9. STRATIGRAPHIC RELATIONSHIPS AND GEOMORPHIC FRAMEWORK

The principles of soil stratigraphy have been applied to the alluvia in the study area in conjunction with soil distribution, soil morphology and landscape features to identify four soil stratigraphic units. Variations within soil stratigraphic units are ascribed to differences in source of parent sediment, differential transport of sand, silt and clay, and differences in internal drainage.

Recognition of a succession of alluvial landforms with particular sets of soils provides a basis for explaining the soil-geomorphic history of the area. Each stage of this history can be expressed as a pedoderm (Brewer *et al.* 1970) composed of several soils (facies) and associated landform elements (Table 9.1, Fig. 9.1). Criteria used in this study to identify pedoderms include landform element, soil morphology and radiocarbon dating.

The relative age of upstream pedoderms was assessed from terraces along Tenthill Creek, assuming that terrace evolution was 'normal', i.e. the higher the terrace, the older its formation. This assumption is based on the law of crosscutting relations which states that the older higher alluvial plain (now terrace) had to be in place prior to truncation by the stream (Section 2.3.3.5). Deep drilling upstream failed to reveal any buried pedoderms.

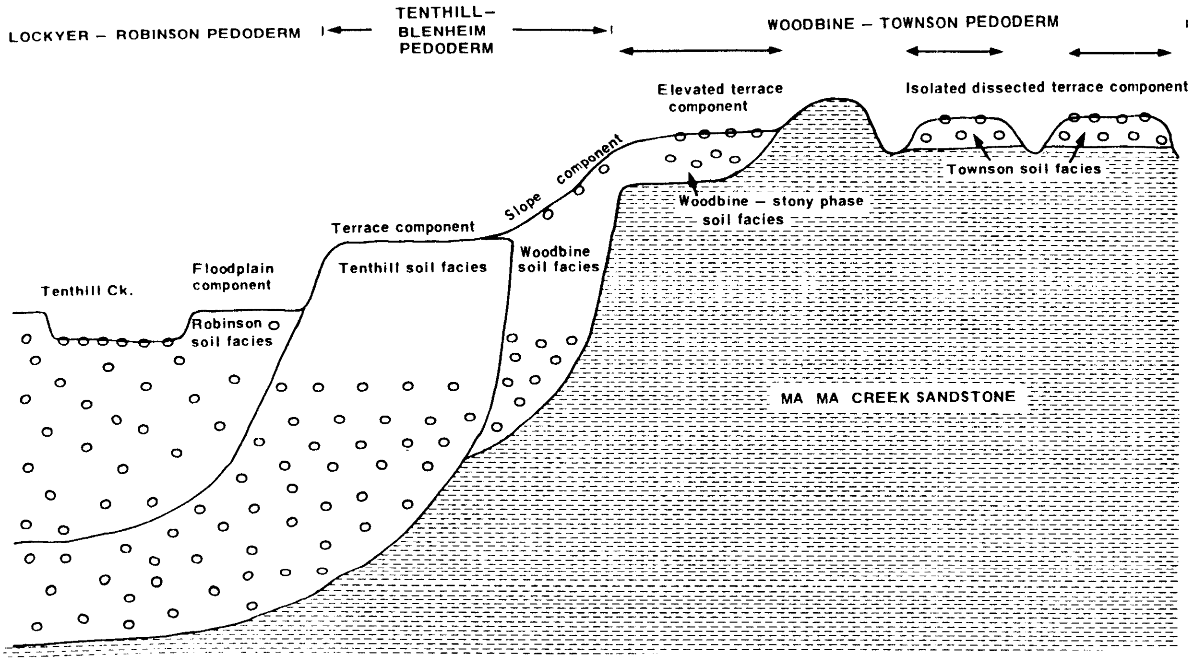
The trend of progressively lower alluvial landscapes in Tenthill Creek parallels that of other major river valleys in eastern Australia. Walker and Coventry (1976) suggest such terrace sequences are associated with a general dwindling of stream discharges in the last 30 000 years.

Downstream on the alluvial plain, terrace scarps are absent and ranking was based on the law of superposition of the younger pedoderm overlying the older as revealed from soil cores and deep borings. Radiocarbon dating of buried palaeosols (Appendix 5) provided some limiting ages for the pedoderms and also an indication of earlier cut and fill processes on the alluvial plain.

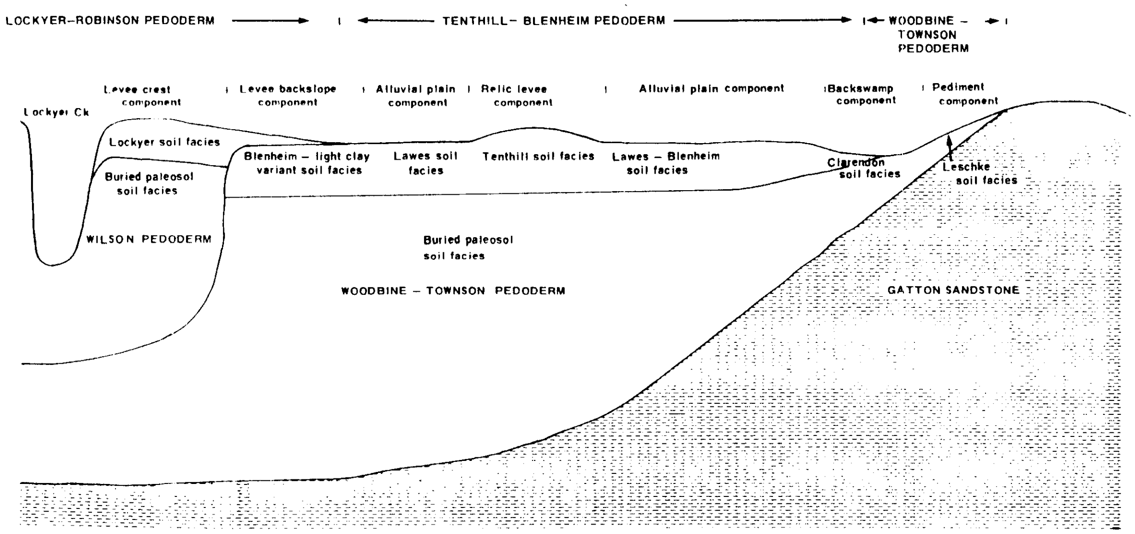
Correlation between upstream and downstream pedoderms is largely based on similarity of soil morphology and to a lesser extent soil mineralogy. Changes in degree of profile development with age were not obvious with the fine textured alluvia. This absence of profile differentiation over time has also been observed by Mulcahy and Churchward (1973) for fine textured soils throughout Australia. Soil mixing and reduced infiltration by water as a result of swelling with moisture changes appear to counteract profile differentiation.

The main age difference between soils developed on fine textured alluvia in the study area was associated with soil colour and subsoil pH. Black earths with alkaline subsoils predominate on the Tenhill-Blenheim Pedoderm (c. 10 000 to 20 000 years b.p.) whereas grey and brown clays with neutral to acid deep subsoils dominate the older Woodbine-Townson Pedoderm (c. $\geq$ 20 000 years b.p.).

However, evidence of soil profile development with time was more obvious for the soils derived from medium textured alluvia. For the Lockyer-Robinson Pedoderm ($<$ 10 000 years b.p.) such alluvia on levees has developed prairie soils (Lockyer) and chernozems (Cavendish) with weak profile differentiation whereas the Tenthill-Blenheim Pedoderm (c. 10 000 to 20 000 years b.p.) on relict levees has developed a red brown earth with a texture contrast profile form (Tenthill - light textured variant). This degree of profile differentiation over such time periods agrees with south eastern Australian soil studies of similar textured alluvial landscapes (Walker and Coventry 1976). Similarly soils derived from the Jurassic sediments, such as the solodic soil forms of the Stockyard and Hattonvale profile classes, are also well developed. Because these soils are laterally continuous with the black earths of the main alluvial terraces and plains, they are believed to be the same age. Lighter textured soils developed on adjacent alluvial fans and pediments (e.g. Abell brown earth) but showing less evidence of soil profile development than the solodics were also considered to be the same age on account of their lateral continuity (see Fig. 7.1c) and the principle of descendancy (see Section 3.2.4).



(a) Tenthill Creek alluvia - middle reach



(b) Lockyer Creek alluvial plain - downstream reach

Fig. 9.1. Pedoderms, soil facies and landform elements in the study area.

9.1. Description of pedoderms

The main features or the four identified pedoderms are summarised in Table 9.1 and are described in more detail below. Pedoderms were named after the more extensive profile classes within them.

Table 9.1. Landform components, soil facies and age of alluvial pedoderms of the Lockyer Valley.

Pedoderm	Landform component	Surface soil facies*	Palaeosol soil facies
Woodbine-Townson	Elevated terraces, fans and	Woodbine, Thornton, Townson,	buried grey clay
minimum age of	pediments (upstream).	Ryan	buried chernozem
19 360 ± 280 yr.b.p. (site 2)	Elevated pediments, fans and	Leschke	
21 770 ± 280 yr.b.p. (site 3)	local alluvial plains (downstream)		
	Backswamps	Clarendon	
Tenthill-Blenheim	Terraced plains.	Tenthill, Lawes, Blenheim,	
		Flagstone, Whiteway, Sippel	
estimated to be between	Relict Levees and prior streams.	Tenthill, Hooper	
10 000-20 000 yr.b.p.	Backswamps.	Clarendon	
	Alluvial fans.	Spellman, Sutton, Laidley	
		Abell, Geisemann	
	Local alluvial plains.	Stockyard, Hattonvale	
	Degraded terrace slopes	Woodbine	
Wilson	No surface expression.		buried chernozem
minimum age of			
10 240 ± 130 yr.b.p. (site 1)			
Locker-Robinson	Floodplains	Robinson, Lockyer	
estimated to be younger	Levee crests	Lockyer, Cavendish	
than 10 240 yr.b.p.	Levee backslopes	Blenheim-light textured variant	
		Cavendish	
	Alluvial fans	Peacock	

* Descriptions of profile classes are given in Section 7

9.1.1. Woodbine-Townson Pedoderm

The surface expression of this pedoderm is largely in the form of grey, brown and black clay soils which occur on elevated terraces, fans and pediments (Fig. 9.1a). Brown and black clays appear to be more basaltic in origin than the grey clays. All soils usually contain carbonate in the subsoil but the grey clays commonly become acid to neutral at depth.

Where the pedoderm has been isolated and abandoned by the major trunk streams, dissection is in a more advanced state. Some elevated terraces have developed into a landscape of gently undulating rises. In contrast occurrences exposed at lower elevations or on the margins of the main alluvial plains are minimally dissected. Such instances are manifested as gently sloping pediplains adjacent to local drainage depressions and within local alluvial plains (Fig. 9.1b).

Within the local alluvial plains and minor fans developed largely out of lower Marburg sediments, a sandy surfaced soloth (Glencairn) has been allocated to the Woodbine-Townson Pedoderm on the basis of its advanced state of soil profile development compared to the other soils present. Deep thick bleached A2 horizons abruptly overlie acid yellow and grey mottled clay B horizons. Acidity and absence of carbonate is a characteristic feature of texture contrast soils belonging to the Woodbine - Townson Pedoderm.

The palaeosol facies of this pedoderm downstream is mainly a buried grey clay (Plate 7.3) that occurs up to 6 m below the surface of the alluvial plain (Fig. 9.1b). Buried palaeosols were radiocarbon dated at about 20 000 years b.p., this being a minimum age for the pedoderm.

Magnesium and sodium are the dominant subsoil cations. Another subsoil characteristic noted is the presence of clean unstained quartz sand grains in the clay matrix.

Clay mineralogy results of profiles from this pedoderm (Table 7.13) indicate the nature of source materials and the degree of weathering. Soils sampled were high in interlayered smectite clay and therefore considered to be derived from basaltic parent materials. As a result of greater weathering, soils were also higher in kaolinite compared to soils from younger pedoderms.

Soils with basaltic components were also found to have low augite values ($<10\%$ of heavy minerals) in the fine sand fraction throughout the profile (Table 7.14). If these values are used as indices of weathering, then the soils are concluded to have been subjected to a prolonged period of weathering since deposition. This evidence supports their memberhsip to the Woodbine-Leschke pedoderm, the oldest soil stratigraphic unit identified in the study.

9.1.2. Tenthill-Blenheim Pedoderm

This pedoderm is the widest occurring soil stratigraphic unit in the study area. It is represented by the main alluvial terraces and plains and their associated fans. It is composed dominantly of black cracking clays with brown, black or grey calcareous subsoil horizons usually well developed. Grey and hydromorphic clays (e.g. Clarendon soil facies in backswamp in Fig. 9.1b) are found on the margins of the alluvial plain and are believed to be composite soils composed of 2 alluvial deposits. The lower deposit is a strongly lenticular grey clay considered to be a buried palaeosol facies of the older Woodbine-Townson Pedoderm. Although the soil of the Tenthill-Blenheim Pedoderm above is also lenticular, it has a moderate grade of structure, and has a stronger chroma or redder hue.

Occurrences on fans and pediments adjacent to the major streams (Fig. 9.1) and minor alluvial plains have differing soils depending on the parent material. Alluvial fans derived from dominantly basaltic sediment have soil facies similar in form to those on the alluvial plain i.e. dark to brown clay loams and clays. Where the fans are composed of sediment derived from upper Marburg beds, soils show moderate solum differentiation in the form of sandy red brown earths and gradational brown earths. Local alluvial plain occurrences derived from the lower beds of the Marburg Formation are mainly solodic soil forms (e.g. Stockyard, Hattonvale). These soils have alkaline subsoils and less well developed A_2 horizons compared to the soloth (Glencairn) of the Woodbine-Townson Pedoderm, i.e. the solodics are less leached and weathered and therefore younger than the soloth which occurs in close proximity.

In some cases the grey clay soil facies of this pedoderm on pediments and local alluvial plains are redistribution products of the Woodbine-Townson pedoderm. In these cases, profile classes may belong to both pedoderms, but separation is based on landform component. Sandier alluvia on the main trunk streams such as those associated with relict levees and prior streams channels or with the terraced plains of Deep Gully have developed red brown earth profile forms (e.g. Sippel, Tenthill - light textured variant).

On levee backslopes in downstream reaches, the Tenthill-Blenheim Pedoderm may occur as a buried palaeosol at depths of up to 0.6 m below the Lockyer-Robinson Pedoderm (Fig. 9.1b). From radiocarbon dates of older and younger pedoderms the Tenthill-Blenheim Pedoderm is estimated to be between 10 000 and 20 000 years old.

Basaltic alluvia belonging to this pedoderm have soils with low proportions of weatherable fine sand minerals in the upper solum but this progressively increases in abundance in the lower B horizons and substrate (Table 7.10). Augite in the Tenthill-Blenheim Pedoderm occurs in higher amounts (16-53% of the heavy fraction) compared to the previous pedoderm, indicating that soils are less weathered and therefore younger. Surface and upper subsoil horizons tend to have smectite clays with a large degree of interlayering as a result of weathering (Table 7.9). Interestingly smectite interlayering seems to be more developed in soils of this pedoderm than in soils of the older Woodbine-Townson Pedoderm. Soils have a characteristically highly lustrous smooth ped fabric. Quartz grains consist of a mixture of clean and stained sand grains in contrast to the clean quartz grains present in the previous pedoderm.

9.1.3. Wilson Pedoderm

During the investigation, only one occurrence of this pedoderm has been observed. This is a buried palaeosol found by deep drilling 6 m below the surface of the Lockyer Creek levee crest at site 1 (see soils map). It has no clear expression in the terraced upper tributaries. It was separated out from the other buried pedoderm (Woodbine-Townson) because of its younger radiocarbon age.)

The Wilson Pedoderm observed appeared to be a buried chernozem with large amounts of carbonate in its subsoil and was radiocarbon dated at about 10 000 years b.p. An extensive deep coring and dating program would be required to map the extent of this pedoderm.

9.1.4. Lockyer-Robinson Pedoderm

This pedoderm is recognised on alluvial fans and narrow tributary floodplains upstream and on levee banks of major streams downstream.

Soils are usually dark loams to clay loams although some textures as heavy as light-medium clay do occur. They are characterised by either an earthy fabric or smooth ped fabric with a relatively dull lustre (Section 7.4.1), presumably due to organic matter and minimal stress cutan development on wetting and drying. Carbonates are absent or present only in minor amounts. On levee backslopes, this pedoderm overlies the Tenthill-Blenheim Pedoderm which can be distinguished by its highly lustrous smooth ped fabric and medium clay texture.

From radiocarbon dating of the underlying Wilson Pedoderm at site 1, the Lockyer-Robinson Pedoderm is known to be younger than 10 000 years b.p. Weatherable fine sand minerals are abundant in the surface horizons of representative soils (Table 7.5) reflecting their relatively young age. In contrast the soils of older pedoderms are progressively lower in weatherable fine sand minerals (Tables 7.10 and 7.14). Similarly, x-ray diffraction traces showed smectites from representative soils to be less interlayered and therefore less weathered than soils of the older pedoderms (see Section 5.5.2 and Fig. 5.1).

9.2. Soil geomorphic history

Since the mid-Tertiary the Lockyer Valley has been supplied with an abundance of erodible regolith due to deep geochemical weathering of the surrounding catchment rocks, especially basalt. These materials filled the valleys made by headward cutting streams. Valleys were filled and eroded in response to changes in climate and sea level during the late Tertiary and Quaternary (see Section 2.2). A downstream constriction of the Lockyer Valley has caused alluvial sediments to accumulate in downstream reaches (see Section 4.1).

Alluvial landscape development of the study area is hypothesized as occurring in 5 stages. These stages are illustrated in Figs 9.2 and 9.3 as idealized cross-sections of Tenthill Creek and Lockyer Creek alluvia and are described below.

Stage 1: Woodbine-Townson Pedoderm (minimum age c. 20 000 years b.p.)

The relict drainage pattern associated with the Woodbine-Townson Pedoderm occurs within embayments cut into the Miocene upper erosion surface of Watkins (1967). The embayments are believed to be a middle erosion surface of late Pliocene-Pleistocene age which is also known as the Woodford surface (Beckmann and Stevens 1978, see Section 6.1.1). The Woodford surface is shown as the raised area above the pedoderms in Fig. 9.2, Stage 1.

The distribution of soils on the Woodbine-Townson Pedoderm marks the upstream limit of valley widening. The upstream reaches of this pedoderm are characterised by stony brown clay soil facies. In middle reaches (Fig. 9.2) where major tributary valleys widen, pediplanation resulted in the formation of coalescing fans and extensive pediplains of grey clays with infilled drainage channels of stony brown and black clays. Here, the pedoderm has been largely eroded and removed, leaving narrow elevated terraces and truncated fans on valley margins. In some cases, elevated terraces have been locally redistributed to form pediment margins during succeeding stages of valley development.

The greatest surface occurrence of this pedoderm is associated with an isolated and abandoned terrace between Tenthill Creek and Deep Gully near their middle reaches (see soils map, Fig. 9.3). The close vicinity of this pedoderm to a cut off scarp upslope suggests stream capture of the relict drainage line by the Wonga Creek tributary. Thus the pedoderm was preserved from later erosive episodes and has since been subjected to gentle dissection only. Evidence of the old valley form associated with this abandoned terrace can be seen in places as high level plains (Plate 7.1) and wind gaps.

Further downstream along Lockyer Creek, an extensive pediplain of grey clays and chernozems developed (Fig. 9.3). Remnants of the pedoderm are now found beneath the wide alluvial plain of Lockyer Creek as buried palaeosols (grey clays and chernozems) or as gently sloping pediments and fans at the alluvial plain margins. Accretion of the floodplain has resulted in relief inversion and these pediments and fans may be found in marginal depressions as grey and hydromorphic clay soil facies (Clarendon profile class).

The development of a downstream pediplain landscape, coupled with radiocarbon dating and high salt contents of the soils, suggest that establishment of the Woodbine-Townson Pedoderm coincided with the onset of cool arid conditions during the Late Pleistocene. According to Watkins (1967) the pediplain landscape would have developed under conditions of low effective precipitation and therefore low runoff ($<$ 50 mm annually). This pedoderm is believed to have been established prior to the extreme episodes of fluvial erosion and deposition experienced in eastern Australia between 20 000 and 30 000 years ago when arid conditions intensified and sea levels were lower (see Section 3.2). The pedoderm is postulated as being older than the radio carbon dates of buried palaeosol facies (c. 20 000 years b.p.) because these represent a minimum age and more likely to reflect the date of burial of this pedoderm.

Stage 2: Tenthill-Blenheim Pedoderm (20 000-10 000 years b.p.)

This pedoderm developed as follows:

(i) The last glaciation was cool, arid and strongly seasonal, and was marked by lower vegetative cover. Lowered temperatures during this period reduced evapotranspiration and increased runoff (Watkins 1967). Accelerated runoff provided the opportunity for greater fluvial erosion of uplands and complementary alluvial deposition in the valley floors. However when the glaciation peaked 20 000 years ago, sea levels were 100 to 140 m below present (Thom and Chappell 1975), and this lowered base level to such an extent that both upland erosion products and the Woodbine-Townson Pedoderm were eroded and removed. Erosion of the pedoderm was more extensive in upstream and middle reaches where coarse stony channel beds prevented vertical incision, and stream energy was expended on lateral erosion of the pedoderm. The exception is where downcutting resulted in stream capture of a Deep Gully tributary by Wonga Creek. This reduced erosion of the Woodbine-Townson Pedoderm along that tributary, which has since been gently dissected. Downstream channel walls consisted of finer sediments and were more stable. Thus erosion was mainly vertical and large areas of the Woodbine-Townson Pedoderm remained intact. In addition hard rock constriction in downstream Lockyer Creek prevented large scale evacuation of alluvial sediment into the Brisbane River system.

(ii) At the onset of the postglacial transgression, rising sea levels caused infilling of the incised channels and tributary valleys as arid conditions and upland erosion continued. The large loads of mixed alluvia were moved by braided streams and deposited mainly by lateral accretion of bedload.

As the postglacial transgression continued, braided stream bedload deposits eventually buried the Woodbine-Townson Pedoderm in downstream reaches (Fig. 9.3) forming a wide floodplain. The material transported by braided streams was high in weatherable minerals, brown in colour and coarse to medium textured.

Williams *et al.* (1986) also identified an episode of substantial bed load deposition by braided channels for the Darling River during a similar time period (20 000 to 12 000 years b.p.). Braiding could have been a typical characteristic of streams in eastern Australia during the time of the postglacial transgression.

(iii) As the climate became warmer and wetter during the postglacial period, the streams carried greater discharges, and like the Darling River (Williams *et al.* 1986) became deeper, narrower and more sinuous, transporting large loads of suspended mud. Deepening of stream channels increased their cross-sectional area, and resulted in lower stream velocities for the same discharge [since discharge (D) = velocity (v) x channel cross-section area (a)]. As a consequence, streams carried mainly suspended load and previously unstable channels became lined and sealed with clay.

In response to the more equable climate, upland catchments were revegetated and stabilized, reducing the load available to streams. With less load to carry, the streams expended their energy by further eroding their channels and by overbank flooding. The extensive overbank flooding by incised streams deposited a mantle of black suspended clay over the brown coarser braided steam sediments.

The alluvial sequence that developed was one of initially coarse then later fine fluvial sediment. This sequence fits the proposition of Schumm (1977) that alluvial plains first develop a braided system which then evolves into an incised channel system.

In the final stages of alluvial deposition overbank flooding of incised meandering streams deposited a mantle of clay rich alluvia over the top of this brown coarser alluvia. Alluvial deposition by overbank flooding eventually ceased, soil development proceeded and the Tenthill-Blenheim Pedoderm was established. This pedoderm is dominated by soil facies with dark clay and clay loam textures at the surface (e.g. Blenheim, Lawes and Tenthill profile classes).

Up to two buried palaeosols or layers with similar properties to the upper solum appear to be present within 1.5 m of this pedoderm surface. These phenomena may relate to earlier episodes of surface stability as the floodplain built up by overbank deposition i.e. composite soils (Morrison 1978). They are regarded as minor discontinuities within the pedogenetic profile of the pedoderm and are possibly the result of temporary interruptions in the general progress of floodplain aggradation (Vita-Finzi 1973). These layers may also mark significant flood events over the former flood plain. In clay soils apparently buried layers may not have been buried at all but may have resulted from subsoil movement by swelling clays associated with the formation of gilgai microrelief.

Stage 3: Wilson Pedoderm (minimum c. 10 000 years b.p.)

Although the early Holocene was a warmer wetter period than the preceding Late Pleistocene glacial period, stream discharges were not of sufficient capacity to significantly erode or bury the Tenthill-Blenheim Pedoderm.

At the onset of the Holocene period a renewed episode of stream erosion incised the Tenthill-Blenheim Pedoderm in response to climatic fluctuations leaving unpaired terraces in upstream reaches, and paired terraces middle reaches. Unpaired terraces upstream were possibly caused by continuous lateral stream erosion concentrated on concave banks of sinuous steams of the Tenthill-Blenheim Pedoderm as the stony bed of the channel resisted entrainment during flood periods. Along middle and downsteam reaches, paired terraces, developed a new cycle of stream downcutting unimpeded by coarse bed load in the channel occurred together with some channel widening.

In downstream reaches incision was following by refilling to a depth some 6 m below the Tenthill-Blenheim terrace where the Wilson Pedoderm developed. This was identified by pedological features, radio carbon dating and its position about 6 m below the Lockyer Creek levee bank. The new floodplain was relatively narrow in downstream reaches, and its expression upstream is unknown. The pedoderm is not related to any known early Holocene climatic event.

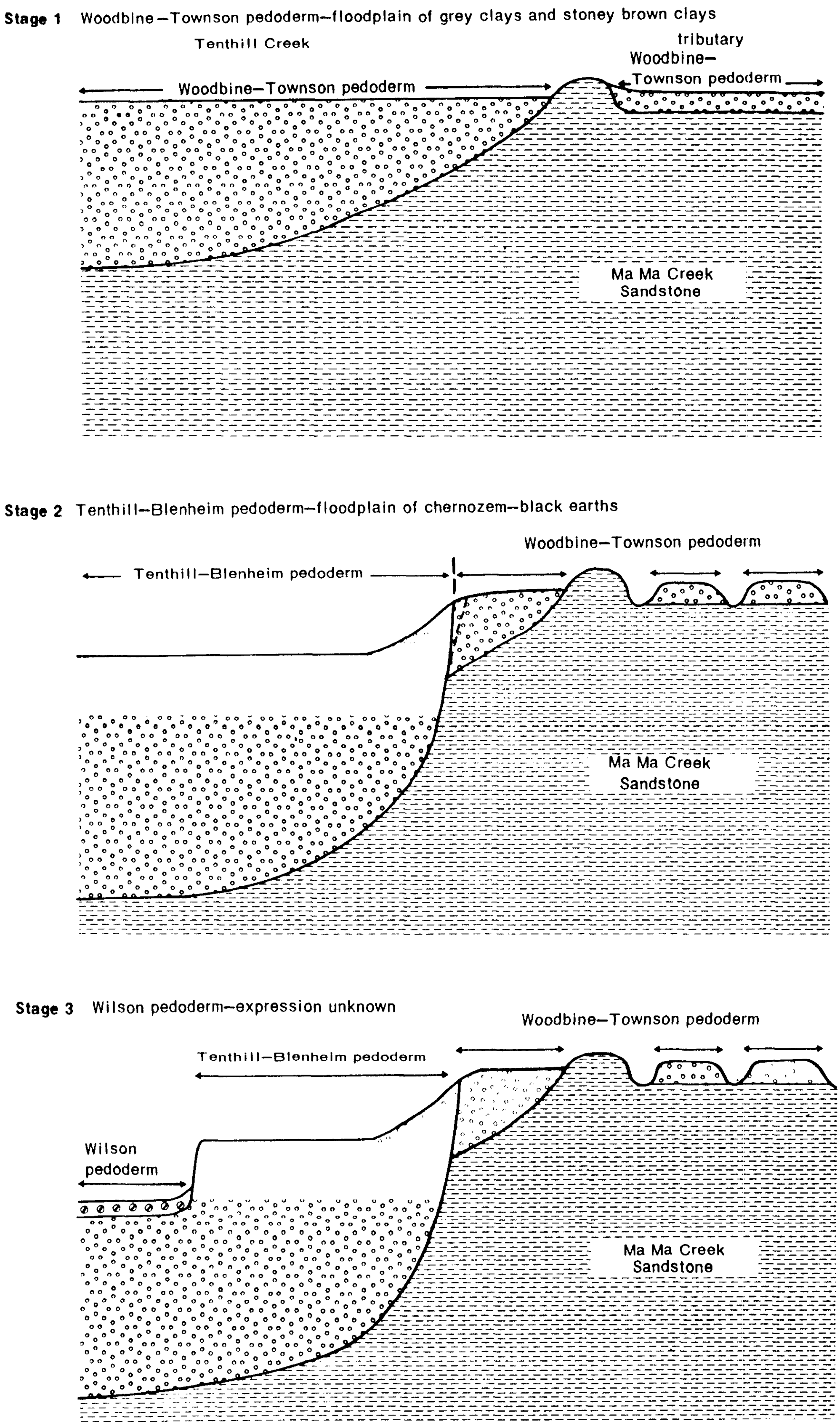
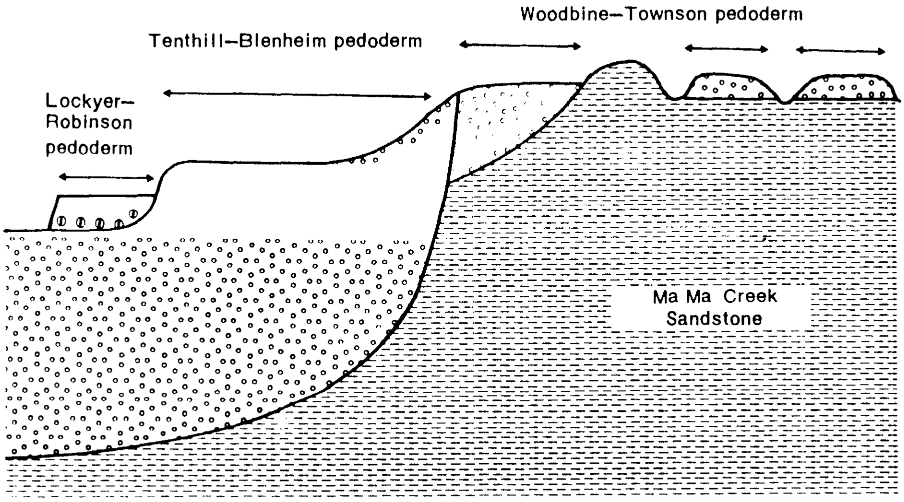


Fig. 9.2. Late Pleistocene-Holocene Pedoderm sequence-Tenthill Creek and tributary alluvia.

Stage 4 Lockyer–Robinson pedoderm–floodplain of prairie soils and alluvial soils often stoney



Stage 5 Incision of stream–channel widening of streams, with erosion of Lockyer–Robinson pedoderm

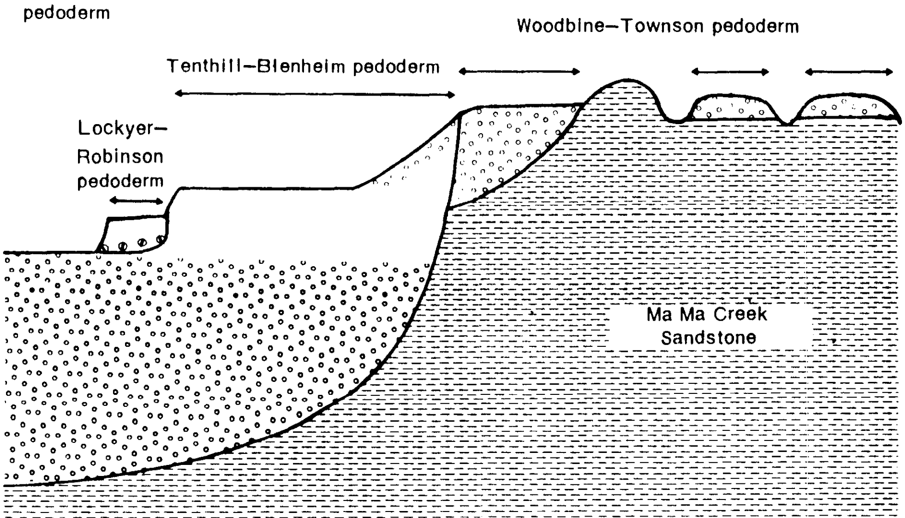
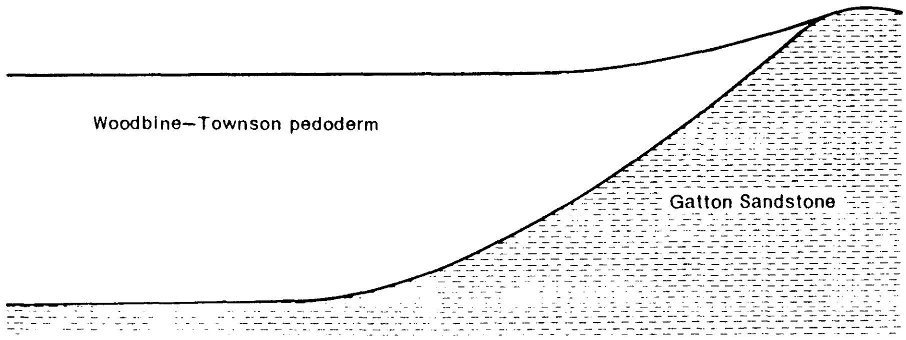
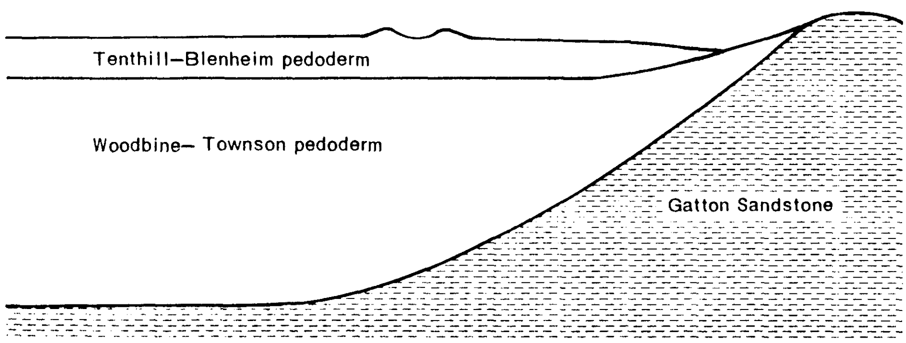


Fig. 9.2. (Continued). Late Pleistocene-Holocene Pedoderm sequence-Tenthill Creek and tributary alluvia.

Stage 1 Woodbine–Townson pedoderm–pediplains of grey clays and chernozems



Stage 2 Tenthill–Blenheim pedoderm–wide floodplain of meandering prior stream with black earths dominant



Stage 3 Wilson pedoderm–narrow floodplain of chernozems

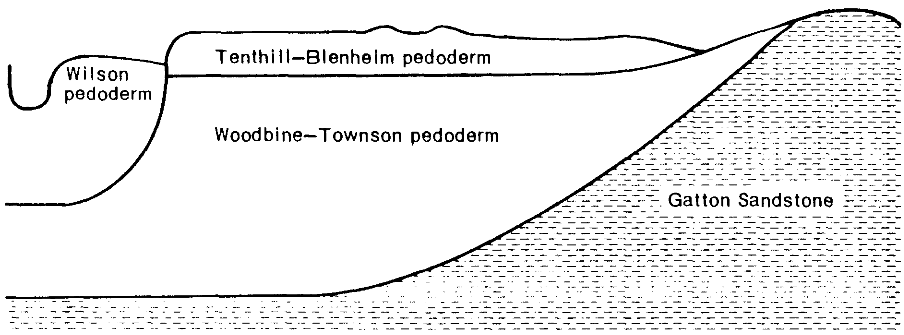
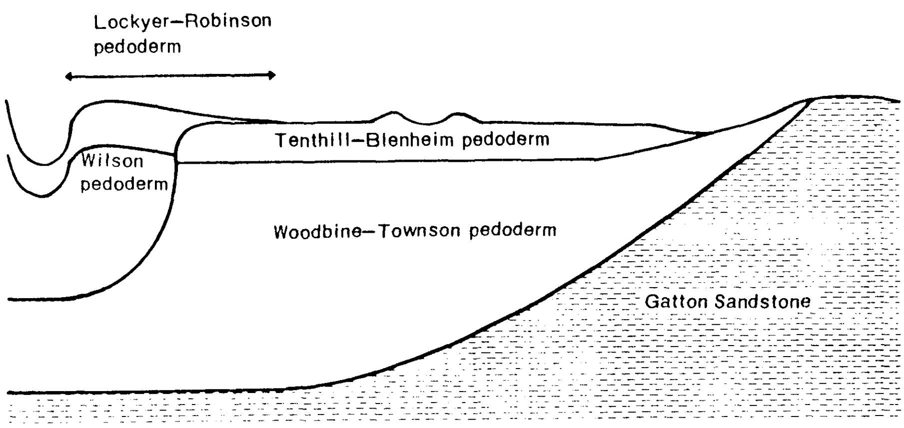


Fig. 9.3. Late Pleistocene-Holocene Pedoderm sequence-Lockyer Creek alluvia.

Stage 4 Lockyer–Robinson pedoderm–narrow levee of prairie soils and chernozems



Stage 5 Incision of stream–very narrow alluvial benches

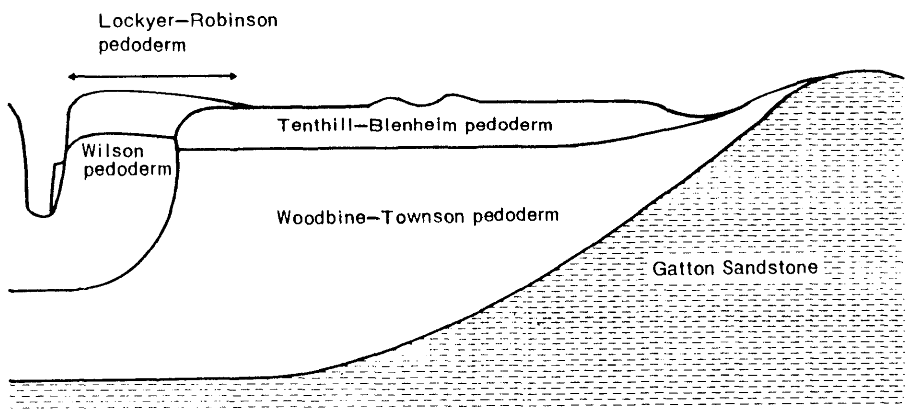


Fig. 9.3. (Continued). Late Pleistocene-Holocene Pedoderm sequence-Lockyer Creek alluvia.

Stage 4: Lockyer-Robinson Pedoderm (Age - younger than 10 000 years b.p.)

Upstream the Wilson Pedoderm, if present, was eroded and removed by floodwaters prior to renewed floodplain aggradation. The newly formed floodplain eventually stabilised to form the Lockyer-Robinson Pedoderm at a level 2-5 m below the terrace component of the Tenthill-Blenheim Pedoderm. This trend of progressively lower alluvial terraces in Tenthill Creek and its tributaries also occurs throughout river valleys in south-eastern Australia (Walker and Coventry 1976).

Downstream the Wilson Pedoderm was buried by floodplain action with up to 6 m of sediment. Floodplain aggradation overtopped the Tenthill-Blenheim Pedoderm in places to extend 50 to 200 m away from the banks of current stream channels.

The sedimentary facies sequence was similar to that for the Tenthill-Blenheim Pedoderm with brown coarser stratified alluvium mantled by dark loams to light-medium clays. Downstream, several pauses in floodplain aggradation or significant flood events are evident from the dark horizons which are possibly buried palaeosols that occur within 0.5 to 2 m of the pedoderm surface. Alluvial deposition of the surface mantle occurred with floodwaters of greater velocity than for the earlier pedoderms. As a result, alluvia with coarser particle sizes were laid down, and soils with lighter textures (loam to light-medium clay) developed. Walker and Coventry (1976) found medium textured soils similar to the ones in this pedoderm to develop deep organic rich A horizons within 5 000 years.

As concluded elsewhere in eastern Australia (Walker 1984) it is believed that establishment of Holocene soil stratigraphic units were controlled by local rather than regional factors i.e. a complex readjustment within the local catchment determined by discharge, width and depth of the channel, velocity, slope, bed roughness and grain size of the load.

Stage 5: Incision of streams

In the Late Holocene, downcutting of up to 20 m occurred in downstream channels. Stable stream banks prevented channel widening and floodplain aggradation ceased. Upstream however, coarse bedload (stone and gravel) has restricted downcutting, encouraged channel widening, and floodplains remain active.

The five stage stratigraphic sequence described above applies only to the study area within the Lockyer Valley, although some of the pedoderms may correlate with other alluvial sequences in the region. Alluvial sequences have been described in adjacent valleys (Paton 1965, Beckmann 1984), but neither are supported by radiocarbon dating. Therefore correlation with other stratigraphic bodies could only be attempted on the basis of similarity of soils and landforms. However, differences in geological structure and lithology, localised valley deposition and general fluvial aggradation in the region must be considered when comparing alluvial stratigraphies. Every valley has a history of its own (Vita-Finzi 1973). For these reasons, a regional correlation was not attempted. Other valleys in the region need to have their alluvial histories documented in more detail before the results of this study can be properly placed in their regional and continental context.

10. CONCLUSIONS

The study has shown that the materials sampled within the upper catchment of Tenthill Creek have clay and fine sand mineral suites similar to soils developed on the valley alluvia below. The origin of soils developed on alluvia has been linked to particular source materials on the basis of similarity of mineralogy and the areal extent and distribution of source materials in the study area.

A soil survey of the alluvial soil landscape showed it to be dominated by cracking clays (Vertisols) on extensive alluvial plains and terraces, with some prairie soils and chernozems (Mollisols) and minor areas of red-brown earths, solodic soils and soloths (Alfisols). The 1:50 000 soil map of the study area identified 25 soil profile classes which were grouped into six lithological-landscape groups on the basis of soil morphology, parent material and or landscape position. 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).

Soil groups were found to have characteristic chemical, physical and mineralogical properties which were determined mainly by source materials.

Along the upper and middle reaches of Tenthill Creek and its major tributaries, the first three soil groups were separately distributed on each of three distinct terraces. In contrast the downstream reaches of the study area along Lockyer Creek was characterised by an extensive alluvial plain containing the first two soil groups only. These groups were also found on the two lowest terraces upstream. All soil groups along the major streams were concluded to have been developed from predominantly basaltic parent material during Late Pleistocene to Holocene time.

The three remaining soil groups were distinguished by their soil morphology and parent alluvium and were associated with minor fans and local alluvial flats.

Numerical analysis (fuzzy classification) of the most extensive alluvial plain landscape in the study area showed that pH profiles related to landscape position, the nature of the parent material and the application of irrigation water. Fuzzy classification also indicated that most of the field-generated soil profile classes were valid. The exception was the Lawes profile class, a moderately deep black earth, which fuzzy classification showed could be more usefully split. Some forms of Lawes were found to be closely related to the Blenheim profile class, a deep black earth, whereas other forms classified as distinct classes.

Fuzzy classification of horizons within profiles were also found to relate to landscape position, buried palaeosols and gilgai incidence. However, fuzzy horizon groups did not reflect age differences between soils younger than 20 000 years b.p. The technique of combining fuzzy classification with ordination was found to usefully sort soil entities.

The alluvial landscape of the study area is concluded to have developed in five stages during Late Pleistocene and Holocene time with the fluvial deposition and erosion of four pedoderms. At the peak of the last global glaciation 18 000 to 20 000 years ago, there was a major geomorphic change with pediment erosion processes being replaced with predominantly fluvial erosion processes. Episodes of lateral erosion followed by infilling occurred in upstream tributaries to form terraces; downstream erosion was mainly vertical, deposition was more extensive and pedoderms were partially or completely buried.

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

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

This soil-geomorphic framework provides an orderly explanation of the nature, distribution and origin of the soils in the study area. The results of this study has also established a time framework for alluvial soil landscape development in south-east Queensland. Radiocarbon dates of c. 20 000 years b.p. and c. 10 000 years b.p. for buried palaeosols provide opportunities for correlation with future datings in the region. A more comprehensive program of deep drilling and radiocarbon dating is required to further refine the geomorphic framework of this alluvial landscape. This together with pollen analysis would permit a fuller reconstruction of the environment during the Late Pleistocene and Holocene.

Detailed pedogenetic studies of individual profiles are also needed to clarify the role of fluvial processes in the genesis of these soils, and to explain changes in mineralogy within and between profiles. The results of this study provide a framework for the implementation of such investigations.