PAJINGO Au–Ag DEPOSITS, QUEENSLAND

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INTRODUCTION

The Pajingo Au–Ag deposits lie 53 km south–southeast of Charters Towers (Figure 1) at 20°32'S, 146°27'E within the CHARTERS TOWERS (SF55-02) 1:250 000 map sheet area. The following summary is drawn from a regional study by Campbell (1996) and an orientation study around the mineralisation by Robertson (1997), assisted by mapping and drilling data provided by Normandy Mining Ltd and Battle Mountain (Australia) Inc.

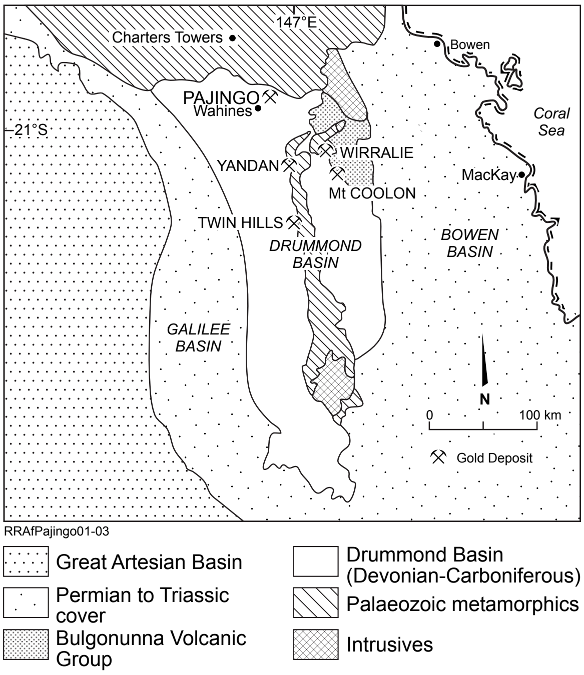

Figure 1. Location map of the Pajingo area in relation to regional geology, Charters Towers and other nearby Au deposits. The Wahines Prospect is close to Pajingo. (after Ruxton and Seed, 1998)

PHYSICAL SETTING

Geology

Epithermal Au mineralisation at Pajingo (Figure 1) occurs in relatively flat-lying Devonian rocks of the Drummond Basin (Bobis *et al.,* 1995; Cornwell and Teddinik, 1995). The rocks include felsic to mafic lava and tuff, volcaniclastic sediments and fluvial to lacustrine sediments. Mineralisation includes the Scott and Cindy lodes (Figure 2) and a number of other auriferous veins within a northwest trending zone in the Janet Range. Large areas of the mineralised Devonian bedrock are masked from surface exploration by an extensive sedimentary cover. Regionally, the cover includes the Tertiary Campaspe, Southern Cross and Suttor formations; the Southern Cross Formation being the most important cover sequence in the Pajingo area (Figure 2). The Tertiary sediments occur at various levels within the landscape (Figure 3).

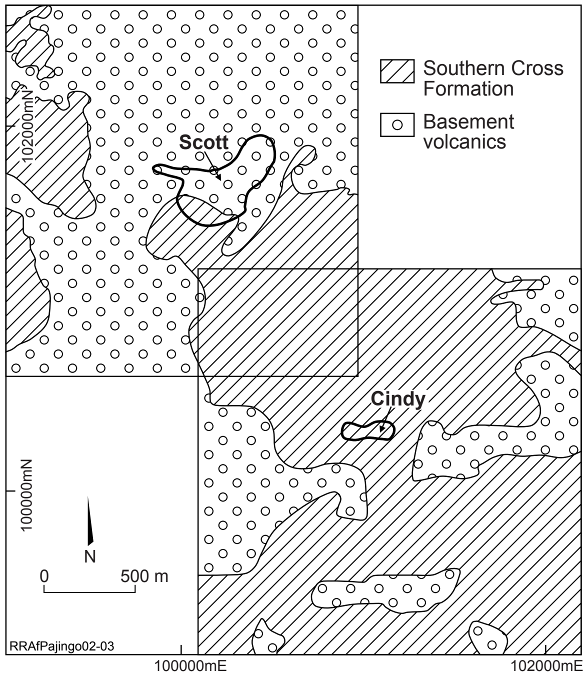

Figure 2. Location map of the Scott and Cindy study areas, showing the extent of Tertiary cover (partly masking the Scott Pit and completely masking the Cindy Pit).

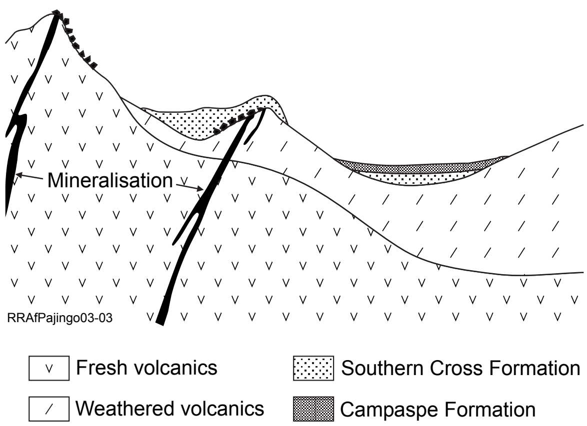

Figure 3. Schematic cross-section of the regolith geology at Pajingo, showing fresh rocks of the Mt Janet Range surrounded by a variably weathered pediment, and Tertiary sediments masking some of the mineralisation.

Geomorphology

Campbell (1996) mapped the areas around Pajingo (at 1:10 000 scale) and the Wahines Prospect (at 1:20 000 scale). Regional regolith mapping was also carried out by Normandy Exploration (unpublished). The basement consists of volcanic and volcaniclastic rocks that are relatively fresh or weathered to saprock in the Mt Janet Range, some 180 m above the surrounding plain (Figure 3). On the lower slopes, a poorly developed lateritic profile has formed on the volcanics. Some gibbsite cements the pisoliths. A complex pediment of weathered basement, mottled Tertiary sediments (Southern Cross Formation), and colluvium, scree and alluvium surrounds the elevated areas of exposed basement.

Climate and vegetation

The climate is tropical, semi-arid, with a summer rainfall of 660 mm/yr (Parkinson, 1986; Bureau of Meteorology, 1988). The maximum daily summer temperature averages 34°C and the humidity ranges from 35 to 65%. Annual potential evaporation of 2200 mm significantly exceeds precipitation. The vegetation comprises open savanna woodland. The hills have not been cleared of vegetation and are densely covered with eucalypts, acacia and other shrubs. Lancewood thrives on the ferruginous soils of mesas. Grasses, shrubs and bare soil are found on the low-lying areas.

REGOLITH–LANDFORM RELATIONSHIPS

Remnants of a poorly formed lateritic profile occur on the Devonian volcanic rocks. This typically comprises pisolitic duricrust of hematite and minor goethite that has been cemented by gibbsite and kaolinite. Weathering profiles occur at a similar level in the Southern Cross Formation, leading Campbell (1996) to propose that both were produced by the same weathering event. Distinguishing weathered basement from weathered sediment can be very difficult. Mottled material below passes into ferruginous saprolite.

The weathered profile on the Southern Cross Formation is variable. Generally it consists of massive to weakly pisolitic, ferruginous duricrust, which has locally degraded to a pisolitic gravel. Pisolitic duricrust is limited to breakaways along the high plateau edges where incision has increased drainage. Ferruginisation is developed in the top few metres of the profile but pisoliths are only developed in the top half metre. The remainder is extensively mottled (goethite and hematite mottles in kaolinite).

Databases of mineral exploration drilling from within 1 km of the Scott and Cindy mines were examined. Topographic contour maps were constructed of the basement–Tertiary sediment unconformity, where cover occurs, and the present landsurface where basement is exposed (Figures 4, 5). The position of this surface was made more precise near the pits by surveying the unconformity exposed in the pit faces.

The base of the Southern Cross Formation indicates ancient drainages in the vicinity of Scott Pit. These extend to the south–southeast (Figure 4A) and have a palaeorelief of about 150 m over 2 km. The topography of the basement–Tertiary unconformity at Cindy Pit shows a small ridge through the centre of the pit, probably related to induration of the host rocks by the Cindy lode (Figure 5). Palaeodrainages occur in the east–central part of the pit and are directed both to the north and to the south (Figures 4B, 5).

Isopach maps (thickness contours) of the Southern Cross

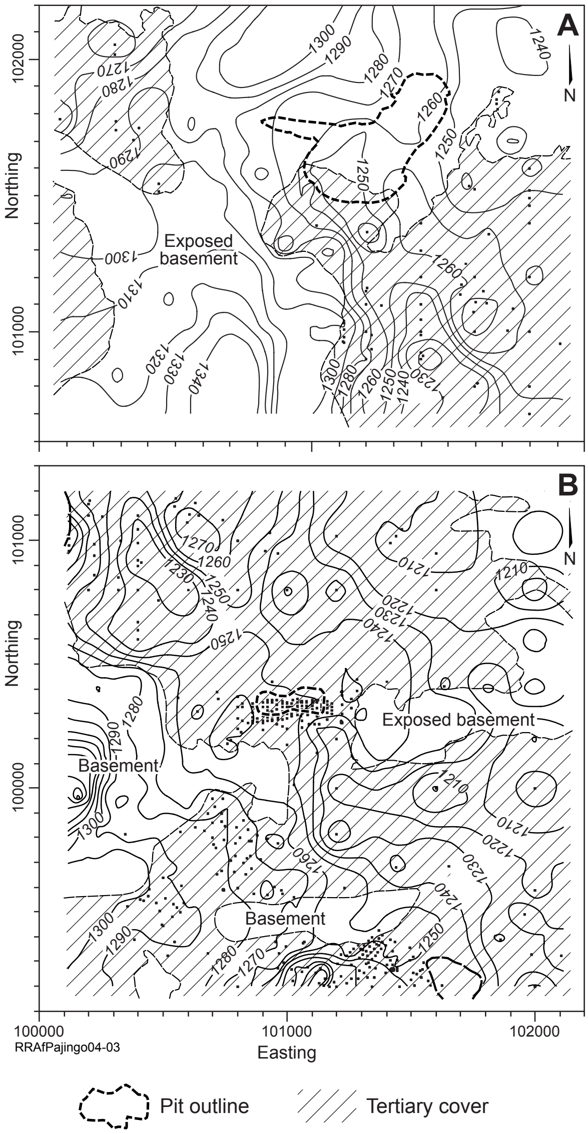

Figure 4. Topography of exposed Devonian basement and the Devonian basement–Tertiary sediment unconformity in the Scott (A) and Cindy (B) study areas. Produced by contouring of drill collar heights and the elevation of the basement–sediment unconformity determined from drill logs. Locations of drill holes shown as dots.

Formation were constructed from the drilling information. At Scott Pit (Figure 6A) the thickest parts of the Southern Cross Formation (40–65 m, possibly reaching 80 m) lie in the southeast, within a palaeovalley which drained the pit area. The Tertiary cover is relatively thin to the west (5–20 m, reaching a maximum of 35 m). At Cindy Pit (Figure 6B), the Tertiary cover is thickest to the south (25–35 m) and north of the pit (70 m), representing the filling of existing palaeovalleys directed to the north and south.

Much younger alluvial deposits, up to 4 metres thick, occur in streams and gullies. These have basal gravels and cobble layers which fine upward into silts. The detritus has been sourced from both the basement and the Tertiary sediments, and consists of fresh and weathered materials (including pisoliths). Soils are developed with distinct A and B horizons of illuviated clays.

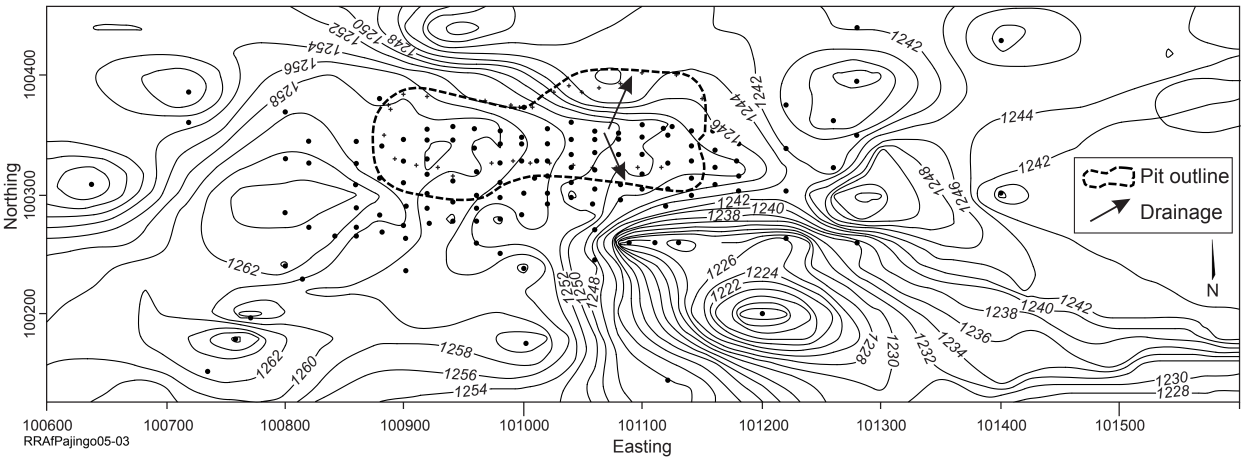

Figure 5. Detailed palaeotopography of the basement–sediment unconformity at the Cindy study area. Dots show drill holes.

REGOLITH CHARACTERISTICS

Scott Pit

The lower part of the weathered profile in Scott Pit consists of ferruginous saprolite of volcanic rocks of the Drummond Basin. The upper part of the pit exposes the edge of an arcuate channel of Southern Cross Formation that is largely situated to the south of the pit (Figure 4A). The steep western edge of the channel is underlain by mottled saprolite and the base of the channel contains dark, red–brown, imbricate mottles, embedded in a small amount of white, kaolinitic clay. This material was probably formed by winnowing of the mottled zone below. Large boulders occur at the base of the channel. The remainder of the base of the channel contains mottled, gritty clays, overlain by a thin layer (2–3 m) of gravels, set in a clay matrix. This is overlain by a wedge-shaped mass of red-brown clays, rich in white, branching, 'root-like' kaolinitic 'mega-mottles', followed by a thicker mass (>10 m) of mottled, gravelly sediments.

Cindy Pit

The southern, or up-slope face of Cindy Pit consists of a basement of saprolite and mottled saprolite of Devonian volcanic rocks. A thin conglomerate (1 m) occurs at the base of the Tertiary sediments, which is overlain by a thick, continuous sequence of sediments, including slightly gritty layers of 2–3 m in thickness. The top part of the Tertiary sedimentary succession consists of mottled materials that were inaccessible.

The unconformity in the northern face is generally lower and inclined towards a channel in the east–central part of the pit (Figure 5). At the base of the Tertiary sediments is a coarse breccia of volcanic fragments resting on mottled saprolite. Above this, fragments of vein quartz commonly occur in a deeply weathered conglomerate or breccia and, higher still, occur mottled grits and conglomerates.

Details of Tertiary sediments

All the sediments, including the 'clays', have a gritty matrix, consisting of subrounded to subangular fragments of vein quartz, deeply weathered volcanic and volcano-sedimentary rock, ferruginous saprolite, and goethite granules. Some fragments are coated with a thin cutan of khaki-yellow, goethite-stained, kaolinitic clay. Other fragments are pisolitic and are composed of goethite-stained kaolinite and small quartz fragments, representing either reworked sediment or deeply weathered, fine-grained volcanic material. The matrix of these complex sediments is fine-grained quartz and clay. The ratio of clasts to matrix varies; some are matrix supported and others clast supported.

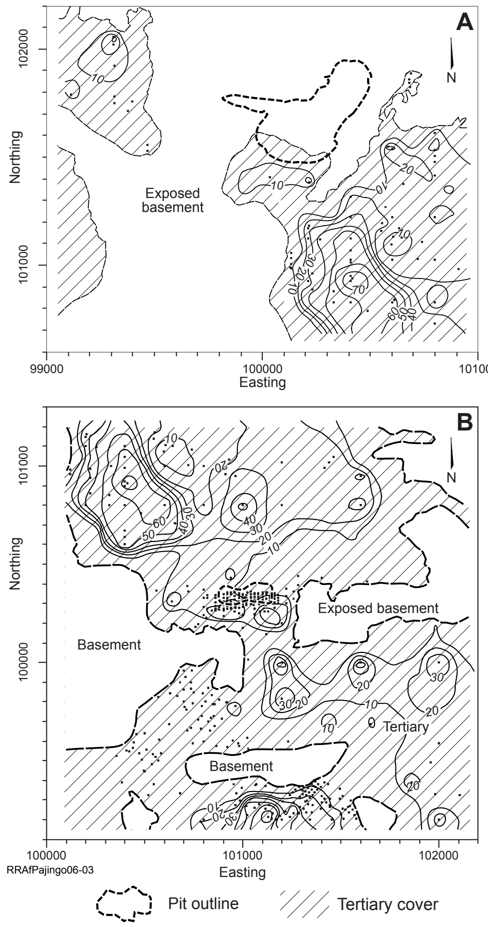

Figure 6. Isopachs of Tertiary sediments at the Scott (A) and Cindy (B) study areas. Dots show drill holes.

DATING

Potassium-bearing manganese oxide minerals formed within weathered basement volcanic rocks at Scott Pit range in age from 3.0 Ma at the base of the profile to 16.2 Ma at the top (Vasconcelos, 1998). No suitable Mn minerals were available to date the weathering of the Tertiary sediments (Anand et al, 1997).

REGOLITH EVOLUTION

Preservation of weathering profiles in areas of high relief, such as the Mt Janet Range (Figure 3), has largely been confined to pediments. Erosion was too intense for preservation of weathered profiles on the higher ground. On the pediments, both the Devonian basement and the Tertiary sediments have weathered to saprolites, mottled zones and, rarely, pisolitic, gibbsitic materials at the edges of well-drained breakaways, where drainage has been particularly effective.

The immature, poorly sorted Tertiary sediments contain a variety of regolith materials derived from different regolith horizons (fresh rock to lateritic residuum). This indicates that deeply weathered basement existed within the area during Tertiary sedimentation and casts doubt on Campbell's conclusion of a single weathering event. A few clasts seem to have been essentially fresh during sedimentation, becoming weathered while within the sediment.

The Southern Cross Formation completely blankets the Cindy Lode and has a thin conglomerate at its base overlying mottled saprolite formed from weathering of the basement volcanic rocks. Higher in the Southern Cross Formation, alternating conglomeratic and gritty layers occur with a thick mottled horizon at the top. The detritus has been derived from a variety of regolith horizons and weathering is most intense at the top.

At Scott Lode, the basement rocks and associated Au–Ag lode are largely exposed with only minor overlap of Tertiary cover. Patchy Au distribution in the Southern Cross Formation (Robertson, 1997, 2003) suggests episodic erosion of the mineralised source area to make up the sediments. The clasts of these sediments consist largely of deeply weathered volcanic rocks with minor epithermal quartz clasts set in a clay matrix. It is unlikely that these volcanic clasts could have survived mechanical transport had they been completely weathered at the time of sedimentation. At least part of the weathering, including mottling, of the sediments is likely to have occurred within the Southern Cross Formation. Understanding these regolith units and distinguishing sediments from weathered basement in drillspoil is problematic but essential for effective mineral exploration.

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