

BLAYNEY–ORANGE DISTRICT, NEW SOUTH WALES

K.M. Scott

CRC LEME, CSIRO Exploration and Mining, PO Box 136, North Ryde, NSW 1670
Keith.Scott@csiro.au

INTRODUCTION

The Blayney–Orange district is located 180 km west of Sydney at 33°30'S, 149°15'E within the BATHURST (SH55-08) 1:250 000 map sheet area. Regolith–landform mapping and regolith characterisation studies of the Bathurst region have been conducted by Chan (1998), and the geochemistry of aeolian components in soils of the Blayney–Orange district has been studied by Dickson and Scott (1998) and Scott (1999).

PHYSICAL SETTING

Geology

The basement rocks of the Blayney–Orange district comprise Palaeozoic volcanics and sediments of the Lachlan Fold Belt, which have been folded and intruded by Carboniferous granitoids and then uplifted during a series of tectonic events extending from the Silurian to the Early Carboniferous. These tectonic events have produced the north–south zones seen in outcrop today. During the late Tertiary (13–11 Ma; Middlemost, 1981), lavas from the Mt.

Canobolas volcano blanketed the landscape, commonly covering pre-Miocene weathering profiles. Subsequently, alluvium has been deposited, especially in gullies, and aeolian deposits have formed, particularly on topographic rises.

Geomorphology

The Blayney–Orange district varies from residual Tertiary lava plains and plateaux to mountainous terrains with variably weathered bedrock. Mt. Canobolas (1 396 m) forms the highest feature in the district, with much of the remaining land surface lying above 1 000 m. High level alluvial sediments (at about 900 m) occur in association with the Tertiary lavas, especially in the Blayney area (Chan, 1999). The district is cut by the northwest–trending Canobolas Divide, which separates the northerly draining Darling River system from the more southerly draining Lachlan River system (Figure 1). Landforms, such as wind-gaps, and the nature of the current drainage pattern suggest that a complex evolution of drainage (from northerly to northwest to westerly) has occurred since the Late Cretaceous (Chan, 1999).

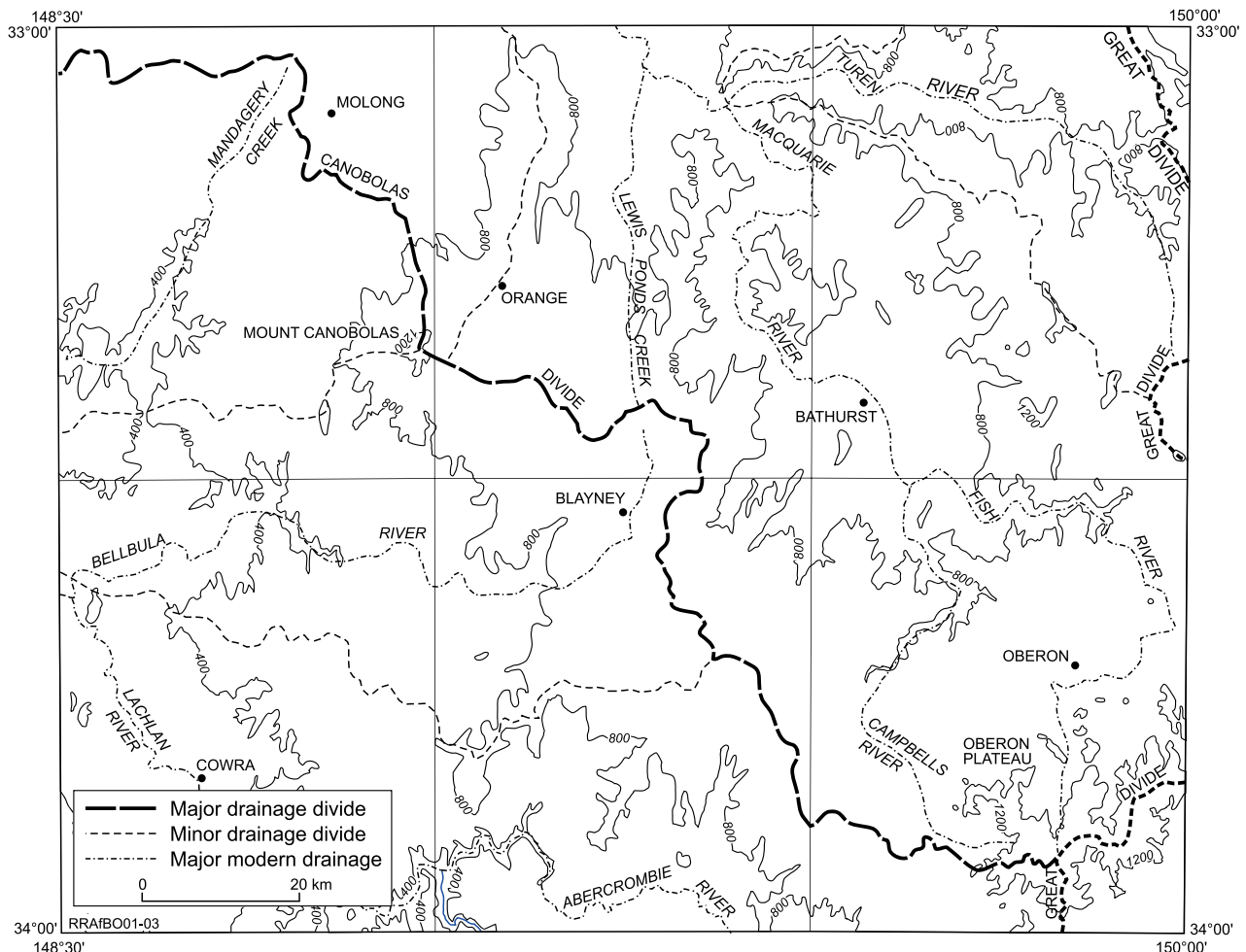


Figure 1. Drainages in the Blayney–Orange district. (after Chan, 1999)

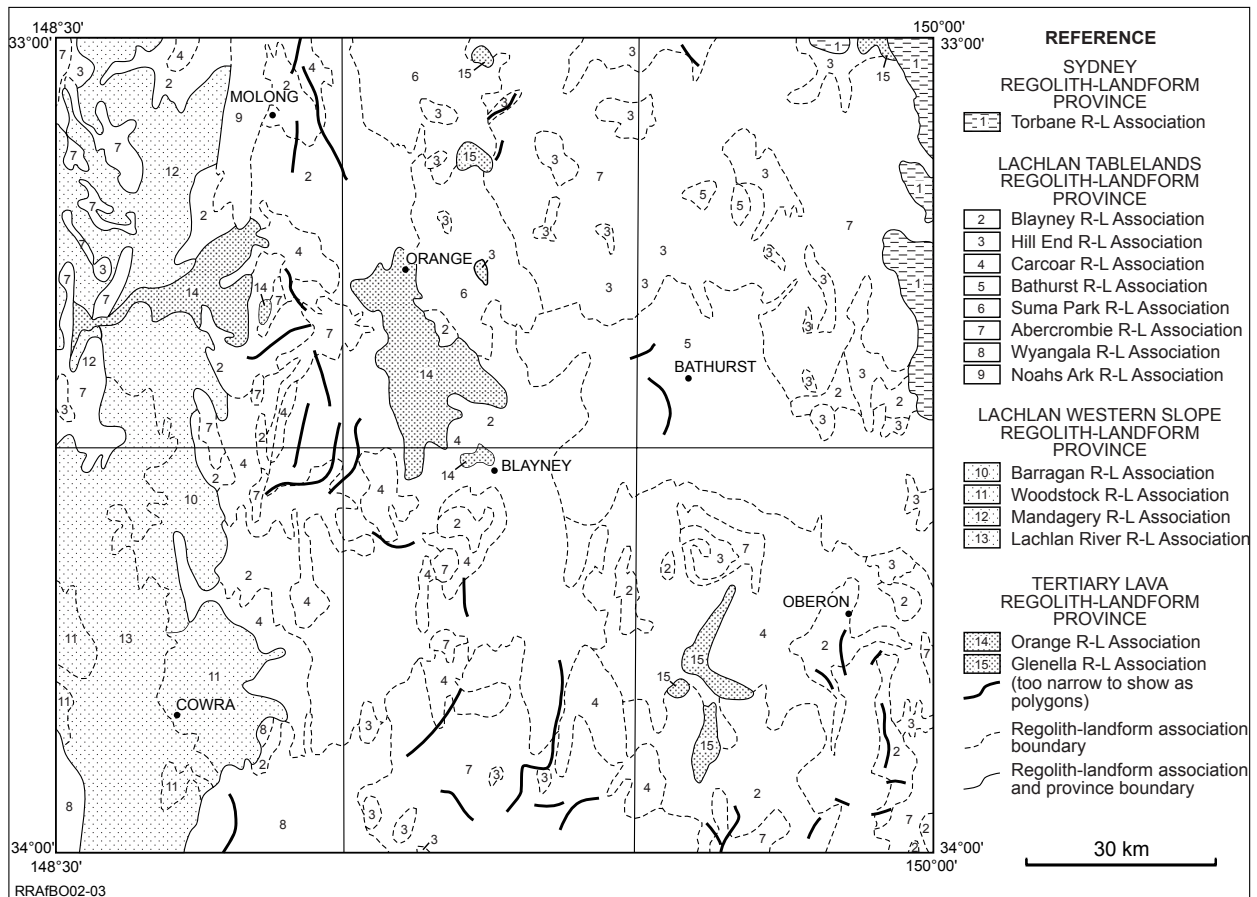


Figure 2. Major regolith–landform provinces in the Blayney–Orange district. (after Chan, 1998)

Climate and vegetation

The climate is temperate with warm to hot summers and cool to cold winters. The mean annual rainfall of 920 mm falls mainly during winter with erratic local thunderstorms during summer. The maximum and minimum temperatures are 37°C and 3°C in January and 18°C and -7°C in July. Remnant savanna woodland (5%), and agricultural crops and pastoral grasses (95%) occur throughout the region.

REGOLITH-LANDFORM RELATIONSHIPS

Maps of regolith–landform relationships at 1:100 000 scale have been produced by the interpretation of aerial photographs and airborne radiometric imagery, substantiated by ground traverses (Chan, 1995; Chan and Fleming, 1995). Two major regolith–landform provinces (Lachlan Tablelands and Tertiary Lava) were identified in the Blayney–Orange district by Chan (1998). The regolith materials that occur in the Lachlan Tablelands Province are either profiles developed by *in situ* weathering of bedrock, or unconsolidated, transported debris, parts of which are secondarily cemented. The sediments infill a more rugged topography than that which exists at present (Gibson and Chan, 1999).

In the Tertiary Lava Province, the basalts may be moderately to highly weathered and give rise to basalt-derived clays (Chan, 1998). Simplified regolith–landform relationships for the Blayney–Orange district are shown in Figure 2. These landforms are mantled by variable amounts of aeolian material, discussed in

more detail below.

REGOLITH CHARACTERISATION

Weathering of mafic Ordovician volcanic rocks has resulted in the development of a thin (commonly <10 m) orange to brown saprolite overlain by <2m of brown soil. Weathering of the Tertiary volcanics (composed of feldspar, augite, olivine, ilmenite and apatite) results in Fe-stained saprolite overlain by red kaolinite-rich soil which often contains corestones of basaltic saprock.

The aeolian mantle in the region is commonly only preserved on the leeward (eastern) side of rises. The best documented of these occurs 1.5 km east of the Browns Creek Cu–Au mine. Here, the aeolian material forms a 3 m thick profile consisting of clay-rich red–brown material above a more grey and red zone and a prominent hardpan above mafic Blayney Volcanics (Dickson and Scott, 1998). The aeolian component consists of quartz, feldspar, hematite, muscovite, kaolinite and anatase, whereas the underlying saprock contains feldspar, amphibole and ilmenite but no quartz. The aeolian material is fine-grained (~80% finer than 63 µm) with most being 28–32 µm sized quartz with straight extinction (Peterson *et al.*, 2000). Quartz from more phyllitic interbeds within the mafic volcanics is generally <20 µm, intergrown with mica and has undulose extinction (Peterson *et al.*, 2000).

The aeolian material is richer in Si, K, Ti, Ce, Rb, Th, W, U, Y and Zr but poorer in Al, Fe, Mg, Ca, Na, Au, Ba, Cr, Ni, Sr, Sc, V and Zn than the underlying Blayney Volcanics (Table 1). Relative to nearby Tertiary volcanic rocks, these differences are also similar (except for higher K, Ti, Y and lower Cr and V; Table 1). Titanium to zirconium ratios are ~13 in the aeolian material, much lower than in the Blayney Volcanics or Tertiary volcanics (Ti/Zr ~70) suggesting a much more felsic source for the aeolian materials (Hallberg, 1984). On the basis of grain size, mineralogy and geochemistry, the aeolian material is thus readily identified as allochthonous.

However, as indicated above, aeolian material is commonly incorporated into soils derived from the Ordovician rocks and Tertiary volcanics. In these cases, the aeolian contribution can often be recognised by a lower Ti/Zr than expected for mafic rocks and by a high proportion of fine material within the soil. The presence of quartz in soils above quartz-poor Tertiary basalts also indicates aeolian additions.

EVOLUTION OF THE AEOLIAN PROFILES

During the last 260 000 years, several discrete periods of aeolian deposition have occurred in southeastern Australia (Wasson, 1987) with aeolian material being recognised well out into the Pacific Ocean (Kiefert and McTainsh, 1996). Such materials have been deposited throughout the Blayney–Orange district, with the grain-size possibly suggesting that the aeolian material in this region was deposited between 60–40 ka (Peterson *et al.*, 2000). However, subsequent bioturbation and/or geomorphic processes have generally mixed the aeolian material with pre-existing soils or led to its transport into local drainages (Melis and Acworth, 1998). Hence “pure” aeolian sequences are rare. Incipient

Table 1. Chemical composition of samples in aeolian profile at Browns Creek (major wt%, minors ppm)

Depth (m)	Browns Ck					Tertiary Basalts (Ave of 6)
	134341 0.3	134342 1	134343 2	134344 3	134345 3.5	
SiO ₂	83.4	80.1	78.0	61.0	51.1	50.1
Al ₂ O ₃	6.46	5.70	6.93	10.4	12.8	15.1
Fe ₂ O ₃	3.09	6.70	6.52	14.7	10.5	11.1
MnO	0.05	0.18	0.04	0.13	0.14	0.11
MgO	0.22	0.22	0.33	1.37	8.43	5.10
CaO	0.15	0.08	0.15	1.08	9.85	7.40
Na ₂ O	0.11	0.10	0.16	0.21	2.28	3.16
K ₂ O	0.85	0.74	0.83	0.99	0.58	1.14
TiO ₂	1.15	1.17	1.18	1.00	0.55	2.08
P ₂ O ₅	0.05	0.10	0.11	0.29	0.07	0.50
SO ₃	0.01	0.01	0.02	0.01	<0.01	-
As	4	11	13	25	19	-
Au (ppb)	<5	<5	<5	<5	9.1	-
Ba	260	270	230	480	500	370
Ce	79	72	56	45	13	-
Co	25	50	8	29	44	40
Cr	130	210	180	840	940	170
Cu	26	25	21	37	20	37
Ni	30	14	19	110	240	98
Pb	20	38	32	45	15	-
Rb	50	38	41	31	<20	-
Sr	44	38	55	66	450	410
Sc	10	8	9	17	39	20
Th	13	15	14	10	1	-
W	5	3	4	<2	<2	-
U	3	3	3	2	<2	-
V	85	150	150	320	230	130
Y	31	28	24	15	12	28
Zn	25	22	26	33	68	130
Zr	640	620	520	340	46	190
Ti/Zr	11	11	14	18	72	66

mottling and the formation of pisoliths within the aeolian material at Browns Creek suggests that weathering processes may alter the nature of aeolian sediments in relatively short periods (60–40 thousand years).

REFERENCES

- Chan, R.A., 1995. Blayney regolith–landforms, New South Wales. Preliminary Edition map. 1:100 000 regolith–landform series, Sheet 8730. Australian Geological Survey Organisation (Geoscience Australia)/National Geoscience Mapping Accord, Canberra.
- Chan, R.A., 1998. Bathurst regolith–landforms. In: J.J. Watkins and D.J. Pogson (Compilers). Bathurst, New South Wales. Explanatory notes. 1:250 000 geological series, Sheet SI55-8, 2nd Edition. Geological Survey of New South Wales. pp 311-328.
- Chan, R.A., 1999. Palaeodrainage and its significance to mineral exploration in the Bathurst region, NSW. In: G. Taylor and C. Pain (Editors). Proceedings of Regolith '98, New Approaches to an Old Continent. CRC LEME, Perth, Australia. pp 38-54.
- Chan, R.A. and Fleming, C., 1995. Orange regolith–landforms, New South Wales. Preliminary Edition map. 1:100 000 regolith–landform series, Sheet 8731. Australian Geological Survey Organisation (Geoscience Australia)/National Geoscience Mapping Accord, Canberra.
- Dickson, B.L. and Scott, K.M., 1998. Recognition of aeolian soils in the Blayney District, NSW: implications for Exploration. Journal of Geochemical Exploration, 63: 237-251.
- Gibson, D.L. and Chan, R.A., 1999. Aspects of palaeodrainage in the north Lachlan Fold Belt region. In: G. Taylor and C. Pain (Editors). Proceedings of Regolith '98, New Approaches to an Old Continent. CRC LEME, Perth, Australia. pp 23-37.
- Hallberg, J.A., 1984. A geochemical aid to igneous rock type identifications in deeply weathered terrain. Journal of Geochemical Exploration, 20: 1-8.
- Kiefert, L. and McTainsh, G.H., 1996. Oxygen isotope abundance in the quartz fraction of aeolian dust: implications for soil and ocean sediment formation in the Australasian region. Australian Journal of Soil Research, 34: 467-473.
- Melis, M.I. and Acworth, R.I., 1998. Dicks Creek field site. In: K.M. Scott, X.Y. Chen and R. Gatehouse (Compilers). Aeolian dust: implications for Australian mineral exploration and environmental management. CRC LEME, Perth. Field Guide. pp. 18-23.
- Middlemost, E.A.K., 1981. The Canobolas Complex, N.S.W., an alkaline shield volcano. Journal of the Geological Society of Australia, 28: 33-49.
- Peterson, E.K., Campbell, J., Humphreys, G.S., Hesse, P.P. and Conaghan, P.J., 2000. Aeolian dust mantles in the Blayney area, NSW. In: K. McQueen and C. Stegman (Editors). Central West Symposium Cobar 2000. CRC LEME, Perth. Extended Abstracts. 77. pp 72-76.
- Scott, K.M., 1999. Regolith effects and Au exploration in the Blayney–Orange District, NSW. In: G. Taylor and C. Pain (Editors). Proceedings of Regolith '98, New Approaches to an Old Continent. CRC LEME, Perth, Australia. pp

109-116.

Wasson, R.J., 1987. Desert dune building, dust raising and palaeoclimate in the southern hemisphere during the last 280,000 years. In: T.H. Donnelly and R.J. Wasson (Editors). CLIMANZ3. Proceedings of the Third Symposium on Late Quaternary climatic history of Australasia. Parkville, Victoria. pp 28-29.