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Reading the Regolith: Mapping the Landscape and Developing an Understanding of the Contribution of Soil Biota to Regolith Formation in Northern Australia

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SUMMARY

The Tanami region of northern Australia is highly prospective for mineral exploration, however exploration has been hampered by the extensive development of regolith. Understanding the relationship between the regolith, landscape, groundwater, biota and the mineralised rocks is the key to developing more effective exploration strategies. Ongoing research combines regolith-landform mapping, geobotanical analysis and geozoological studies with geophysics and hydrogeochemistry to develop an understanding of the nature of current regolith-forming processes.

Outputs of the project include an established geozoological framework that considers surficial termite-regolith-landform relationships and characteristics, to reflect the depth of transported cover in regolith-dominated terrains. The poor understanding of the role of termites in regolith formation and in the generation of surface geochemical anomalies in Northern Australia will be addressed in future research. Regolith mapping is the key to establishing a good geozoological framework, a necessary first step in improving this understanding.

Key words: *termitaria, regolith-landform mapping, Tanami Desert, geochemical exploration*

INTRODUCTION

The tropical to semi-arid savannah of the Tanami region, northern Australia, is considered highly prospective. Many of the known prospects were discovered by traditional prospecting techniques including pattern drilling. However, drilling through the regolith in this remote area is inconvenient and costly. Companies are therefore looking to regolith-related research to boost their knowledge of the Tanami landscape, to assist with collecting samples for geochemical analysis that will better represent the underlying geology.

This study is part of a collaborative regolith research project on the Tanami being facilitated by CRC LEME. We are researching the contribution of termites to the formation of regolith and the generation of surface geochemical anomalies. Regolith landform mapping and observations about the density and type of termitaria reported on in this presentation are being used to develop a geozoological framework for our research.

STUDY AREA

Situated within the Tanami Desert, crossing the Western Australian and Northern Territory borders, is the Tanami region. This region lies between the monsoonal zone of the tropics and the semi-arid climatic zone to the south. The climate of the Tanami is therefore semi-arid to tropical, with distinct wet and dry seasons (Bureau of Meteorology, 1984). Rainfall varies both seasonally and annually, with high evaporation rates throughout the year leaving very little surface water by the time subsequent summer rains arrive (Gibson, 1986).

The soil-landscape setting of the Tanami has been described in by Northcote & Wright (1983), while Gibson (1986) has identified several physiographic zones. The study areas featured in this abstract lie within salt-lake, sand dune, depositional plain and rocky outcrop zones. A comprehensive report of the geology of the Tanami region may be found in Blake *et* al. (1977), Hendrickx *et al.* (2000) and Wygralak *et al.* (2001).

Wilford (2001) used remote-sensing images as well as aerial photographs to generate a regolith map at 1:500,000 scale of the Tanami region. Local variations in the nature of the landscape and the distribution of regolith materials, which are important in the interpretation of surface geochemical data are not mappable at this scale. For this study 1:10,000 scale mapping, which complements the mapping by Wilford, was carried out at Coyote and Titania.

Coyote is an Au deposit approximately 750 km northwest of Alice Springs and 300 km southeast of Halls Creek (Figure 1).

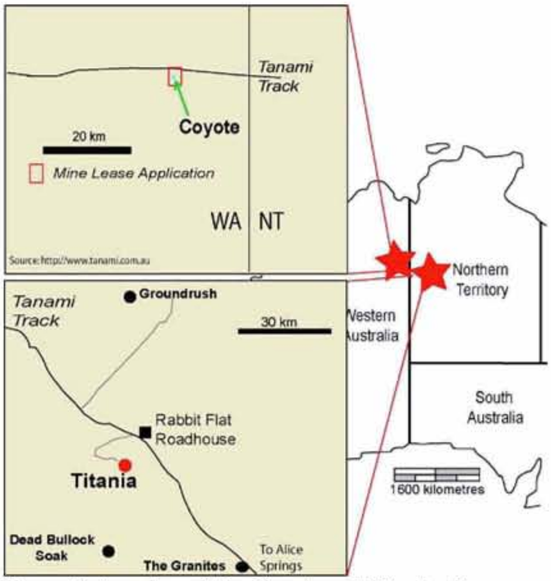

Figure 1. Location of the Coyote and Titania sites.

Titania is an Au prospect located in the Northern Territory approximately 600 km north-northwest of Alice Springs (Figure 1).

FIELD METHODS

Regolith-landform mapping techniques are based on understanding the contemporary geomorphological processes acting upon the surficial geology of an area of interest. Detailed site descriptions of the surface materials, vegetation assemblage, landform, geomorphic processes and any minor features are incorporated into regolith-landform units and their associated map legend descriptions. Comprehensive reports by Britt & Smith (1998), Pain *et al.* (2000), and Thomas *et al.* (2002) detail regolith-landform mapping methodologies.

Termite identification has been based on previous work by Hill (1956), Holt & Coventry (1980), Andersen & Jacklyn (2000), and Aspenberg & Traun (1998).

RESULTS OF COYOTE AU DEPOSIT FIELDWORK AND MAPPING

A detailed account of the regolith-landform mapping of the Coyote is given in Petts & Hill (2005a and b). The Coyote deposit, owned by Tanami Gold NL, lies to the north of a buried, southwest trending palaeochannel. The prospect is on a flat, to gently undulating depositional plain covered by a veneer of colluvial sheetwash sediments (including some aeolian sand) and ferruginous lag.

Mapping data was collected along a north-south transect, and observations made at 64 sites as shown in Figure 2. This transect is sub-perpendicular to mineralisation and stratigraphic trends.

The location and relative height of termitaria was also recorded along the transect, with a total number of 550 separate mounds observed along a 20 m wide corridor. Figure 3. illustrates the relative height of the termitaria together with additional information on the RLUs (Petts & Hill, 2005b). A general trend in the termitaria height and density may be identified as transported cover thickens, with both values increasing to the south. This figure also illustrates that the contribution of eroded mound material by termites to topsoil may be high in those areas with relatively more termitaria than those without, i.e. drainage depressions and their proportionally higher numbers of termitaria. If Coyote is considered a representative site in the Tanami, then it is essential to understand the distribution of termitaria before to place any soil sampling or geochemical survey results in a landscape context.

RESULTS OF TITANIA AU DEPOSIT FIELDWORK AND MAPPING

The Titania Prospect is located only a short distance from The Granites and Callie gold mines, owned by Newmont Gold Australia. The landscape varies from low hills and rocky outcrops, to salt lakes and longitudinal dune systems. The prospect itself lies between a low range of hills to the west, and a large salt lake, that marks out a significant palaeochannel system, to the east. The rapid change in landforms from west to east across the Titania Prospect,is associated with considerable changes in regolith materials, vegetation and soil organisms (notably, termitaria).

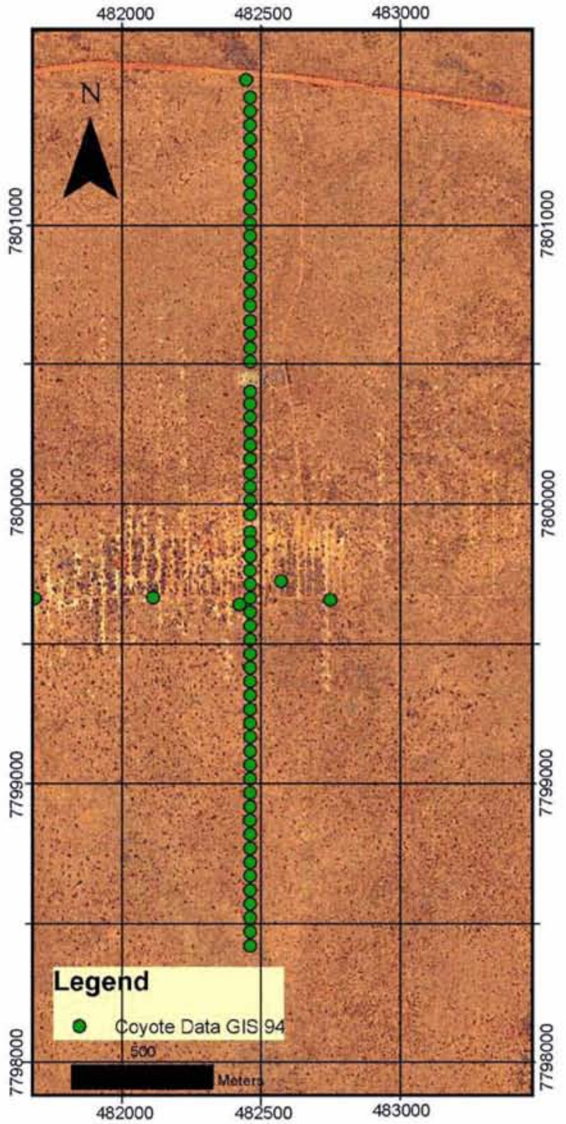

Figure 2. Datapoints display the N-S transect used to collect regolith-landform data at the Coyote Au-Deposit, W.A.; AGD66 z52 was used for GPS-based data collection.

The topography of the area can be generally described as low relief, with the main Oberon Au Deposit located within a depression or ephemeral swamp. The cover thickness increases away from the low hills and towards the salt lake and palaeochannel system in the east.

Over 80 observations were made within a 2 km by 3.5 km grid across the prospect (Figure 4). The grid overlies the main Oberon Au Deposit, but also includes the Lamaque Au Deposit nearby. The grid also coincides with previous soil geochemical surveys and an RC drilling program. Geobotanical descriptions, soil algae and biogeochemical samples were collected alongside the regolith-landform unit descriptions and samples of termitaria.

Preliminary analysis of the results suggests that, as at Coyote, there is an association between termite species, relative termitaria height and regolith-landform unit. At Titania, the most obvious termite-regolith-landform relationship is with cathedral termite (*Naustitermes triodiae*) and clay-rich soils and water-logged units (Figure 5a). Ephemeral, alluvial drainage depressions (Aed) are widespread over mineralisation at the prospect and become significant regolith-landform features as cover thickens within the alluvial overbank deposit (Aod) units, where palaeo drainage channels are visible through the contemporary landscape cover.

Scattered cathedral termite mounds have been noted within sandier units such as sandplains in the area, however these are largely degraded. Their presence in this unit implies that the cathedral termites rely on construction materials found deeper in the regolith profile, potentially sampling regolith materials that may have been blanketed by sediments.

Termitaria density decreases rapidly in the aeolian-dominant depositional plain due to the increasing amount of sand in the topsoil in this unit (Figure 5.b). Some *Amitermes* spp. mounds are visible, however pavement-building termites such as *Drepanotermes rubriceps* are common. The subterranean galleries form hard pavements for metres in diameter around the low mounds, and are visible at the surface.

Colluvial sheetwash depositional plains (CHpd) are markedly different in their termite occurrences, with the dominant species being *Amitermes* spp. The termitaria are much more common within the colluvial sheetwash drainage depressions, with the relative heights of the mounds increasing with density. The vegetation assemblage and termitaria species and density changes rapidly in the vicinity of the colluvial sheetwash fan deposits to the west of the mapping area (Figure 5.c), where surface materials are more locally derived. The decrease in depth-to-bedrock is apparent in the 'thinning-out' of termitaria.

The regolith-landform map of the Titania Prospect will provide an illustrated description of the regolith-landform associations across the prospect. Determining a system for mapping termite density is of high priority, as are a number of orientation studies concerning the geochemistry of the mounds, and the particle size preferences of the different termite species. It is hoped that this research will lead to a better understanding of the role of termites in the formation of regolith and in the generation of surface geochemical anomalies.

TERMITARIA AND THE REGOLITH

Regolith mapping at Coyote and Titania and observations about the density of termitaria and the distribution of termite species has highlighted geozoological associations and supports speculation by other researchers that termites themselves may alter regolith geochemistry through the cycling of material from depth to the surface. Robertson (2003) mentions that termites have the capacity to carry fine soil particles, including the underlying weathered basement, from depth and through thin colluvium to the surface. These soil particles may carry the geochemical signatures of the underlying regolith, an idea that has been exploited since

Babylonian times as reported by Brooks (1982). By either directly mining termitaria for metals or by sampling mounds, prospectors around the world have utilised termitaria in the past in mineral exploration.

The construction of mounds above ground and the recognition of mound residuals allow the sampling of the material for geochemistry without the need for drilling (Bernier, 1999). The potential for utilising termitaria in mineral exploration in Australia has been overlooked in the past, however present research and initial geochemical surveys conducted in the Tanami sites give a very positive indication for the adoption of termitaria in geochemical exploration.

CONCLUSIONS

Regolith mapping and observations about the density and type of termitaria as well as the distribution of termite species has been used to establish a number of geozoological associations in the Tanami landscape. It may be possible to exploit these associations to improve mineral exploration strategies in the Tanami region. This possibility is being addressed by additional work focused on sampling and analysing termitaria and surrounding soil materials in order to test the metals content both of extant mounds and eroded and dispersed mound remnants.

Future work includes defining the geochemical sampling techniques of termitaria for mineral exploration purposes. The results from orientation studies will be combined with the existing regolith and landform framework to present a wholistic view of the Tanami landscape.

Our work has highlighted the poor understanding of the role of termites in regolith formation and in the generation of surface geochemical anomalies in Northern Australia. Regolith mapping is the key to establishing a good geozoological framework, a necessary first step in improving this understanding.

ACKNOWLEDGMENTS

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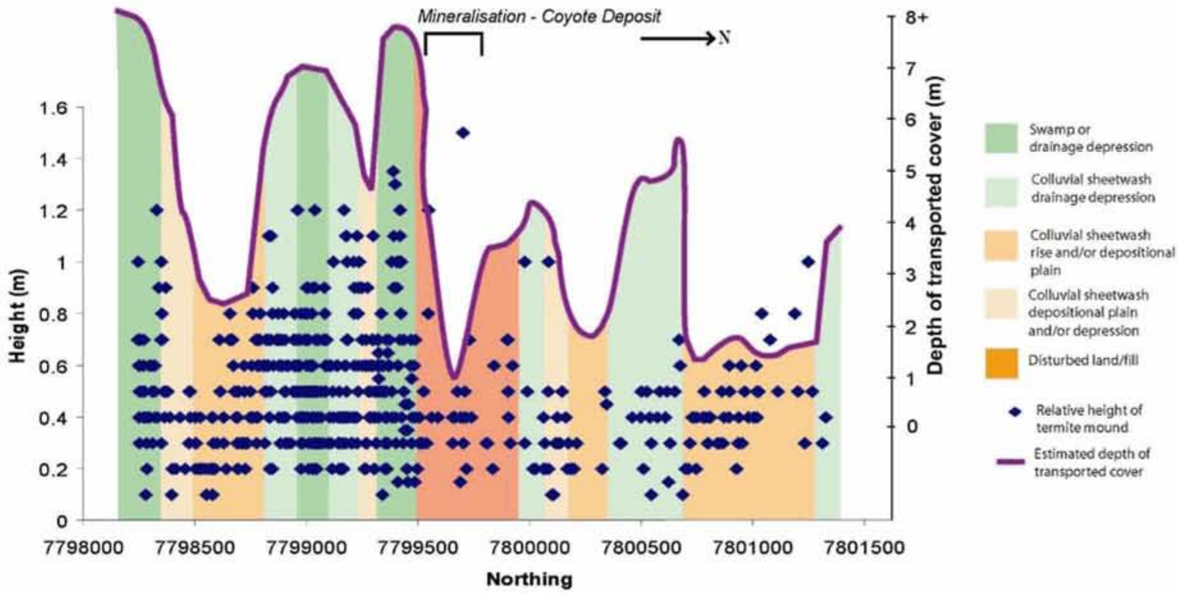

Figure 3. The association between the regolith-landform units and relative termitaria height is illustrated in this diagram, which is based on the N-S transect show in Figure 2 at the Coyote site. The general trend of increased termitaria density, and increased relative height, is highlighted to the south of mineralisation at Coyote. This trend is also related to the change in RLU from colluvial sheetwash depositional plains to colluvial sheetwash and alluvial drainage depressions, and ephemeral alluvial swamps.

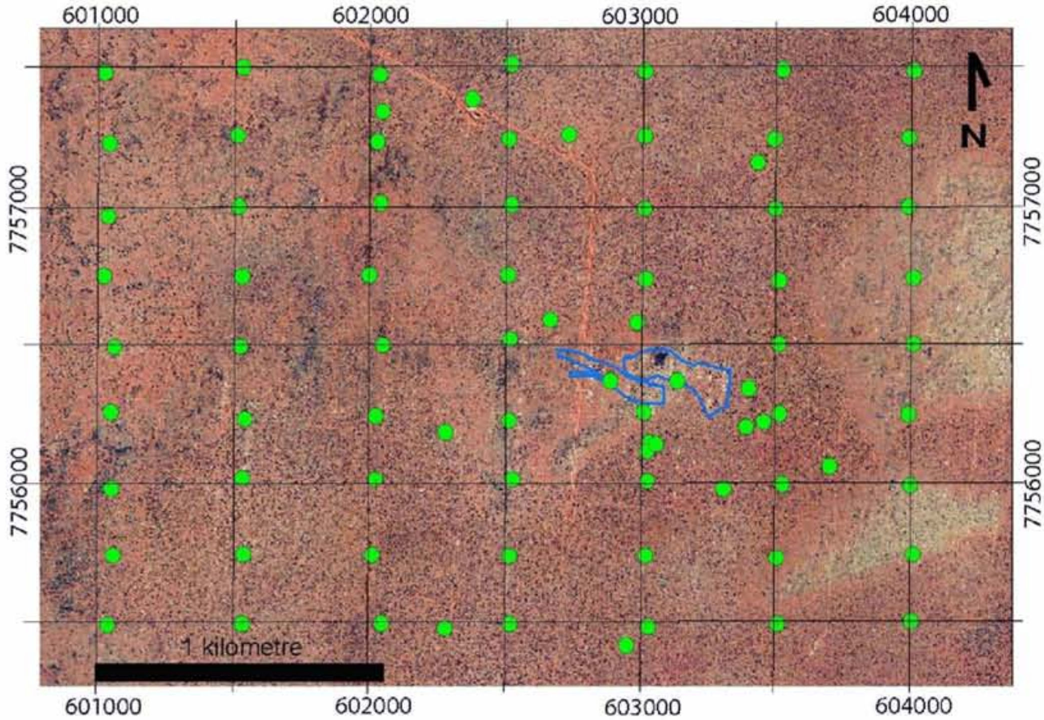

Figure 4. Gridded pattern of regolith-landform mapping at Titania Prospect, W.A. Fieldpoints were collected using AGD66 z52 datum and a GPS. Termite samples were taken at these sites, for geochemical and particle analysis. This gridded sampling also compliments the biogeochemical, hydrogeochemical and soil sampling conducted by members of the project team. Blue polygons outline the main Oberon Au-deposit at Titania Prospect.

Figure 5. Representative site photographs from the Titania Prospect: a.) Juvenile cathedral termit emound with *Melaleuca glomerata* growing alongside it. Surface materials are dominated by grey-brown sily sands; b.) Sandplain with bulbous pavement termite mound in foreground, *Melaleuca glomerata* and spinifex dominate the vegetation assemblage; c.) Colluvial fan deposit with colluvial sheetwash depositional plain and associated drainage depressions in the background. Indurated ferruginous gravels are bare, some spinifex has regenerated after burning.