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REGIONAL REGOLITH MAPPING AROUND ALICE SPRINGS, NORTHERN TERRITORY

S.J. Fraser, M.S. Skwarnecki and I.D.M. Robertson

CRC LEME OPEN FILE REPORT 118

January 2002

(CSIRO Exploration and Mining Report 746R/CRC LEME Report 148R, 2000.
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CRC LEME is an unincorporated joint venture between CSIRO-Exploration & Mining, and Land & Water, The Australian National University, Curtin University of Technology, University of Adelaide, University of Canberra, Geoscience Australia, Bureau of Rural Sciences, Primary Industries and Resources SA, NSW Department of Mineral Resources-Geological Survey and Minerals Council of Australia.
Headquarters: CRC LEME c/o CSIRO Exploration and Mining, PO Box 1130, Bentley WA 6102, Australia

This report presents outcomes of research by CRC LEME for Gutnick Resources NL as support for their search for Witwatersrand style Au deposits in the Ngalia and Amadeus basins, Northern Territory. The Project was commenced in April 1999, concluded in 2000 and was led by Dr I.D.M. Robertson. Agreement was reached between Gutnick Resources NL and CRC LEME on 19th December 2001 to release CRC LEME Reports 144R, 148R and 149R into the public domain through the CRC LEME Open File Report series. It is intended that publication of the reports will be an additional factor in transferring technology to aid the Australian mineral industry.

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PREFACE AND EXECUTIVE SUMMARY

This study was a collaborative research initiative between Gutnick Resources N.L. and CRC LEME. The CRC provided a geochemical and regolith research background for a major exploration program being undertaken by Gutnick Resources N.L. for Witwatersrand-style gold mineralization in the sediments of the Ngalia and Amadeus Basins.

This report documents a regional, first-pass assessment of the landform and regolith over twenty-five 1:250 000 map sheets in Central Australia. Work began on compiling these maps in April 1999. So that draft maps would be available by September 1999, extensive use was made of pre-existing CSIRO Land Systems Mapping. The mapping units from this earlier work were re-categorized in terms of their landform and regolith characteristics.

Two maps were produced.

1. A Landform Interpretation Map (1:1 000 000 scale) showing the distribution of various landform units; and,
2. A Regolith-Landform Status Map (1:1 000 000 scale) grouping the landform units into three broad categories: Relict, Erosional and Depositional.

The relict terrains group is relatively small. In the erosional terrains, there has been little preservation of deeply weathered profiles on lithologies of the Arunta Province. Rocks of the Amadeus Basin are either not deeply weathered or weathering is difficult to recognize; saprock is common.

Depositional terrains dominate the area. Two types can be identified; i) flat, low, regional plains; ii) 'perched' deposits that occur above the regional plains. The regional plains were formed by filling a deeply eroded basement topography with proximal and distal sediments, now largely overlain by wind-blown sand. Hidden beneath some are deep Tertiary basins. 'Perched' depositional areas are small, dominated by local materials and include fans, river terraces or valley-fills that are being reworked. All comprise a significant barrier to exploration and will require drilling or techniques that can 'see through' the cover.

Lateritic, ferruginous materials should be sampled within relict terrains. Within the erosional terrains, stream sediment, soil, lag and rock-chip sampling should be adequate but small anomalies are likely.

Low, regional plains will need sub-surface sampling. Although substantial occurrences of calcrete were observed, at least some are of the groundwater type and so are unsuitable for Au search. Consideration should be given to groundwater geochemistry. The groundwaters are of low salinity, so anomalies are expected to be weak but distinct.

I.D.M. Robertson

Project Leader

TABLE OF CONTENTS

APPENDIX

LIST OF FIGURES

ABSTRACT

This report is part of the final documentation of a collaborative research initiative between Gutnick Resources N.L. and CRC LEME. The CRC provided geochemical and regolith research into a major exploration program being undertaken by Gutnick Resources N.L. for Witwatersrand-style gold mineralization in the sediments of the Ngalia and Amadeus Basins.

As part of this initiative, the CRC produced a rapid, first-pass assessment of the regional landform and regolith over an area of twenty-five 1:250 000 map sheets. The specific objectives were to: -

1. Establish broad spatial relationships between landforms, regolith and lithology;
2. Propose effective geochemical exploration strategies for different regolith-landform settings.

Two maps were produced: -

1. A Landform Interpretation Map (1:1 000 000 scale) showing the distribution of various landform units. These units were based on i) a re-assessment of previous land system mapping (1:1 000 000 scale; Perry, 1961), ii) interpretation of landforms from Landsat MSS imagery, and iii) five weeks of limited fieldwork. Because of inaccuracies in the land system mapping, it is not recommended that the final maps be viewed at scales greater than 1:1 000 000.
2. A Regolith-Landform Status Map (1:1 000 000 scale) grouping the landform units into three broad terrain categories: Relict, Erosional and Depositional.

The relict terrains group is tentative, subjective and relatively small. In the erosional terrains, there has been little preservation of deeply weathered profiles on lithologies of the Arunta Province. Rates of erosion have kept pace with, or exceeded, those of chemical weathering. Rocks of the Amadeus Basin are either not deeply weathered or weathering is difficult to recognize; saprock is common.

Depositional terrains dominate the area. Two types can be identified; i) flat, low, regional plains; ii) 'perched' deposits that occur above the regional plains.

The regional plains are low and flat, formed by filling of a deeply eroded basement topography with proximal and distal sediments, now largely overlain by a veneer of wind-blown sand. Hidden beneath some of these are Tertiary basins up to 200 m deep. 'Perched' depositional deposits are small and are dominated by locally derived materials. They include fans, river terraces or valley-fills which are being reworked. All these comprise a significant barrier to exploration. Drilling or use of techniques, that can 'see through' the cover will be needed to prospect them adequately.

Lateritic, ferruginous materials should be sampled within relict terrains. Within the erosional terrains, stream sediment, soil, lag and rock-chip sampling should be adequate but small anomalies are likely, unless iron-rich mottles and nodules can be located. Where detritus in the streams reflects local lithologies, significant stream sediment dispersion trains in all fractions are expected but where the detritus is dominated by distal material, weak dispersions are likely only in the finest fraction (<75 µm).

Low, regional plains are a significant barrier to exploration. They will need sub-surface sampling. Although substantial occurrences of calcrete were observed, initial indications are that at least some are of the groundwater type and so are unsuitable for Au search. Consideration should be given to groundwater geochemistry. The groundwaters are of low salinity, anomalies are expected to be weak but distinct.

1. INTRODUCTION

1.1 Background

This report accompanies 'Landform Interpretation' and 'Regolith-Landform Terrain Status' maps of twenty-five 1:250 000 sheets in the southern part of the Northern Territory (Appendix I). The mapping is part of the Rand Project, a project carried out for Gutnick Resources N.L. by CRC LEME. This regional evaluation was part of a three-tiered approach, which also included selective tenement-scale regolith-landform mapping and geochemical orientation studies.

Gutnick Resources hold substantial tenements in the area (Figure 1), and wished to assess the regolith and landscape in terms of how it may influence their proposed geochemical sampling programs.

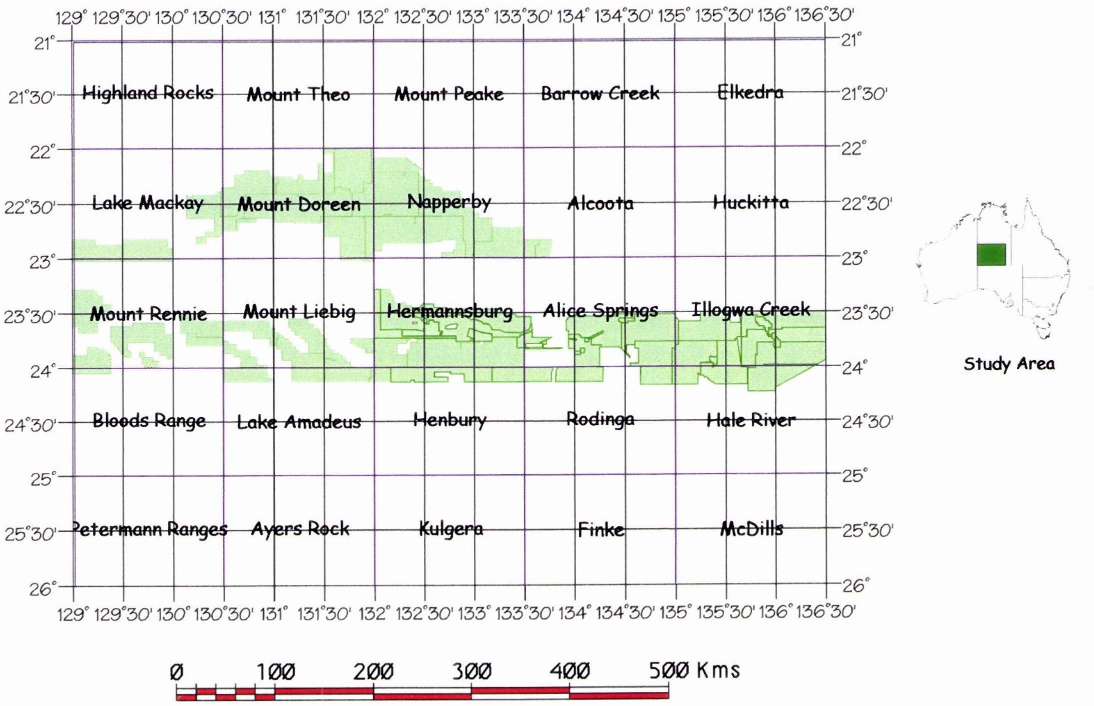


Figure 1: Location of the Rand Study Area. The twenty-five 1:250 000 map sheets are shown, along with the Gutnick Resources N.L. tenements in green.

This project covers metamorphosed rocks of the Arunta block, which are in tectonic contact with folded and faulted sediments of the Amadeus and Ngalia Basins. In parts of the study area, there are extensive 'valley-fill' and aeolian sand deposits that mask the bedrock geology.

Work began on the compilation of these maps in April 1999, so that a draft regional map would be produced by September to assist Gutnick Resources geologists in their field program. Because of the limited time available, extensive use was made of the pre-existing 'Land Systems Mapping' of Perry *et al.,* (1961) (Figure 2). A digital version of this map was provided by CSIRO Wildlife and Ecology in Alice Springs. So that such a large area could be covered within the imposed time frame, it was decided to retain the mapping-units from this earlier work and describe them in terms of their landform and regolith characteristics by revising the legend.

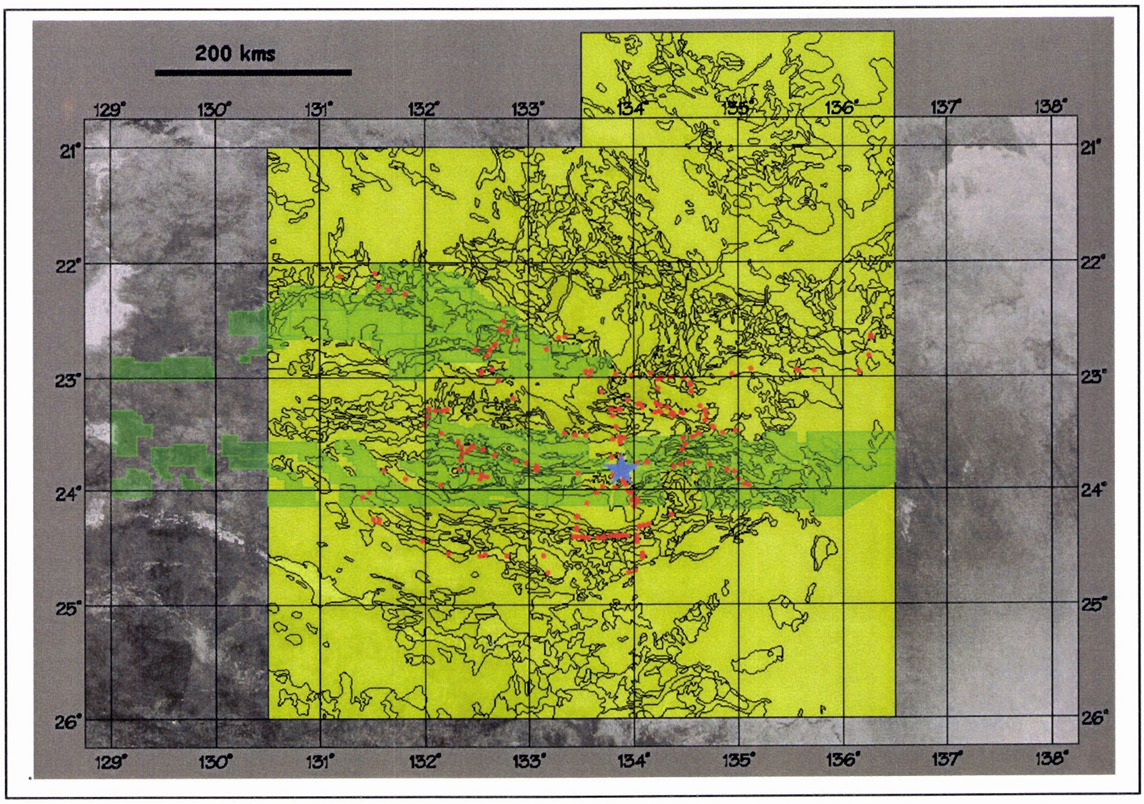


Figure 2: Coverage of the Perry (1961) mapping (yellow) compared with the extent of the Gutnick Resources' tenements (green), with a Landsat MSS band as background. Sites of field observation are marked in red; the blue star marks Alice Springs.

1.2 Objectives

The objective of the regolith-landform mapping was to understand how the regolith and landscape of the area are related. By establishing broad spatial relationships between landforms, regolith and lithology, effective geochemical exploration strategies for different regolith-landform settings can be proposed.

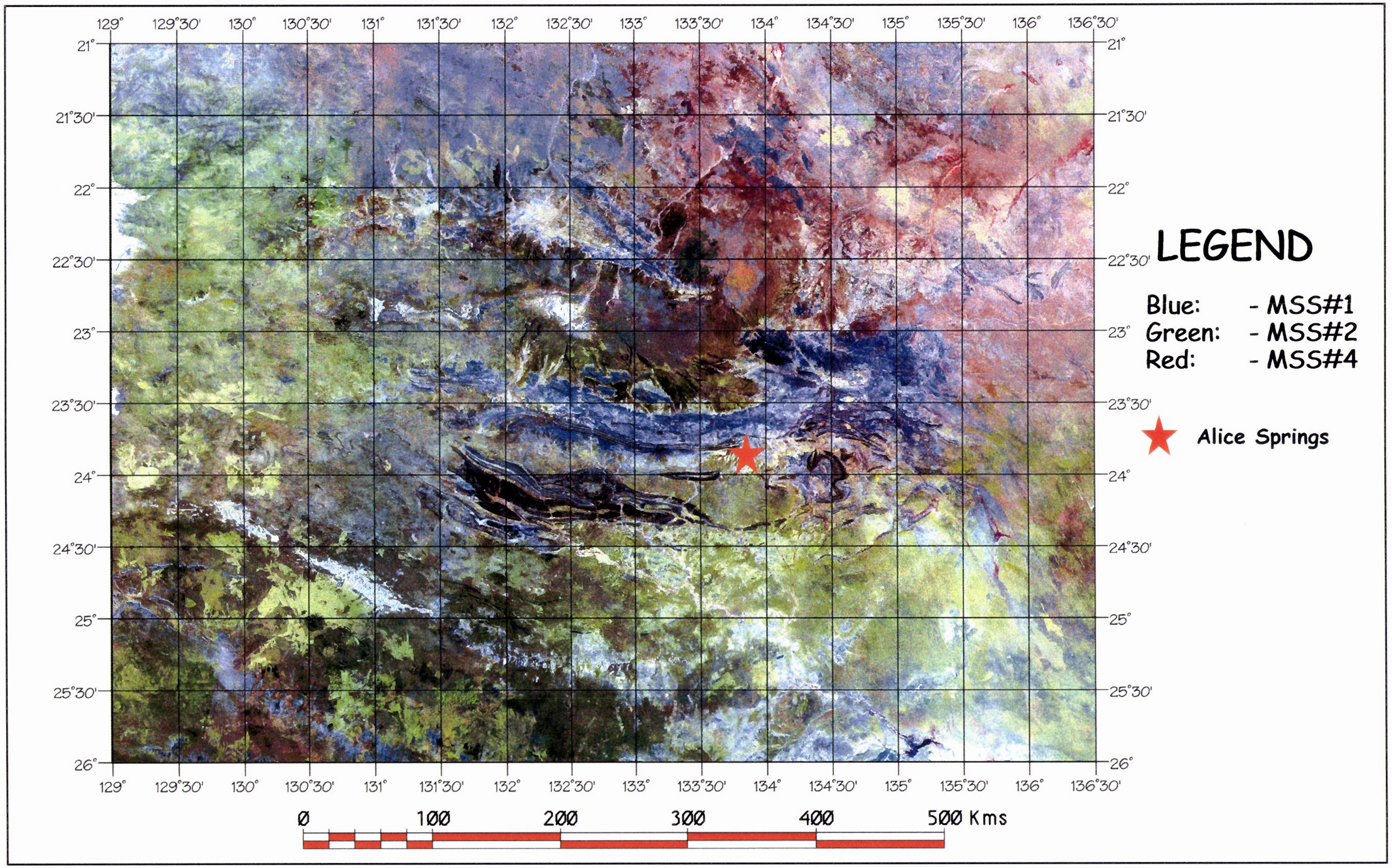
2. METHODS

2.1 Landsat MSS Data

A rectified Landsat MSS mosaic (Figure 3) was used as a base. This large-area mosaic, available commercially from GeoImage, is a composite of some 32 MSS scenes, which have been colour-balanced and stitched together. Because this product is composed of multiple scenes that have been individually colour-balanced prior to being joined as a mosaic, the product is unsuitable for further spectral processing (such as ratioing).

2.2 Regolith-landform interpretation

To assist in this study, extensive use was made of the 'landform units' of the land systems mapping of the Alice Springs Area (Perry et al., 1961). However, this map does not cover the full extent of the area of interest to Gutnick Resources, particularly the five 1:250 000 map sheets on the western side of the study area. A digital version of this map was obtained from CSIRO Wildlife and Ecology in Alice Springs) but its spatial integrity appears to be compromised. There are apparent displacements of up to three kilometres when this mapping is compared against the geo-referenced Landsat imagery The Landsat imagery was checked against AUSLIG 1:250 000 digital vector data, and appears to be geo-referenced correctly.


LEGEND
Blue: - MSS#1
Green: - MSS#2
Red: - MSS#4
Alice Springs
0 100 200 300 400 500 Kms

During the late 1950's, when the Perry Land Systems mapping was undertaken, accurate base maps probably were unavailable. The base used would have been a mosaic of aerial photographs, well controlled near population centres (e.g., Alice Springs), but less accurate in remote areas. When the Perry mapping and the Landsat imagery are compared, there is a progressive, non-systematic increase in distortion towards the map-edges, symptomatic of a decrease in base-map control towards remote areas (Figure 4). There is, however, general agreement between this mapping and landforms evident on the Landsat MSS. The non-systematic nature of this distortion does not allow it to be easily corrected. Essentially, each vector polygon would need to be individually warped - an extremely time-consuming procedure that, in reality, suggests it would be more efficient to re-map the area using the Perry Mapping as a guide. However, the distortions on the Perry Mapping were not considered critical at scales smaller than 1:1 000 000.

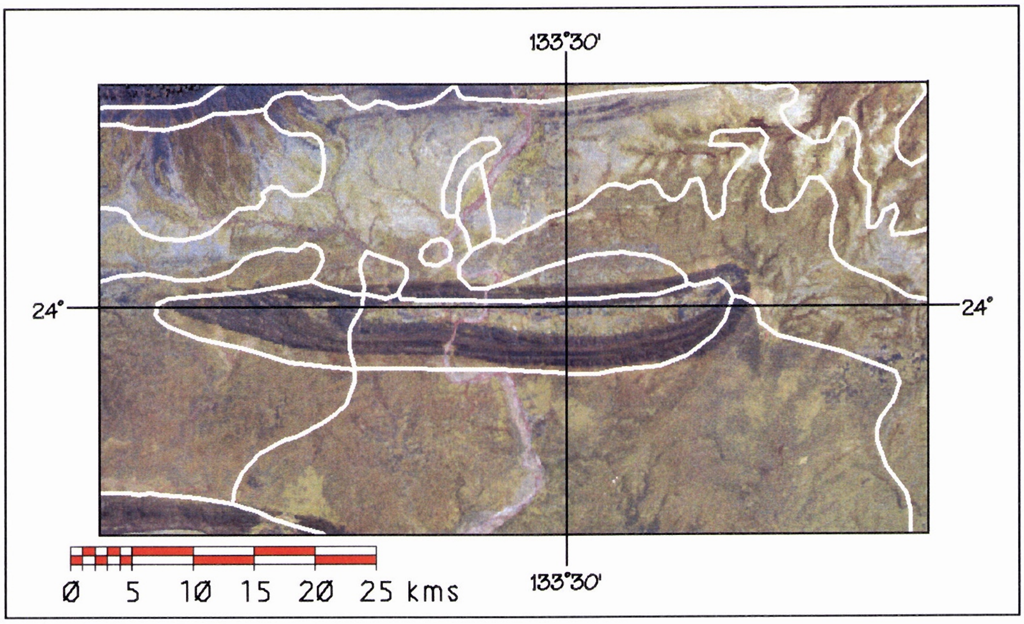


Figure 4: Landsat MSS overlain with Perry Land System vectors. This figure shows the spatial mismatch between these data sets (up to 2 km).

After discussion with Gutnick Resources' geologists as to their requirements, and because it would not have been possible to re-map the whole area within the required timeframe, it was decided to proceed using the Perry Mapping landform units. All parties needed to be aware of the limitations of this mapping at scales more detailed than 1:1 000 000.

Extrapolation and on-screen digitizing over the Landsat image were used to map the five 1;250 000 map sheets on the western border of the study area (Highland Rocks, Lake Mackay, Mount Rennie, Bloods Range and Petermann Ranges).

Approximately five weeks were spent in the field checking the Perry mapping and devising a new regolith-landform classification. The field checking was limited primarily to existing roads and tracks (see Figure 2).

The resulting Landform Interpretation Map (Figure 5, with legend shown as Figure 6 – also presented at 1:1 000 000 scale in Appendix I) is a combination of the Perry Mapping and the on-screen digitizing.

Landform Interpretation Map

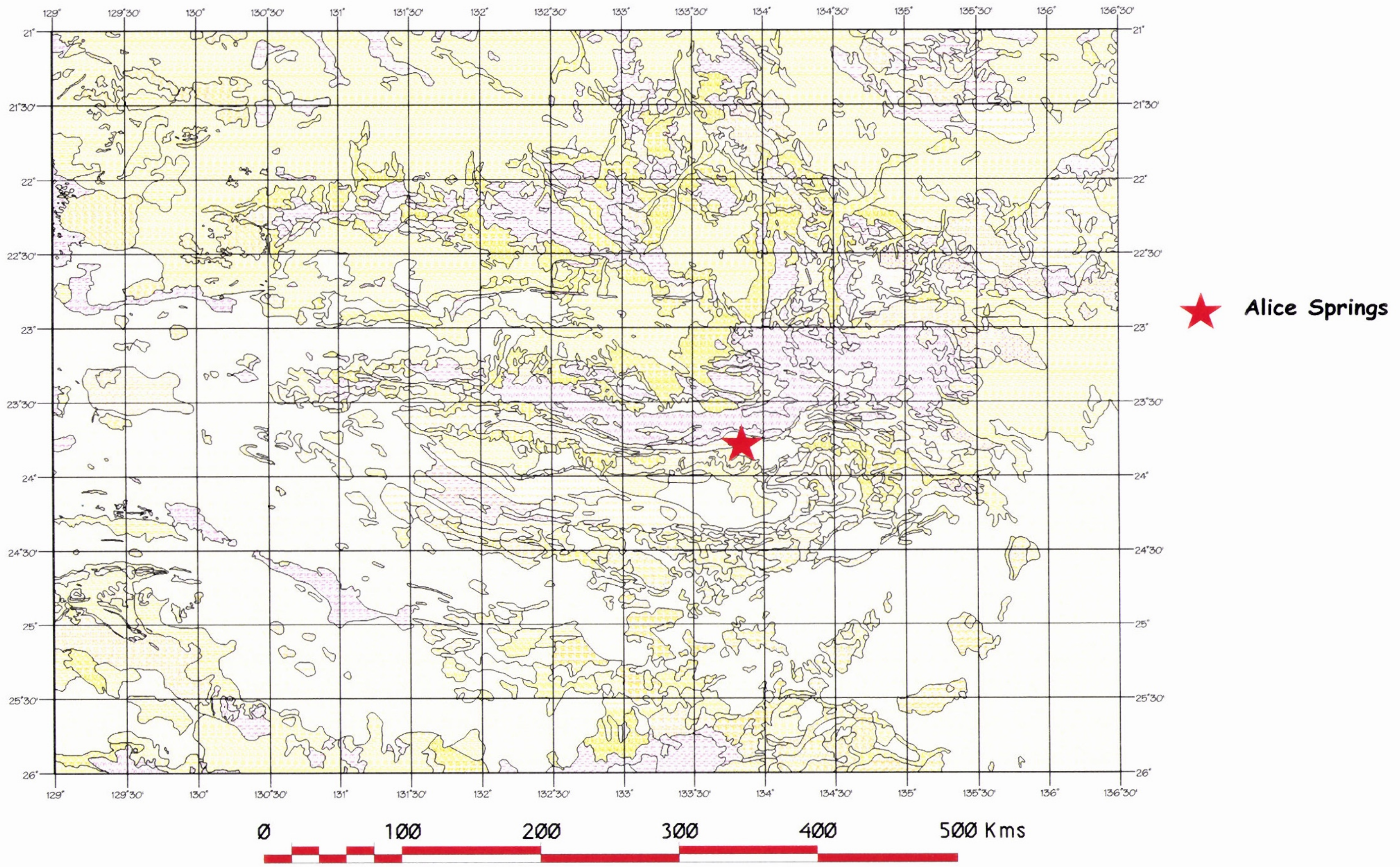


Figure 5: Landform Interpretation Map at full detail. (See Figure 7 for a simplified version).

Legend : Landform Interpretation Map

Erosional Terrain - Sediments

- eh(1): hills and ridges; quartzites and sandstones
- eh(2): hills, ridges and foothills; limestone
- el(1): low hills & ridges; sandstones, conglomerates
- el(3): low hills, spurs, mesas; folded and flat-lying sedimentary rocks
- em(1): mountains & ridges; quartzites and sandstones
- ep(3): plains and terraces; flat-lying and folded sedimentary rocks
- ep(4): plains; flat lying sedimentary rocks
- ep(5): plains and rises; partially stripped of aeolian sand cover
- eu(1): rises; unweathered ?, folded sedimentary rocks (incl carbonates)
- l(1): plateaux; flat lying sandstone
- l(2): plateaux; flat lying limestone
- l(3): plateaux, mesas, ridges; weathered sedimentary rocks
- rl(1): low hills; sandstone quartzites
- rn(2): peneplains on sedimentary rocks

Erosional Terrain - Metamorphics

- el(2): low hills; on folded sedimentary and igneous rocks
- ep(1): plains; stripped weathered granite, gneiss, schist
- ep(2): plains; granite schist gneiss unweathered?
- rh(1): hills(& plains); granite,gneiss,schist
- rm(1): mountains; weathered granite, gneiss

Relict Terrain

- en(1): peneplains; dissected weathered granite, gneiss, schist with minor limestone cover
- l(4): plateaux, mesa and terrace remnants; chalcedonic material overlying weathered land surfaces
- rh(2): hills and ridges; quartzites and sandstones with ferruginous duricrust
- rm(2): mountains & ridges; quartzites and sandstones with ferruginous duricrust
- rn(1): peneplains on weathered granite, gneiss

Depositional Terrain

- af(1): active floodplains and flood-out basins
- pp(1): playa plain; includes playa lakes
- al(1): piedmont gravel terraces; some fine-medium grained sandstones; appear as mesas
- ap(1): plains; aluvial stable
- dp(1): plains & rises; chalcedonic material, sand covered with calcareous earths
- fa(1): alluvial fans, floodplains, basins
- u(1): dunefields; undulating plains, rises
- ul(1): parallel dunefield

Figure 6: Legend: Landform Interpretation Map

3. GEOMORPHIC PROVINCES AND LANDFORM UNITS

The landform units (Figure 5) were defined using the Perry Land System descriptions combined with drainage-texture and photo-form information from the Landsat MSS. The resulting map is a broad-scale representation of the landscape, and the mapped units are not homogeneous.

The landform units have been grouped into three broad categories: depositional terrains, erosional terrains (two subsets identified: metamorphic-igneous and sedimentary) and relict terrains (Figure 7, see also Appendix II). Again, the Perry Land System descriptions, combined with field observations (that were primarily limited to the eastern side of the study area), are the basis of these groupings. The categories used are broadly in accord with the Relict, Erosional and Depositional scheme[1] (Anand *et al.*, 1993), which was devised as a practical regolith-landscape classification for the Yilgarn Craton in Western Australia. Depositional and erosional terrains dominate the region, with few areas exhibiting properties that suggest preservation of deeply weathered ferruginous materials (i.e., relict terrains).

The depositional terrains show evidence of active sedimentation. Landform units grouped into this category include, active floodplains, alluvial plains and fans, playa plains, playas and dune-fields. In general these flat, lowland areas dominate the study area.

The erosional terrains have been actively stripped. Landform units include eroding plains, rises, hills and mountains. Two sub-groups were identified on the basis of the parent material that is being eroded, i.e., sedimentary rocks (Amadeus and Ngalia Basins) and metamorphic/igneous rocks (Arunta Province).

Because of the scale of this study, and the nature of the MSS mosaic, it was not possible to unambiguously determine the potential for weathering-related materials to be preserved (either partially or completely). Consequently, the areas assigned to the relict terrain are tentative, especially in view of the limited fieldwork undertaken. Areas so delineated constitute less than 15% of the mapped area and are considered to be overestimated. Several areas of relict terrain, identified during fieldwork, were indicated to Gutnick Resources at the review meeting held in Melbourne, in October 1999.

4. CONCLUSIONS AND IMPLICATIONS FOR EXPLORATION

4.1 Limitations of interpretation

The Landform Interpretation and Landform-Regolith Terrain Status maps presented here are regional. More detailed interpretations of regolith materials are needed to control exploration geochemical sampling at tenement and more detailed scales. However, this regional landscape study provides a ready framework for more detailed evaluations. The regolith-landform units defined herein are not homogeneous and some variability is inherent because of scale limitations. At the scale of this investigation it was not possible to define specific areas of silcrete or calcrete, though fieldwork indicates they occur sporadically throughout the area. The following sections document the exploration significance of the landform interpretations made in this study.

[1] Grouping of units into the RED scheme is an interpretation based on a genetic model.

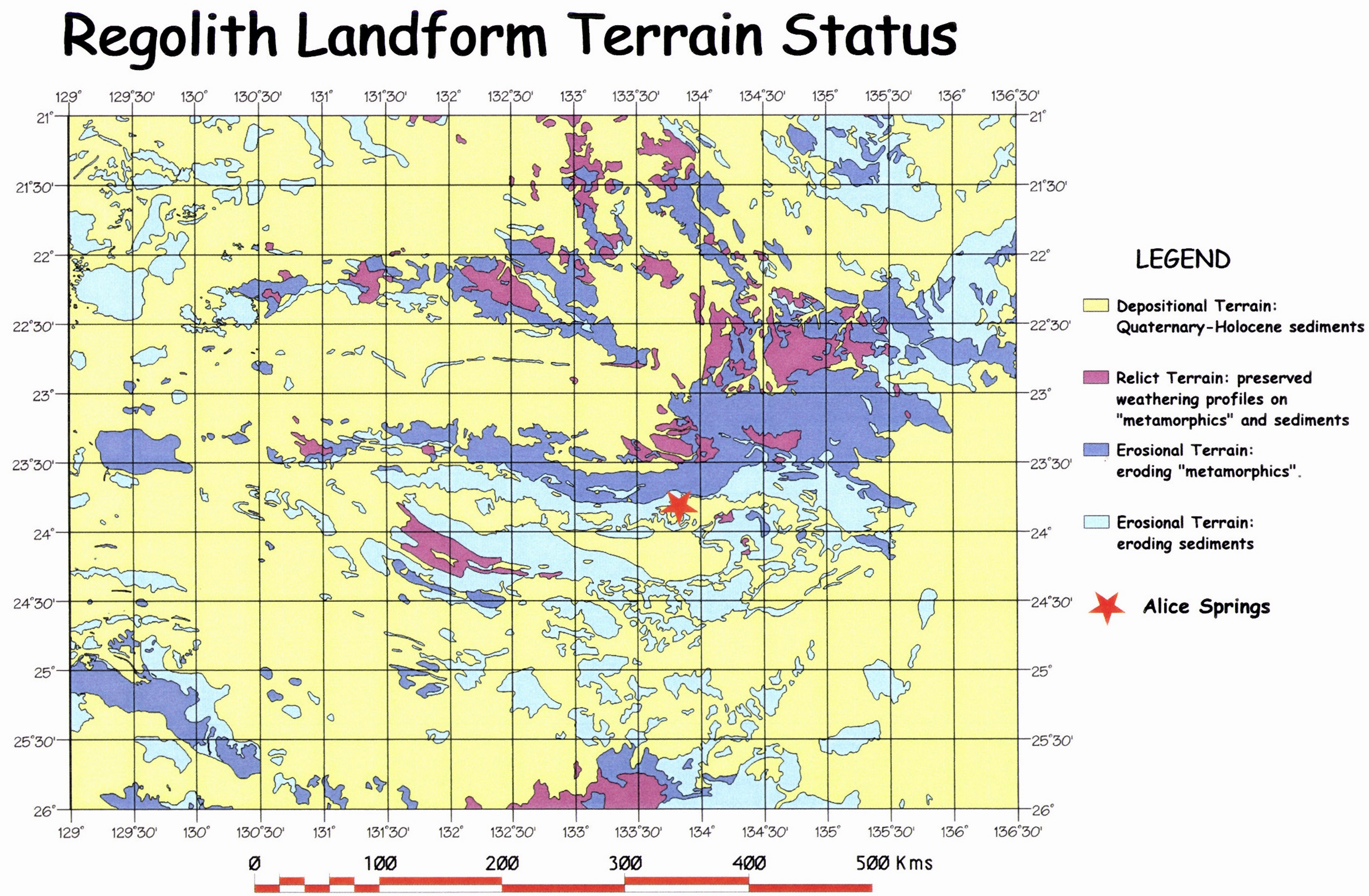


Figure 7: Regolith-Landform Terrain Status Map

4.2 Relict terrains

Allocation of landform units to the relict terrains group is tentative and subjective. It is strongly recommended that these areas be checked by field investigations, prior to any geochemical sampling. If the allocation is correct, it is to be expected that lateritic and related ferruginous materials would be present and these should be sampled preferentially.

4.3 Erosional terrains

Conditions have not been conducive for extensive preservation of deeply weathered profiles on exposed metamorphic and igneous lithologies (Arunta Province). These lithologies, where exposed, are variably weathered, but this is mostly surficial, or controlled by water permeability and porosity. The rates of mechanical erosion have kept pace with, or exceeded, the rates of chemical weathering.

Deeply weathered profiles on the erosional terrains on rocks of the Amadeus Basin are typically either not preserved (on siltstones or claystones) or difficult to recognize (on quartzites). This is because of the high rate of mechanical erosion and their quartz-rich nature respectively. Hence, within the erosional terrains, saprock is common. Conventional exploration geochemistry (e.g., lag, soil, stream sediments etc.,) is likely to be successful here but secondary dispersion would be expected to be minimal and sampling intervals should be adjusted accordingly.

4.4 Depositional terrains

Depositional terrains dominate the area. Two classes of depositional terrains can be identified: -

i) those that occur as flat, low, regional plains;

ii) those that are 'perched' in that they occur above the current level of the regional plains, and are associated with now topographically-elevated basins, valley fills and alluvial fans.

The *regional plains* are low, flat areas that appear to have been formed by filling of a deeply eroded basement topography with both proximal and distal sedimentary detritus. The surficial sediments are typically alluvial and commonly have a substantial, recent veneer of wind-blown sand. However, the basement palaeotopography, within the Arunta Province, may have considerable relief and, in places, there are Tertiary basins up to 200 m deep (Senior *et al.,* 1995). These basins are contained within areas mapped here as regional plains. Apart from the known basins, it is probable that additional substantial thicknesses of Tertiary sediments may be concealed within the depositional terrains.

'Perched' depositional deposits are typically small, but they could conceal prospective lithologies. In areas of high relief, they are dominated by locally derived materials. They are temporary deposits, which are being reworked relatively quickly. Other 'perched' depositional areas are more extensive, and these may have accumulated over a greater period. For example, fans and even some river terrace or valley-fill deposits are currently being reworked by erosion, whereas deposition is active elsewhere.

All sediments comprising the depositional terrains are a significant barrier to exploration. Drilling or more sophisticated techniques, that can 'see through' the cover will be needed to prospect them adequately and this will limit their feasibility as targets. Fundamental to any decision to prospect beneath this cover is estimation of its depth. Minimum estimates could be obtained from existing water bores and exploration drilling, where available, but ground acoustic profiling (GAP) or ATM may well be needed in specific cases (see Lazebnick et al., 2000).

4.5 Sample media

- Selective sampling of lateritic and ferruginous weathered materials within any *relict terrains* would take advantage of enhanced dispersion. A decision to sample high or low in the lateritic materials would need to be determined by orientation studies. The extent of relict terrains appears to be small.

- Within the *erosional terrains*, most geochemical exploration methods (stream sediment, soil, lag and rock-chip sampling of fresh rock, saprock and saprolite) should be adequate. However, the sizes of the anomalies are likely to be small (see Skwarnecki and Fraser, 2000a and b). Where there has been significant weathering, iron-rich mottles and nodules should be considered in preference.
- *Stream sediment sampling* in the erosional terrains has been briefly investigated by Skwarnecki et al., (2000). Where detritus in the streams reflects local lithologies, there are significant dispersion trains that are readily apparent in all fractions. However, where stream detritus is dominated by material from a distal source, for instance by quartzite detritus from a nearby range, weak dispersions are to be found only in the finest fraction (<75 µm). A response is only achieved by removing as much as possible of the generally coarse, diluting material.
- The low, *regional plains* are a significant impediment to geochemical exploration. The nature and thickness of these deposits needs to be ascertained, as they mask the underlying geology and its geochemical expression. Sub-surface sampling will most likely be required (drilling or trenching). Particular attention should be given to understanding the sub-surface stratigraphy and palaeo-topography as this may provide valuable guides towards suitable sampling materials. The surface proportional relationships between relict and erosional terrains implies that erosional terrains are most likely to be intersected beneath the cover, implying an expectation of narrow anomalies; interface sampling would be a valid method (Robertson, 1999). If, as is less likely, relict terrains are intersected, sampling of buried ferruginous lateritic materials is recommended.
- Near small *'perched' deposits*, normal geochemical methods (such as stream-sediment sampling) should be an effective exploration method, although responses will be diluted by detritus eroded from the perched sediments.
- Post-depositional chemical deposits (*ferricrete, calcrete and silcrete*) have been noted, and their suitability as geochemical sampling media has yet to be determined. Substantial occurrences of calcrete were observed in the depositional plains south of Alice Springs. Initial indications are that at least some of these calcretes are of the groundwater type and so are unsuitable for Au search. If there are recognisable pedogenic calcretes among them, these may have potential but it is unlikely they will record a useful response through more than 10 m of cover. They may, however, indicate a district-wide Au potential.
- Consideration should be given to *groundwater geochemistry*. Initial indications are that the groundwater chemistry is controlled by lithology. Because the groundwaters are of low salinity, anomalies are expected to be weak but distinct. Groundwater is available from a number of stock bores and its geochemistry has the greatest value in areas covered by sediments, provided the bore penetrates the basement beneath.

5. ACKNOWLEDGEMENTS

Gutnick Resources N.L. are thanked for their support and, in particular, the encouragement of and candid discussions with Jonathan Law and Neil Phillips are acknowledged. Mal Jones (QDME) and Charles Butt (CRC LEME) provided valuable editorial comment and reviewed the report and maps.

6. REFERENCES

Anand , R.R., Churchward, H.M., Smith, R.E., Gozzard, J.R., Craig, M.A., and Munday, T.J., 1993: Classification and Atlas of Regolith-Landform Mapping Units. CSIRO Restricted Report 440R, 87pp.

Lazebnick, V., Matveev, B. and Koulmametiev, B. 2000. Resonance acoustic profiling trials in Australia. CRC LEME Restricted Report 127R.

Perry R.A., Mabbutt J.A., Litchfield W.H., and Quinlan T., 1961: Landsystems of the Alice Springs Area, Northern Territory CSIRO Division of Land Research and Region Survey. Published by CSIRO Melbourne

Robertson, I.D.M. 1999. Prospecting beneath colluvial-alluvial cover at Quasar and Harmony in the central part of Western Australia: the value of interface sampling. 19th International Geochemical Exploration Symposium - Symposium program and abstracts volume. Association of Exploration Geochemists, Nepean, Ontario, Canada. 46-47.

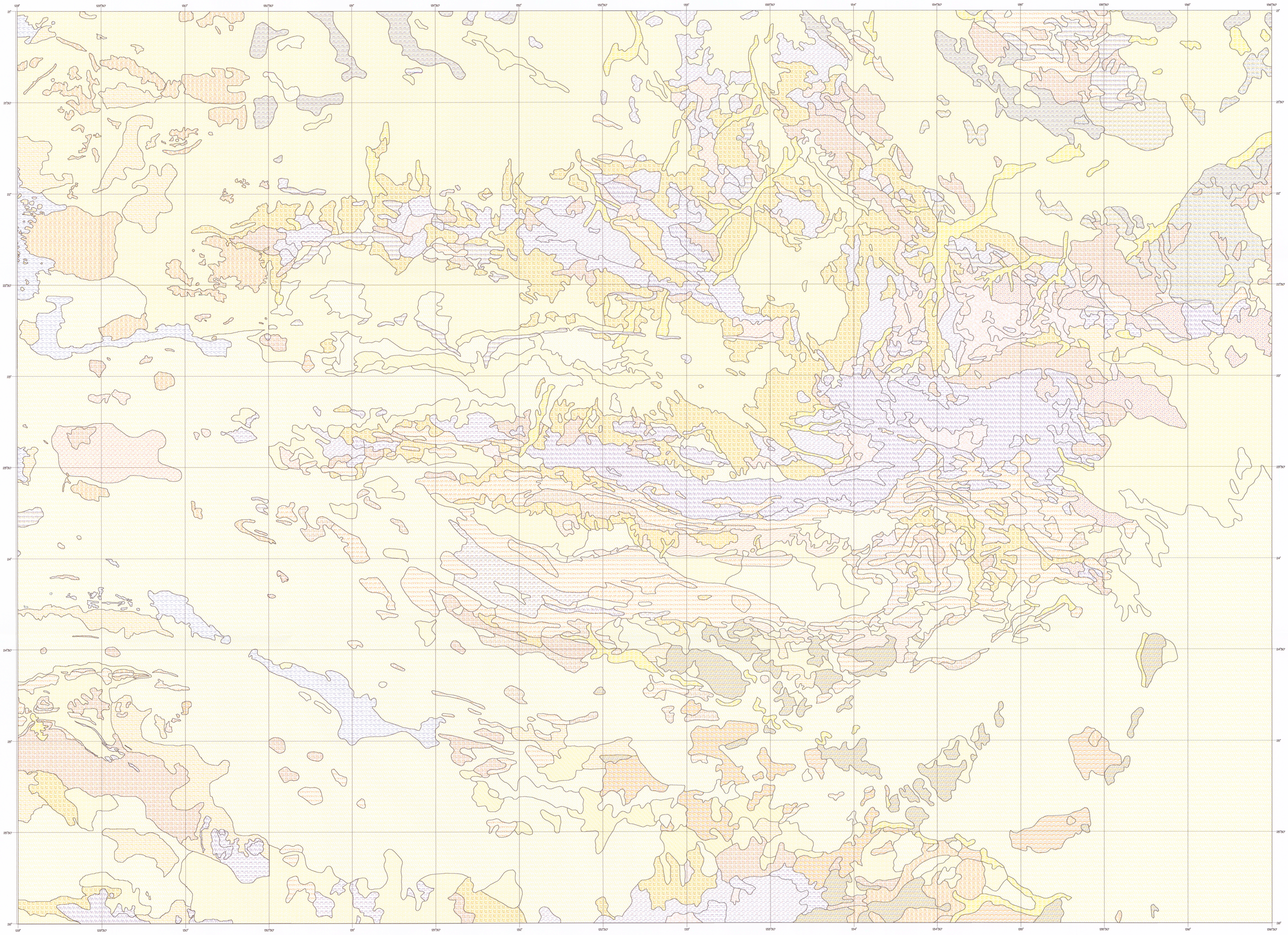
Senior B.R., Truswell, E.M., Idnurm M., Shaw R.D., and Warren R.G., 1995: Cainozoic sedimentary basins in the eastern Arunta Block, Alice Springs region, central Australia. AGSO Journal of Australian Geology and Geophysics 15(4), 421-444.

Skwarnecki, M., Li Shu, Fraser, S.J. and Robertson, I.D.M. 2000. Geochemical orientation surveys and regolith geology in the S.W. Arunta Province, Northern Territory (ARGOS Project). CRC LEME Resrticted Reoprt 129R.

Skwarnecki, M.S. and Fraser, S.J. 2000. Geochemical orientation soil-lag traverse at the Garland Gold Mine, Winnecke Goldfield, Northern Territory. CRC LEME Restricted Report 144R.

Skwarnecki, M.S. and Fraser, S.J. 2000. Geochemical orientation soil-lag traverse at the Edwards Creek base metal prospect, Strangways Range, Northern Territory. CRC LEME Restricted Report 149R.

Landform Interpretation Map: Rand Project



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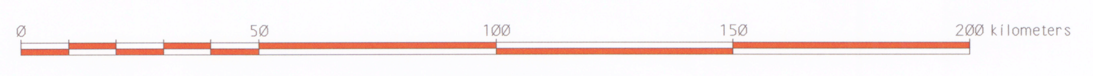

Scale 1:1,000,000

Location Map

Erosional Terrain - Sediments

- eh(1); hills and ridges; quartzites and sandstones
- eh(2); hills, ridges and foothills; limestone
- el(1); low hills & ridges; sandstones, conglomerates
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- ep(5); plains and rises; partially stripped of aeolian sand cover
- eu(1); rises; unweathered ?, folded sedimentary rocks (incl carbonates)
- l(1); plateaux; flat lying sandstone
- l(2); plateaux; flat lying limestone
- l(3); plateaux, mesas, ridges; weathered sedimentary rocks
- rl(1); low hills; sandstone quartzites
- rn(2); peneplains on sedimentary rocks

Erosional Terrain - Metamorphics

- el(2); low hills; on folded sedimentary and igneous rocks
- ep(1); plains; stripped weathered granite, gneiss, schist
- ep(2); plains; granite schist gneiss unweathered?
- rh(1); hills(& plains); granite,gneiss,schist
- rm(1); mountains; weathered granite, gneiss

Relict Terrain

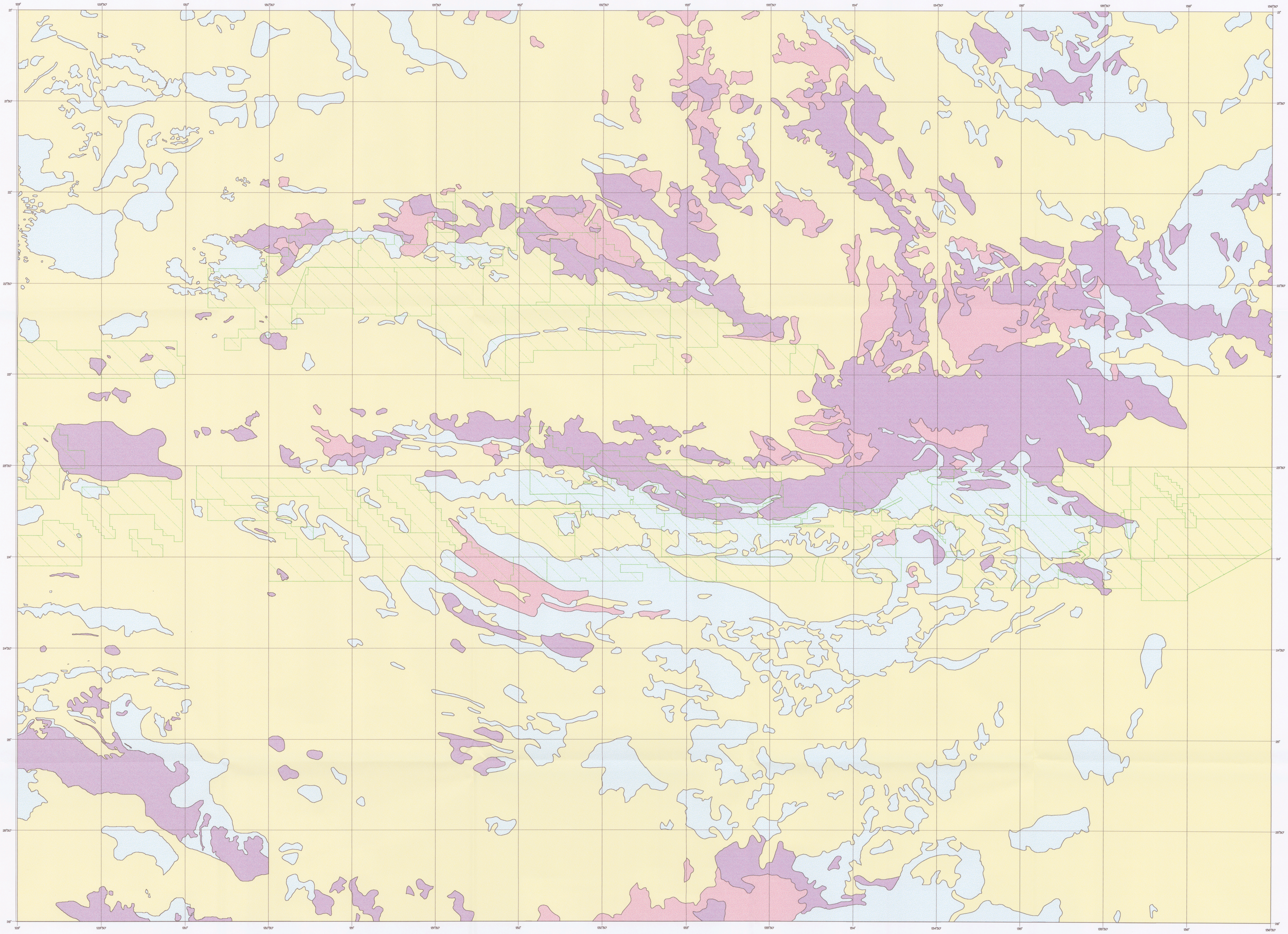
- en(1); peneplains; dissected weathered granite, gneiss, schist with minor limestone cover
- l(4); plateaux, mesa and terrace remnants; chalcedonic material overlying weathered land surfaces
- rh(2); hills and ridges; quartzites and sandstones with ferruginous duricrust
- rm(2); mountains & ridges; quartzites and sandstones with ferruginous duricrust
- rn(1); peneplains on weathered granite, gneiss

Depositional Terrain

- af(1); active floodplains and flood-out basins
- pp(1); playa plain; includes playa lakes
- al(1); piedmont gravel terraces; some fine-medium grained sandstones; appear as mesas
- ap(1); plains; aluvial stable
- dp(1); plains & rises; chalcedonic material, sand covered with calcareous earths
- fa(1); alluvial fans, floodplains, basins
- u(1); dunefields; undulating plains, rises
- ul(1); parallel dunefield

APPENDIX 1

Regolith-Landform Terrain Status: Rand Project



Scale 1: 1,000,000

Location Map

LEGEND

- Depositional Terrain: Quaternary-Holocene sediments
- Relict Terrain: preserved weathering profiles on "metamorphics" and sediments
- Erosional Terrain: eroding "metamorphics".
- Erosional Terrain: eroding sediments

APPENDIX 2