides and other insoluble constituents of the solum.

#### CONCLUSION

Analysis of the morphology, x-ray diffraction and particle size, indicate that the Terra Rossa is derived from more than one parent material. The chemistry of the profile has largely been influenced by the dolomite, however contributions have been received from up-slope. The very stable and high-grade angular blocky structure is evidence of the influence of dolomite as it provides Ca that promotes clay aggregation. Thus it appears that the mechanism of soil formation is a combination of weathering *in situ* and down-slope accession. The relative contribution of the two processes to the Terra Rossa, the contribution of aeolian accession and the mode of formation of the podzolic soil will be discussed in the symposium presentation.

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