DUNDAS TABLELAND, VICTORIA

M.D. Paine and C. Phang

CRC LEME, CSIRO Exploration and Mining, PO Box 1130, Bentley, WA 6102

Mark.Paine@csiro.au

INTRODUCTION

The Dundas Tableland lies at the centre of the HAMILTON 1:250 000 (SJ54-7) map sheet in southwestern Victoria (Figure 1). The tableland is a dissected plateau bounded to the east by the Grampians Ranges and to the southeast by the Tertiary Volcanic Plains. The tableland also separates the Otway Basin to the south from the more topographically subdued Murray Basin to the north. The following case study is based on work undertaken by Paine (1995), Dahlhaus *et al*. (2000), Paine (2002), and ongoing work as part of Paine's PhD study.

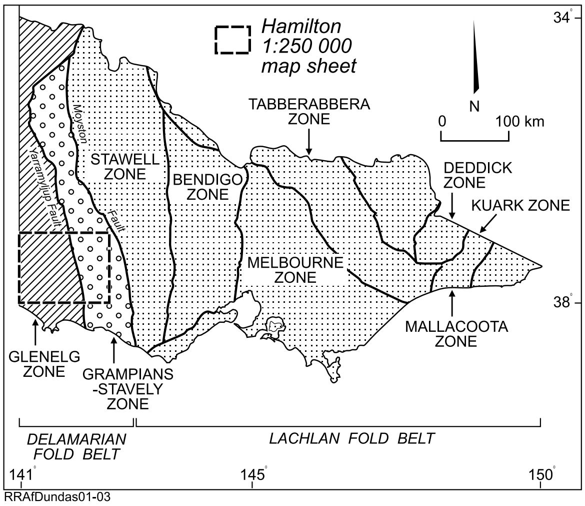


Figure 1. Location and structural setting of the HAMILTON 1:250 000 map sheet in western Victoria. (Modified after VandenBerg *et al*., 2000)

PHYSICAL SETTING

Geology

Basement rocks on the Dundas Tableland form part of the Delamarian Fold Belt (Figure 1), which is the oldest part of the Tasman Fold Belt System in eastern Australia. In western Victoria, the Delamarian Fold Belt is divided into two structural zones; the Glenelg Zone and the Grampians-Stavely Zone (VandenBerg *et al*., 2000). The basement rocks on the Dundas Tableland are largely Cambrian in age and include high-grade metamorphic rocks, sedimentary rocks and minor volcanic strata. These are unconformably overlain by Silurian sediments of the Grampians Group, which form the main part of the Grampians Ranges, the Black Range and Mount Dundas. Lower Devonian rocks of the Rocklands Volcanic Group unconformably overlie the Cambrian basement and Grampians Group rocks. Scattered Permian deposits occur in the Coleraine and Moree areas, and Cretaceous Otway Group rocks are poorly exposed to the southwest of the Dundas Tableland, where they form the Merino Tableland.

Tertiary sediments in southwestern Victoria are concentrated in the Murray and Otway basins. The intracratonic Murray Basin is dominated by fluvial and shallow marine sediments that were deposited during a series of marine transgressions and regressions in the Cenozoic. Units in southern portions of the basin include gravels to clays of the Palaeocene–Lower Oligocene Renmark Group, carbonate-dominated sediments of the Oligocene–Miocene Murray Group and quartz sands and gravels of the Pliocene Loxton-Parilla Sand. Tertiary sediments in the Otway Basin have been broadly subdivided into shallow marine to continental deposits of the Palaeocene–Eocene Wangerrip Group and dominantly marine limestone and marl of the Heytesbury Group. Post Heytesbury Group sediments, such as the Grange Burn Formation and Dorodong Sand, were deposited during short-lived marine transgressions into the northern portions of the Otway Basin.

Geomorphology

The Dundas Tableland is a variably dissected plateau (Jenkin, 1988; Figure 2A) forming the western-most portion of the Central Victorian Uplands. Dissection of the Dundas Tableland was chiefly accomplished by the Glenelg and Wannon rivers and their tributaries (Gibbons and Downes, 1964). Valleys formed by these rivers often incise bedrock and have slopes of about 2–4^{o}, although slopes of 8–15^{o} occur along the more deeply dissected drainage lines (Jerenic, 1993). The term "Dundas Surface" was applied by Kenley (1975) to describe the extensive but highly variable ferruginous duricrust capping that is characteristic of the tableland plateau.

Climate and vegetation

The Dundas Tableland experiences hot dry summers and cool wet winters with average maximum temperatures being 26^{o}C in summer and 12^{o}C in winter. Average yearly rainfall is 645 mm and pan evaporation is 1326 mm per year. Soils tend to become saturated between May and September when rain contributes to overland flow, depression storage and recharge (Jerenic, 1993).

The major tree species that occur in the area are red gum (*E. camaldensis)*, mana gum (*E. viminales*) and swamp gum (*E. ovata*) (Jerenic, 1993). Some remnant vegetation exists in the area and some areas have been revegetated. Predominant land use is sheep and cattle grazing with on-farm diversification including yabby production and agro-forestry (Woof, 1994).

REGOLITH CHARACTERISATION

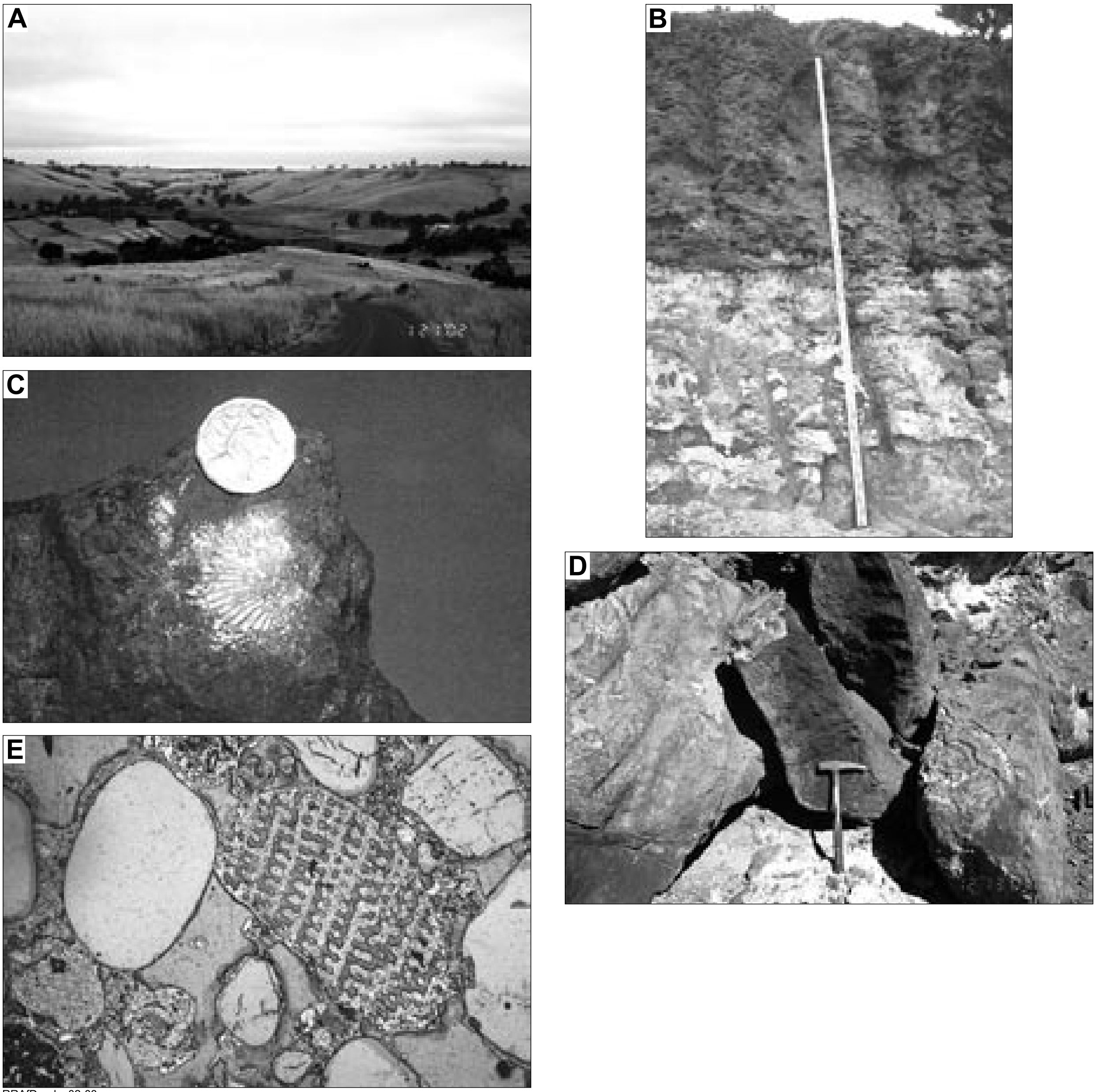
The Dundas Tableland contains a regolith of variable thickness that has developed within a variety of substrates ranging from Cambrian basement through to Quaternary sediments. Exposures of the regolith are limited to road cuttings, quarries and natural exposures generally formed at the break of slope. Typical regolith exposures include white to mottled kaolinitic saprolite and clay zones, overlain by a variety of ferruginous duricrusts. Initial observations indicate that the weathering profiles comprise both residual and transported components.

Residual profiles

Profiles developed on the dominantly felsic basement rocks typically display a white to mottled saprolite that grades into a mottled clay zone. Many of the primary structural features of the underlying rock, such as joints and porhyritic fabric, are preserved in the saprolite. At the Boral Quarry at Wannon, red iron-rich mottles make up about 30% of the mottled saprolite and commonly occur at the centre of joint bounded blocks with a white kaolinite/halloysite-rich matrix (Figure 2B). Where exposed, the clay zone, (when dry) is characterised by desiccation cracks and is consequently very friable. At a road cutting on Diprose Road, the clay zone displays distinctive, largely sub-horizontal mottles, often referred to as "tiger mottles". Post-mottle root channels also occur throughout top metre of the profile and are commonly filled with grey silty clay containing surface-derived nodules and pisoliths. Where preserved, the duricrusts developed over weathered felsic basement are relatively thin and typically comprise weakly cemented pisoliths and nodules in a sandy clay matrix.

Sediments

A variety of sediments are exposed on the Dundas Tableland, but limited outcrop and extensive weathering overprints, particularly pervasive ferruginisation, hamper their recognition. Two largely



RRAfDundas02-03

Figure 2. (A) Typical landscape of the southern Dundas Tableland; (B) Weathering profile comprising mottled saprolite developed over acid volcanic rocks overlain by Loxton-Parilla Sands; (C) *Annachlamys sp* in ferruginised Murray Group sediments; (D) Loxton-Parilla Sands exposed at the Boral Quarry, northwest of Hamilton; (E) Echinoderm plate in Loxton-Parilla Sands.

marine units are discussed here and are regarded as equivalent to units in the adjacent Murray and Otway basins. The stratigraphic nomenclature of Brown and Stephenson (1989) is used for sediments of the Murray Basin.

Massive vesicular or vermiform ferruginous duricrusts exposed at the break of slope, particularly near the flanks of the Dundas Tableland, appear to be equivalent to the Murray Group. At Englefield, near the centre of the Dundas Tableland, a massive ferruginous duricrust unconformably overlies granodiorite. Well-preserved marine fossil moulds (Figure 2C) found in this material include *Annachlamys* sp. and *Proxychione* sp. (T. Darragh, pers comm., 1995).

Massive ferruginised sands unconformably overlie Palaeozoic basements rocks and ferruginous duricrusts of the Murray Group. These are regarded as equivalent to the Loxton-Parilla Sands. At the Boral Quarry northwest of Hamilton, these sandy clays are up to 6 m thick and appear to become more clay-rich with depth (Figure 2B). A variety of mottles occur throughout the unit, ranging from wispy, flame-like mottles in lower portions to more uniform, ferruginisation in upper portions. Modern root channels in the top one to two metres of the unit are infilled with sandy, kaolinitic clays. These abandoned channels are common in fallen blocks (Figure 2D). Loose ferruginous nodules and pisoliths are set in a sandy matrix at the top of the profile. Echinoid fragments comprising spines and plates (Figure 2E) are found in ferruginous pisoliths, nodules and mottles throughout the unit, as well as in the surficial ferruginous lag.

REGOLITH EVOLUTION

Historically, regolith profiles on the Dundas Tableland have been collectively termed "laterites" and "laterite profiles", comprising pallid, mottled and ferruginous horizons (e.g. Marker, 1958; Gibbons and Downes, 1964) with only minor sedimentary components being recognised (Kenley, 1971; Spencer-Jones, 1971). More recently, transported components have been identified in a number of weathering profiles on the tableland (Paine, 1995; Quinn, 1997; Morand *et al*., 2002). The deposition of many of these sediments can be linked to marine transgressions and regressions into the adjoining Murray and Otway basins during the Tertiary.

A major marine transgression initiated in the late Early Oligocene can be correlated with deposition of the marine and marginal marine formations of the Oligocene–Middle Miocene Murray Group sequence over the western part of the Murray Basin. Exposures of this unit on the Dundas Tableland suggest that this transgression, rather than being limited to the Murray and Otway basins, must have covered much, if not all of the Dundas Tableland. The relatively good condition of the fossil molds *Annachlamys* sp. and *Proxychione* sp. at the Englefield site implies that the shells were intact upon deposition and consequently they are considered to be of local origin. The fossils are of Late Oligocene to mid Miocene age and indicative of open marine shelf environments (T. Darragh, pers comm., 1995).

Following regression of the sea in the Middle Miocene, sea levels rose again in the Late Miocene resulting in deposition of various marine and marginal marine units, including the Loxton-Parilla Sands. These deposits are charaterised by various near shore sediments. Stranded beach rides associated with this unit form positive topographic relief features in the Murray Basin and, where exposed, occur as Th anomalies in radiometric images in the southern end of the Murray Basin and the Dundas Tableland (Quinn, 1997; Dahlhaus *et al*., 2000). Exposures coincident with these anomalies on the Dundas Tableland include those at the Wannon Quarry and numerous deposits in the northern portion of the Dundas Tableland.

The age of the weathering that has overprinted both residual and transported material on the Dundas Tableland remains poorly understood with most authors suggesting a Miocene to Pliocene age. In the Murray Basin, the top few metres of the Loxton-Parilla Sands contain an interstitial white kaolinitic or gibbsitic matrix and are capped by a pisolitic ferricrete with a siliceous cement (Brown and Stephenson, 1989). These weathering overprints have been well documented by Kotsonis (1995) and the resultant unit or surface has been referred to as the Karoonda Surface (Firman, 1973; Kotsonis, 1995) or as the Timboon Pedoderm (Gill, 1973).

REFERENCES

Brown, C.M. and Stephenson, A.E., 1989. Geology of the Murray Basin, southeastern Australia. Bureau of Mineral Resources (Geoscience Australia), Canberra. Record 1989/53. 422 pp.

Dahlhaus, P.D., MacEwan, R.J., Nathan, E.L. and Morand, V.J., 2000. Salinity on the southeastern Dundas Tableland, Victoria. Australian Journal of Earth Sciences, 47: 3-11.

Firman, J.B., 1973. Regional stratigraphy of surficial deposits in the Murray Basin and Gambiar Embayment. South Australian Geological Survey. Report of Investigations 39. 68 pp.

Gibbons, F.R. and Downes, R.F., 1964. A study of the land in southwestern Victoria. Soil Conservation Authority Victoria. 289 pp.

Gill, E.D., 1973. Geology and geomorphology of the Murray River region between Mildura and Renmark, Australia. Natural Museum of Victoria, Memoir, 34: 241-251.

Jenkin, J.J. 1988. Geomorphology. In: J.D. Ferguson (Editor). Geology of Victoria. Geological Society of Australia. Special Publication 5. pp. 403-426.

Jerenic, F.L., 1993. A hydrogeological study of dryland salinity in the Bulart region, western Victoria. B.Sc. (Hons) Thesis, University of Ballarat. (Unpublished).

Kenley, P.R., 1971. Cainozoic geology of the eastern part of the Gambier Embayment. In: H. Wopfner and J.G. Douglas (Editors.). The Otway Basin of southeastern Australia. Special Bulletin of the Geological Surveys of Victoria and South Australia. pp. 89-153.

Kenley, P.R., 1975. Geology and geomorphology of western Victoria. Paper presented at the A.I.A.S. Symposium, Horsham, Victoria.

Kotsonis, A., 1995. Late Cainozoic climatic and eustatic record from the Loxton-Parilla Sands, Murray Basin, southeastern Australia. M.Sc. Thesis, University of Melbourne. (Unpublished).

Marker, M.E., 1958. Soil erosion in relation to the development of landforms in the Dundas area of western Victoria. Proceedings of the Royal Society of Victoria, 71: 125-136.

Morand, V.J., Wohlt, K.E., Cayley, R.A., Kemp, A.I.S. and Taylor, D.H., In prep. Glenelg Special Map Area Geological Report. Geological Survey of Victoria. Report.

Nathan, E.L., 1998. Dundas landscapes and dryland salinity. M.App.Sci Thesis, University of Ballarat. (Unpublished).

Paine, M.D., 1995. Regolith development on the southeastern Dundas Tableland. B.Sc. (Hons) Thesis, University of Ballarat. (Unpublished).

Paine, M.D., 2002. A preliminary report on Tertiary regolith evolution on the Dundas Tableland. In: G.N. Phillips and K.S. Ely (Editors). Victoria Undercover. CSIRO Publishing, Melbourne. pp. 161-164.

Quinn, N.H., 1997. Regolith of the Balmoral 1:100 000 sheet, Western Victoria. B.Sc. (Hons) Thesis, University of Melbourne. (Unpublished).

Spencer-Jones, D., 1971. Marginal Tertiary deposits on the Tyrendarra Embayment – Grassdale and Hamilton district. In: H. Wopfner and J.G. Douglas (Editors). The Otway Basin of southeastern Australia. Special Bulletin of the Geological Surveys of Victoria and South Australia. pp. 241-249.

VandenBerg, A.H.M., Willman, C.E., Maher, S., Simons, B.A., Cayley, R.A., Taylor, D.H., Morand, V.J., Moore, D.H. and Radojkovic, A., 2000. The Tasman Fold Belt System in Victoria. Geology and mineralisation of Proterozoic to Carboniferous rocks. Geological Survey of Victoria. Special Publication. 462 pp.