NATURE, DISTRIBUTION AND ORIGIN OF SOILS ON AN ALLUVIAL LANDSCAPE IN THE LOCKYER VALLEY, SOUTH-EAST QUEENSLAND

by

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PREFACE

This thesis follows the conventions of the CSIRO style guide. Maps are enclosed in the pocket in the back cover.

The thesis contains two major components. The first major component is a review of the literature relevant to the study of alluvial soil landscapes. The second component covers the investigation of the study area with the results of the study being discussed under the themes of alluvial source materials, soils on the alluvium, numerical analysis and stratigraphic-geomorphic relationships.

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SUMMARY

Lockyer Creek and its major tributary, Tenthill Creek, have extensive alluvial landscapes up to 6 km wide. These are derived from the erosion of upslope Tertiary basalt, the argillaceous Jurassic Walloon Coal Measures and the Jurassic Marburg Formation which is predominantly sandstone. The alluvial landscape has been largely cleared of its original vegetation and is intensively cropped. To investigate the nature, distribution and origin of the alluvial soil landscape, a multidisciplinary study incorporating aspects of pedology, geomorphology and statistics was carried out.

The geomorphology, and fine sand and clay mineralogy of upslope source materials and the alluvial soil landscape in the valley below were investigated and compared. Soils on alluvia along the major streams were found to have developed from predominantly basaltic sediment. Alluvial landforms of minor drainage lines were derived from mainly basaltic materials in upstream reaches, from upper Marburg beds in middle stream reaches, and from lower Marburg beds in downstream reaches.

A soil survey of the alluvial soil landscape showed it to be dominated by cracking clays (Vertisols) with some prairie soils and chernozems (Mollisols) and minor areas of red-brown earths, solodic soils and soloths (Alfisols). A 1:50 000 soil map identified 25 soil profile classes which were grouped into six soil lithological - landscape groups. These are:

(i) Soils of the major stream flood plains and levees;

(ii) Soils of the major stream terraces and plains;

(iii) Soils of the major stream elevated terraces, fans and pediments;

(iv) Soils of the alluvial fans derived from basalt (upper reach tributaries);

(v) Soils of the alluvial fans and flats derived from upper Marburg beds (middle reach tributaries); and

(vi) Soils of the alluvial fans and flats derived from lower Marburg beds (lower reach tributaries).

The first three soil groups were associated with three separate terraces in the upper and middle stream reaches of Tenthill Creek. In contrast, the downstream reach along Lockyer Creek only contains the first two soil groups on a relatively featureless alluvial plain landscape. The remaining three soil groups occur on minor tributary alluvia.

To assess soil variability across the alluvial plain, morphological data was collected at 25 m intervals along a transect and subjected to numerical analysis. Fuzzy classification was carried out for pH profiles, morphology profiles and morphological horizons. Classifications of morphological profiles and horizons were usefully combined with ordination techniques, including multivariate planing. The numerical analysis showed relationships between pH profiles and landscape position, parent alluvium and addition of irrigation water high in dissolved salts. It also validated the field classification of soils and indicated which profile class definitions could be further improved. Numerical analysis of horizons within profiles showed that horizons incidence related to landscape position, buried palaeosols and gilgai incidence.

Radiocarbon dating of buried palaesols showed that most of the present alluvial landscape developed during the last 20 000 years. The alluvial landscape is believed to have evolved in five stages with a major change from predominantly pediment erosion processes to fluvial erosion processes during the last global glaciation. The confined valley floors of upstream reaches responded to episodes of fluvial cut and fill by developing terraces whereas downstream episodes of erosion were dominantly vertical and were followed by widespread alluvial deposition and burial of older alluvial landscapes. Periods of stability between episodes of erosion and deposition led to the development of four soil stratigraphic units (pedoderms). These are:

(i) The Woodbine-Townson Pedoderm;

(ii) The Tenthill-Blenheim Pedoderm;

(iii) The Wilson Pedoderm; and

(iv) The Lockyer-Robinson Pedoderm.

These were identified on the basis of soil morphology, geomorphology, stratigraphy and radiocarbon dating. In some instances, clay mineral and fine sand mineralogy were used as indices of weathering to confirm the relative age of pedoderms.

Soils of the Woodbine-Townson Pedoderm developed on fine textured basaltic alluvia deposited prior to the peak of the last glaciation are predominantly grey and brown clays with neutral to weakly acid deep subsoils. Soils of the Tenthill-Blenheim Pedoderm developed on similar parent alluvium deposited during the post-glacial transgression are predominantly black earths and heavy textured chernozems with alkaline subsoils, commonly less than 1.5 m deep. With increasing age, fine textured soils become progressively richer in kaolinite clay and lower in weatherable fine sand minerals.

Soils developed on medium textured basaltic alluvia of stream levees were found to show greater profile differentiation with time compared to fine textured alluvia. Alluvia deposited during the post-glacial transgression have developed into red-brown earths with moderate texture differentiation (Tenthill-Blenheim Pedoderm), whereas soils of Holocene age have developed into prairie soils and chernozems with weak texture differentiation (Lockyer-Cavendish Pedoderm). During this time, smectites in the clay fraction have become increasingly interlayered towards the surface and fine sand minerals progressively weathered.

The soil-geomorphic framework established provides an orderly explanation of the nature, distribution and origin of the soils in the alluvial soil landscape.