The influence of parent rocks and sediments on soil variation in the Narrabri district

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Introduction

CSIRO Division of Soils is examining the distribution and properties of the soils of the lower Namoi Valley with emphasis on the nature and variability of the heavy clay soils, west of Narrabri, used for cotton growing. The questions are: how do these soils vary? and why do they vary? Each question is posed with the background of "what is the relevance of this to soil management?" Three earlier soil surveys cover different parts of the study area (Flint and Hawkins, 1957; Northcote, 1966; Stannard and Kelly, 1977). All are broadscale, with few soils differentiated in the area. Only Stannard and Kelly (1977) discussed geological relationships and then only of sand deposits deep beneath ancient streams.

This paper address why there are differences in the soils of the lower Namoi Valley. At present it is commonly accepted that there is little variation in the heavy clay soils west of Narrabri because they have formed from a common source of material - clay deposited from the Namoi River. Preliminary evaluation of our data indicates that this explanation is too simple to explain the range of soil characteristics found in the area.

Background

In Soil Science there is a fundamental concept that the nature and distribution of the soils is primarily determined by past depositional events. Today's landscape is made up of distinct areas of material, now different because (i) they were laid down at different times, (ii) were composed of material from various sources and (iii) were deposited by different processes. Within each of these areas the similarity of material, source and process give certain characteristic soils and inter-relations of these soils.

Thus recognition of the different bodies of materials making up the landscape provides an initial, broad stratification of a region.

Aims

This paper presents information on the nature and distribution of the source materials of the soils of the lower Namoi Valley west of Narrabri, and discusses the effects of this on the soils of the area.

Methods

The study area is the Edgeroi 1:50 000 map sheet, with reconnaissance investigations on neighbouring sheets. The information on source materials comes from (i) field observations, including rock exposures, road cuts and borrow pits, and (ii) 300 soil profiles (ranging in depth from 3m - 8m) from the systematic examination of the 1:50 000 Edgeroi map sheet.

Results and Discussion

There are both *residual rocks* and *transported sediments* in the study area.

1. Residual rocks

In general, the residual rocks form the ridges and high points in the study area but they do not give rise to extensive areas of soil. The rocks have been named by previous geological surveys (Geological Survey, 1968; Dulhunty, 1968).

Pilliga Sandstone forms prominent ridges in the east of the study area. Soils *in situ* are sandy, acid and low in nutrients. Beneath the sandstone, as demonstrated on the Bingara Road (see Fig. 1) at the crest of 12-Mile Hill, lie relatively soft clayey sands with mudstones of the Purlawaugh Formation. Within the Purlawaugh Formation are igneous rocks (their source being a long-extinct volcano) named Garrawilla Volcanics, and these form rocky outcrops or lie close to the surface on the slopes above Bobbiwaa and Spring creeks east of the Bingara Road. Associated soils are high in clay, reddish brown and apparently quite fertile. Younger igneous rocks (basalts, dolerites, trachytes) named Nandewar Volcanics form the Nandewar Range as well as the low-lying hills at Bald Hill, "Green Timbers" and "Oakvale". Soils on these rocks are shallow, black, high in clay, well structured and fertile. All of the Rolling Downs Group lies off the Edgeroi map sheet, principally on the northern part of the I.A. Watson Research Farm. It consists of clays rich in calcium carbonate. In places the calcareous beds are thick enough to have attracted mining for agricultural lime, e.g. on the Bingara Road, north-east of the I.A. Watson farm. Overlying the Rolling Downs beds is soft, yellow Tertiary-age sandstone visible to the west of the Killarney and Bobbiwaa State Forests. Soils are similar to those on Pilliga Sandstone.

2. Transported sediments

There are three types of transported sediments in the study area.

A. *Colluvium*. These sediments are formed locally from hill-wash processes, so their composition depends on the nature of the local rock. They are thin at the top of the slope and thick (up to 4m) at the bottom. As their travel is limited they are poorly sorted and tend to form sheet-like deposits on hillsides. An example of colluvium is the northern flank of the sandstone-composed hills at Twelve Mile on "Murrumbilla".

B. *Alluvium*. These sediments are transported more widely than colluvium, by water in streams and rivers. In the study area there are three main sources of alluvium. (i) Streams rising in the Nandewar Range bring material past Pilliga Sandstone to the plains, depositing the material to form flat-floored valleys and alluvial fans that flood around isolated high points such as Bald Hill and "Green Timbers". (ii) The Namoi River brings alluvium of mixed composition but mainly fine size to the country northwest of Narrabri. Its plains have low gradients and the ground slopes away from the river, so that the streams from the Nandewars (e.g. Galathera and Ten Mile Creek) are diverted to the northwest before reaching the Namoi. The junction of the Namoi alluvium with the more basalt-rich alluvium of the west-flowing streams is a broad and shallow depression that guides Galathera Creek towards Thalaba, near Millie. (iii) Bohena Creek and others rising in areas of Pilliga Sandstone to the south of the study area bring large quantities of quartz sand to the district. Upon reaching the Namoi River these sandy sediments become mixed with finer grained alluvium of other river systems.

The highly intermittent flows of the local streams and the low-volume flow of the Namoi River cannot explain the large extent of the alluvial plains in today's landscape. One answer is to suggest that the alluvial accumulation took place over a very long time.

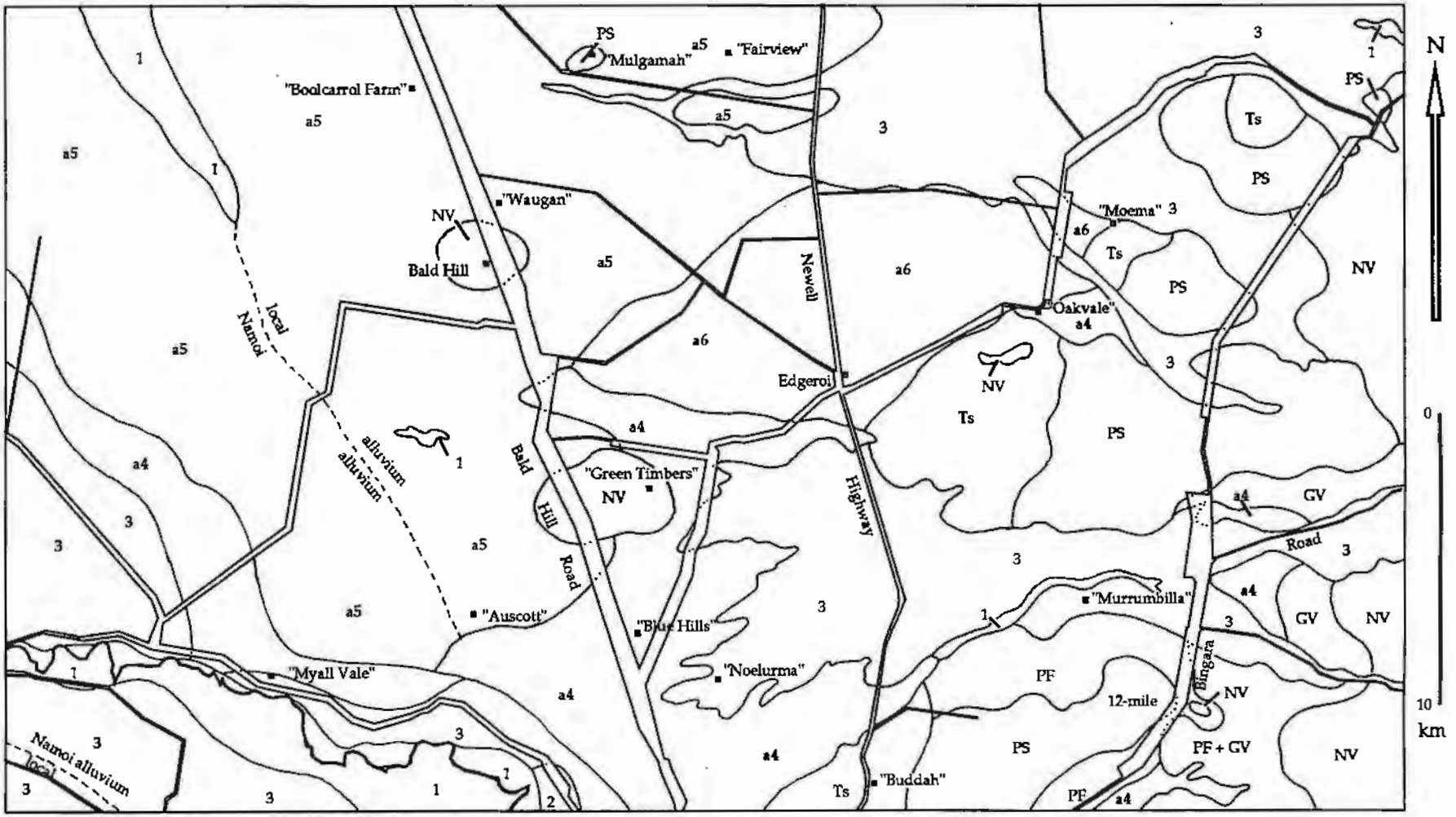

Figure 1. Parent rocks and sediments, Edgeroi sheet. PS, Pilliga Sandstone; PF, Purlawaugh Formation; GV, Garrawilla Volcanics; NV, Nandewar Volcanics; Ts, Tertiary sandstone; Rolling Downs Group, not on map; colluvium, not shown; 1, 2, 3, alluvium 1, 2, 3; a4, a5, a6, aeolian clays associated with alluvium 4, 5, 6.

Support for this notion is found in the recognition of six alluvial accumulations in the study area, numbered as 1-6 from youngest to oldest (Fig. 1).

Each alluvial body has distinctive features.

Alluvium 1 represents the contemporary, fresh deposits from the Namoi River. These are frequently flooded and cut channels are common.

Alluvium 2 is yellow sandy clay and clay, seen at Narrabri, e.g. at Doctor's Creek, but its distribution is patchy to Wee Waa, where significant areas are associated with Pian Creek.

Alluvium 3 consists primarily of red brown sandy clay to clay soils from Baan Baa (30 km SE and upstream of Narrabri) to Myall Vale. At the latter it forms a large fan falling gently towards Spring Plains. Alluvium 3 can be seen overlying alluvium 4 at "Noelurma" just east of the Bald Hill Road where the western edge of the sediments of Bobbiwaa Creek feathers out over alluvium 4.

Alluvium 4 is seen as grey and yellowish grey clays that are well developed beside Mulgate Creek and the southern fields of the I.A. Watson Research Farm, but are limited in extent down to Myall Vale, to become more widespread beyond Wee Waa.

Alluvium 5 forms extensive plains around "Auscott" and Bald Hill. In general the sediment is dark grey clay to 80-100 cm depth but on well-drained lands reddish brown clays predominate (e.g. at "Boolcarrol", "Mulgamah", "Fairview").

Alluvium 6 consists of clay, carries belah forest, and lies mostly to the east of the Newell Highway at a higher elevation than more recent alluvium. The landscape is very gently undulating, due to natural erosion over the long period it has been exposed to weathering, with well defined streams. The soils are deep, grey clays.

Aeolian deposits

Some evidence has been found of aeolian deposits in the study area. Such deposits are either drifted sands or dust deposits. The sands are transported relatively short distances on the ground surface and form sand ridges or dunes. In the study area wind-blown sands have been observed at Yarrie Lake and Round Swamp, west of Narrabri, and at "Bonny Hill" near Merah North. At Yarrie Lake the 1m high, crescent-shaped sand ridges lie NNE of the lake, where sand has been blown from the lake during dry periods. At "Bonny Hill" the sand forms a mound 1m high but is deeper than 10m, suggesting that this is a dune partly buried by later sediment accumulation.

Unlike the distinctive landforms produced by drifting sand, windblown dust is spread widely over a landscape, with no recognizably distinct landforms. Detection of windblown dust relies on field observation, and on laboratory work that examines the size distribution of the particles. Aeolian material extends from plains onto hills and can introduce minerals which are not in the local rocks. It is "finger-printed" by a size-frequency peak in the 20-50 micron (0.02-0.05mm) grain size as the wind is unable to carry coarser fractions. Numerous sites in the study area have been subjected to particle size analysis. The examples here have been chosen either to represent sites where the nature of the sediments suggests an aeolian deposit or where the mineral quartz would not be expected unless deposited by the wind.

Of the first type, samples were taken at "Waugan" from a low (60cm) mound of clay suspected of being a clay dune, and from an old clay soil now buried by locally-derived sand sediments at "Murrumbilla". The results of the analyses show a peak in the size fraction at 30-35 microns, implying that aeolian deposits have been added to these materials (Fig. 2

(i) and (ii)). Of the second type, a sample was taken from soil on the crest of Bald Hill. Again, the results (Fig. 2 (iii)) show a peak at 30-35 microns; the inference is a deposition of aeolian dust upon the soils forming from the basaltic rock. This peak is of quartz, which does not occur in the rock at Bald Hill.

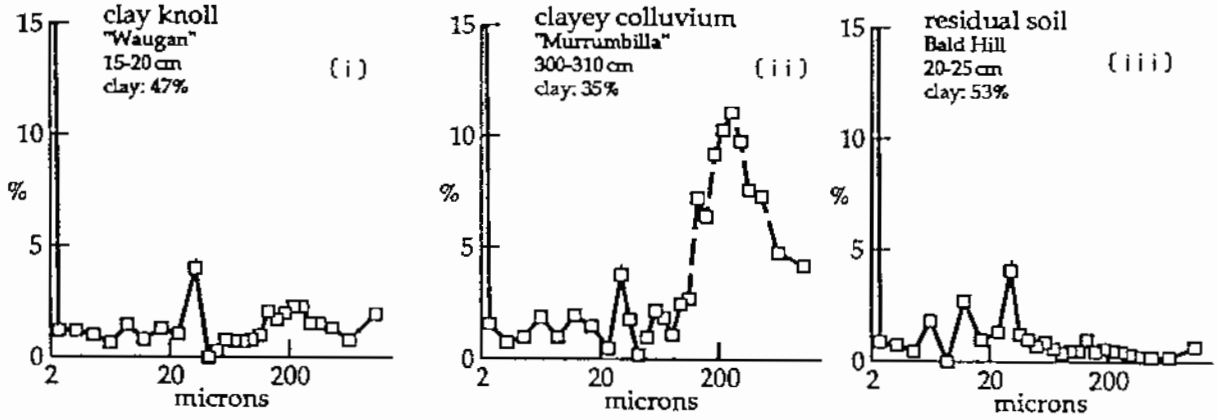

Figure 2. Evidence of aeolian dust. Particle size distributions of soils from the study area demonstrating the peak at 30-35 microns (1 micron = 0.001 mm).

Our studies have now established a framework within which to study the stratigraphy and soil distribution in the lower Namoi Valley. It is anticipated that recognition of the source materials will assist in understanding the variation of soil properties in the region, and their interpretation in terms of land use and soil management.

Acknowledgements

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