NORTHPARKES AREA, NEW SOUTH WALES

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INTRODUCTION

The Northparkes area (Figure 1) is situated in central New South Wales about 40 km northwest of Parkes and 350 km northwest of Sydney within the FORBES (SI55-7) 1:250 000 map sheet. The following summary is based on detailed regolith characterisation, including regolith–landform mapping, mineralogical and geochemical studies (Chan and Tonui, 2003; Tonui *et al.,* 2003).

PHYSICAL SETTING

Geology

The Northparkes area lies within Palaeozoic rocks of the northeastern portion of the Lachlan Fold Belt. Bedrock consists of Upper Ordovician Wombin and Goonumbla Volcanics in the east, and Devonian–Silurian Derriwong Group sediments in the west. An Upper Ordovician monzonite to syenite intrudes the Wombin Volcanics and Goonumbla Volcanics (Figure 1).

Geomorphology

Northparkes is situated on the western slopes of the Eastern Highlands, which divides the coastal Tasman Sea drainage to the east from the inland drainage to the west. The area sits within the headwaters of the northerly flowing Bogan River just a few kilometres north of the Canabolas Divide, a regional northwesterly drainage divide between the Darling River catchment to the north and the Lachlan River catchment to the south. Relief on the western slopes is subdued with plains to rises (<30 m relief) and a few north trending low hills to hills (30–300 m). Relief and elevation rises towards the east.

Climate and vegetation

The climate within the Parkes area is semi-arid with average daily maximum and minimum temperatures of 23 and 11ºC, respectively, and an annual rainfall of 586 mm (approximately 85 mean rainy days per year). The vegetation is extensively cleared woodland comprising grey box, rosewood, white cypress pine and casuarinas.

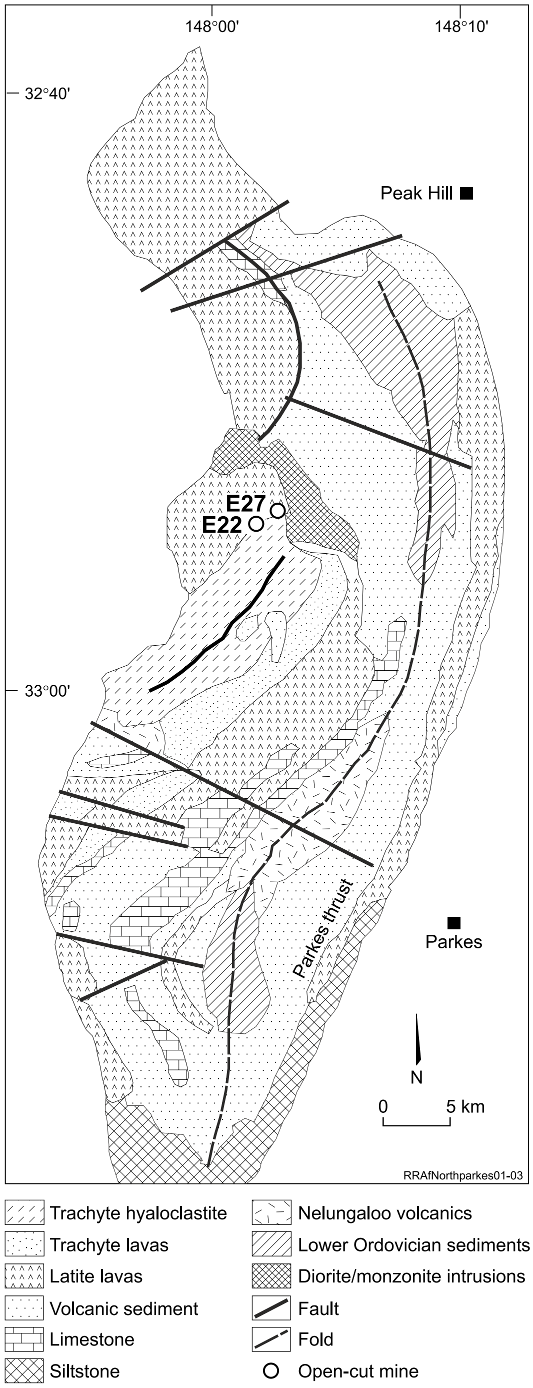

Figure 1. Location and geological setting of the Northparkes region. E22 and E27 Cu–Au deposits are also shown.

REGOLITH–LANDFORM RELATIONSHIPS

Regolith–landform mapping was completed over the FORBES 1:250 000 sheet (Gibson and Chan, 1999) and the area surrounding the Northparkes Cu–Au mine (Adamson, 1996). Detailed mapping of the mine pits was performed by Tonui *et al.* (2003). Seven regolith–landform units were identified by Chan and Tonui (2003), three of which comprise *in situ* regolith with localised aeolian, colluvial and alluvial materials. A few areas of lag in the southwest and central-south of the area occur on the east facing slopes of a ridge of Devonian sandstones of the Derriwong Group. The lag comprises ferruginous sandstone gravels and rounded quartz pebbles.

The regolith over much of the area consists of clay with alluvial gravel bands of polished ferruginous sandstone and rounded quartz in the top metre. The sediments in this regolith–landform unit overlie weathered Upper Ordovician Wombin Volcanics rocks. Three other units of transported regolith, which partly

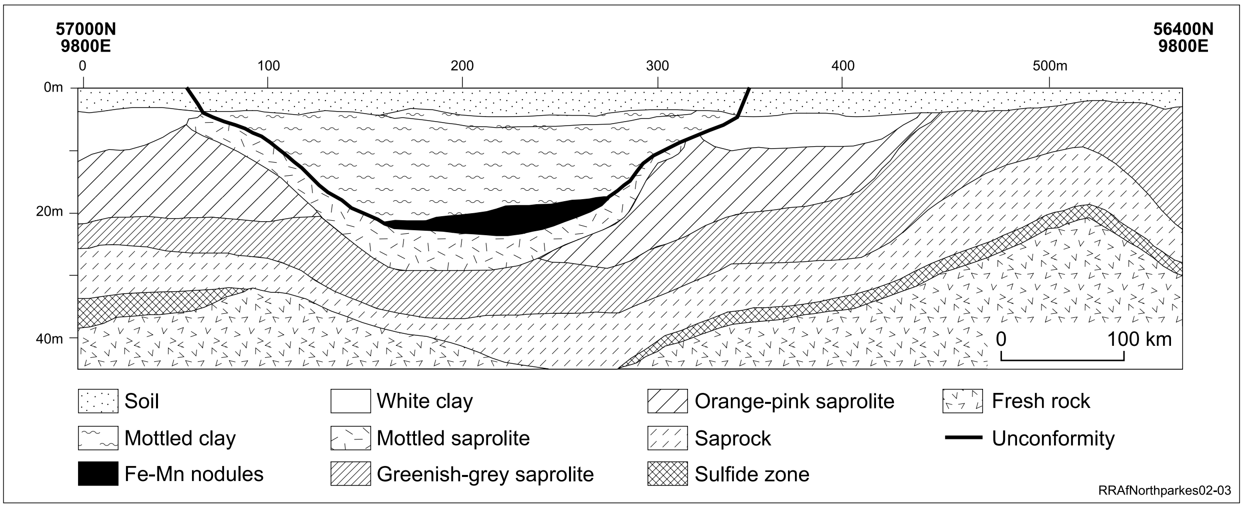

Figure 2. Distribution of the regolith at the Northparkes E22 deposit.

overlie the alluvium, comprise: 1) a possible aeolian clay loam and clay unit with iron–manganese and carbonate nodules that occurs in slightly higher parts of the landscape; 2) poorly drained gilgai areas with fine sandy loam to heavy clay with mottles and carbonates; and 3) erosional gullies along modern drainage lines containing sandy loam to clay layers with quartz and sandstone gravel fragments associated with headwater tributaries of the Bogan River.

Regolith cuttings from a line of drill holes running west to east across the northern edge of the study area reveal an incised palaeotopography buried beneath sediment. A palaeotopographic low in the western edge of the traverse is up to 30 m deep and contains sediments that are weathered to a depth of 11 m. It is separated from a second palaeovalley to the east by a buried palaeohigh that has fresh bedrock at 8 m depth. The depth of sediments is similar to those infilling palaeovalleys in the Endeavour open-pits. Some of the material from the drill holes contains up to four gravel layers with interbedded fine sediments.

REGOLITH CHARACTERISATION

In situ regolith

Weathering of the trachyandesite has formed saprock and kaolinite-rich saprolite of various types which are mostly overlain by weathered alluvial or colluvial sediments (Figure 2). The saprock is greenish-grey, slightly weathered and jointed, and ranges in thickness from 5 to 10 m. Its boundary with the fresh rock is gradual. Three zones of saprolite have been distinguished. Greenish-grey saprolite overlies saprock and contains remnants of quartz veins and ranges in thickness from 15 to 25 m. The greenish grey colour is indicative of a reducing environment (least weathered), as evidenced by an abundance of nontronite. Orange-pink saprolite overlies the greenish-grey saprolite and ranges in thickness from 10 to 20 m. It is soft and highly friable with most of the primary minerals having weathered to Fe^{3+} rich clays in an oxidizing environment. Mottled saprolite occurs below the mottled clay unit and ranges in thickness from 5 to 10 m. It appears to have formed by infusion of Fe into saprolite from the overlying sedimentary mottled clay.

Some regolith units are restricted in their distribution. A white clay unit occurs in the E22 pit overlying the orange-pink saprolite (Figure 2) and ranges in thickness from 6 to 10 m. White clays frequently form *in situ* beneath the water table, in anoxic conditions implying that this part of the profile underwent prolonged saturation. A high intensity of weathering would have reduced the competence of the upper saprolite so that settling of the clays occurred as the rock fabrics were being destroyed by authigenesis (Tonui *et al.,* 2003).

Transported regolith

Transported regolith at Northparkes comprises mottled clay, Fe–Mn units and opaline silica rich zones. The mottled clay is hematite–goethite rich and consists of mini, medium and mega mottles. The mini-mottled zone occurs below the soil with thickness of 1–2 m and contains mottles that are <5 mm in diameter. The medium-mottled zone is reddish brown to reddish grey and contains mottles that are 5–30 mm in diameter. It ranges in thickness from 4 to 6 m. Both mini- and medium-mottled clay zones contain rounded to sub-rounded ferruginous nodules (<5–10 mm in diameter). The mega-mottled zone ranges in thickness from 5 to 10 m, is brown to reddish grey, and contains mottles with dull and earthy appearance that are 50–300 mm in diameter.

Two nodular Fe–Mn units occur within the mottled clay unit in E27 and one unit occurs at the boundary between transported and *in situ* regolith in E22 (Figure 2). They range in thickness from 5 to 7 m and are characterized by dark-coloured rounded to sub-rounded Fe–Mn rich nodules (5–300 mm in size) in a pale green to pink clay matrix. The siliceous aggregates occur mainly within the mega-and medium-mottled clay as opaline nodules. These nodules are coated by dolomite and sub-angular and elongate in shape, with sizes ranging from 20 to 50 mm.

DATING

Palaeomagnetic analyses of the mega-mottled clay and orange-pink saprolite returned Tertiary and Late Carboniferous ages, respectively (Pillans *et al.,* 1999). The latter represents one of the oldest recorded ages of weathering in SE Australia.

REGOLITH EVOLUTION

Regolith–landform mapping, palaeomagnetic and apatite fission track thermochronology data (O'Sullivan *et al*., 2000) indicate preservation of Early to Mid-Carboniferous weathering at Northparkes through repeated episodes of burial and exhumation. The region has been affected by multiple episodes of denudation and cooling, and burial and heating, with an overall tectonic stability resulting in the preservation of deeply weathered profiles. The data suggest that the area has been sub-aerially exposed several times since the Late Devonian followed by significant depositional and erosional periods in the Late Mesozoic. Deposition of alluvial and colluvial sediments on the eroded saprolite surface at Northpakes occurred after the Late Mesozoic, though remnants of older sediments may exist. Weathering of sediments and differentiation into mini-, medium- and mottled clay occurred during the Cenozoic, as did the infusion of saprolite with Fe to form mottled saprolite (Chan and Tonui, 2003).

The transported material at Northparkes accumulated in palaeotopographic lows (or palaeovalleys). The Fe–Mn units appear to represent ancient redox fronts associated with old water tables. The presence of two ancient redox zones associated with palaeowatertables at the E27 deposit suggests that there were multiple (probably cyclical) climatic changes rather than a single event. The formation of this unit appears to correlate well with the interpreted shift to cooler and drier climates in the region since mid Miocene (Martin, 1991).

Weathered palaeoevalley sediments, as occurring at Northparkes, are likely to be widespread within the northern Lachlan Fold Belt. These sediments also bury palaeohighs indicating a palaeorelief significantly greater than that of the present landsurface. Extensive exploration drilling and field mapping undertaken by several mining companies, notably Rio Tinto (formerly North Ltd), in the region continue to intersect these palaeovalley sediments (R. Jones, Rio Tinto, personal communication, 2002).

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