SUPPLEMENTARY NOTES AND REGOLITH MAP FOR THE ENIGMA PROSPECT (WOLLUBAR), KALGOORLIE, WESTERN AUSTRALIA

M.A. Craig, M.J. Lintern and D.J. Gray

CRC LEME OPEN FILE REPORT 111

June 2001


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RESEARCH ARISING FROM CSIRO/AMIRA YILGARN REGOLITH GEOCHEMISTRY PROJECTS 1987-1996

In 1987, CSIRO commenced a series of multi-client research projects in regolith geology and geochemistry which were sponsored by companies in the Australian mining industry, through the Australian Mineral Industries Research Association Limited (AMIRA). The initial research program, “Exploration for concealed gold deposits, Yilgarn Block, Western Australia” had the aim of developing improved geological, geochemical and geophysical methods for mineral exploration that would facilitate the location of blind, buried or deeply weathered gold deposits. The program commenced with the following projects:

Its scope was development of methods for sampling and interpretation of multi-element laterite geochemistry data and application of multi-element techniques to gold and polymetallic mineral exploration in weathered terrain. The project emphasised viewing laterite geochemical dispersion patterns in their regolith-landform context at local and district scales. It was supported by 30 companies.

The project investigated the distribution of ore and indicator elements in the regolith. It included studies of the mineralogical and geochemical characteristics of weathered ore deposits and wall rocks, and the chemical controls on element dispersion and concentration during regolith evolution. This was to increase the effectiveness of geochemical exploration in weathered terrain through improved understanding of weathering processes. It was supported by 26 companies.

These projects represented an opportunity for the mineral industry to participate in a multi-disciplinary program of geoscience research aimed at developing new geological, geochemical and geophysical methods for exploration in deeply weathered Archaean terrains. This initiative recognised the unique opportunities, created by exploration and open-cut mining, to conduct detailed studies of the weathered zone, with particular emphasis on the near-surface expression of gold mineralisation. The skills of existing and specially recruited research staff from the Floreat Park and North Ryde laboratories (of the then Divisions of Minerals and Geochemistry, and Mineral Physics and Mineralogy, subsequently Exploration Geoscience and later Exploration and Mining) were integrated to form a task force with expertise in geology, mineralogy, geochemistry and geophysics. Several staff participated in more than one project. Following completion of the original projects, two continuation projects were developed.

The approach of viewing geochemical dispersion within a well-controlled and well-understood regolith-landform and bedrock framework at detailed and district scales continued. In this extension, focus was particularly on areas of transported cover and on more complex lateritic environments typified by the Kalgoorlie regional study. This was supported by 17 companies.

The significance of gold mobilisation under present-day conditions, particularly the important relationship with pedogenic carbonate, was investigated further. In addition, attention was focussed on the recognition of primary lithologies from their weathered equivalents. This project was supported by 14 companies.

Most reports related to the above research projects were published as CRC LEME Open File Reports Series (Nos 1-74), with an index (Report 75), by June 1999. Publication now continues with release of reports from further projects.

P252: Geochemical exploration for platinum group elements in weathered terrain. Leader: Dr C.R.M. Butt.
This project was designed to gather information on the geochemical behaviour of the platinum group elements under weathering conditions using both laboratory and field studies, to determine their dispersion in the regolith and to apply this to concepts for use in exploration. The research was commenced in 1988 by CSIRO Exploration Geoscience and the University of Wales (Cardiff). The Final Report was completed in December 1992. It was supported by 9 companies.

P409: Geochemical exploration in areas of transported overburden, Yilgarn Craton and environs, WA.
Leaders: Drs C.R.M. Butt and R.E. Smith.
About 50% or more of prospective terrain in the Yilgarn is obscured by substantial thicknesses of transported overburden that varies in age from Permian to Recent. Some of this cover has undergone substantial weathering. Exploration problems in these covered areas were the focus of Project 409. The research was commenced in June 1993 by CSIRO Exploration and Mining but was subsequently incorporated into the activities of CRC LEME in July 1995 and was concluded in July 1996. It was supported by 22 companies.

Although the confidentiality periods of Projects P252 and P409 expired in 1994 and 1998, respectively, the reports have not been released previously. CRC LEME acknowledges the Australian Mineral Industries Research Association and CSIRO Division of Exploration and Mining for authority to publish these reports. It is intended that publication of the reports will be a substantial additional factor in transferring technology to aid the Australian mineral industry.

This report (CRC LEME Open File Report 111) is a second impression (second printing) of CSIRO, Division of Exploration and Mining Restricted Report 339R, first issued in 1997/02, which formed part of the CSIRO/AMIRA Project P409.

Copies of this publication can be obtained from:
The Publication Officer, CRC LEME, CSIRO Exploration and Mining, Private Bag 5, Wembley, WA 6913, Australia. Information on other publications in this series may be obtained from or http://leme.anu.edu.au/

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PREFACE

The CRCLEME-AMIRA Project 409 "Exploration in areas of transported overburden, Yilgarn Craton and environs" has, as its principal objective, development of geochemical methods for mineral exploration in areas with substantial transported overburden, through investigations of the processes of geochemical dispersion from concealed mineralization. An earlier report (EM Report 98R), entitled "Progress statement for the Kalgoorlie study area, Enigma prospect (Wollubara), Western Australia", focussed on soil geochemistry. Subsequently, district-scale regolith-landform mapping (1:50000 scale) has been undertaken to determine the geomorphological setting of the Enigma prospect. This should more readily enable comparisons between this site and equivalents in the region.

The procedures by which the map has been compiled are briefly described and a copy of the map itself is included. This report and Report EM 98R are complementary and should be read in conjunction with one another.

C.R.M. Butt
R.E. Smith
Project Leaders
January 1997
1. **INTRODUCTION**

This report supplements that previously issued (Lintern and Gray, 1995) by providing a regolith landform map and explanatory notes for the Wollubar-Enigma district. The mapping was undertaken in order to establish the geomorphological setting of the detailed geochemical studies described in the earlier report. These two reports are complementary. The area was visited in May 1996 in order to calibrate aerial photographic patterns and supplementary Landsat Thematic Mapper image patterns, to assist in the overall framework interpretation for the area. Due to the limited time available, the map is not fully rectified.

2. **METHODS**

For regolith landform map construction, 1:86000 RC9 black and white aerial photographs were used. Approximately 130 locations were visited and observations recorded to assist with regolith interpretations and map construction. The data were used to construct regolith landform units from calibrated photopatterns and used to modulate data interpreted from satellite imagery. Compilations were performed at photoscale by scanning aerial photographs with overlays attached without the intricate removal of radial distortion. All photographs with overlays were edge-matched then compiled into one composite sheet. The regolith polygons were scanned and imported into ARC/INFO to allow the automatic diagram layout and automatic legend planning.

3. **INTERPRETATION**

The dominant regolith landform unit for the Enigma (Wollubar) area is depositional which comprises 77% of the total mapped area (TMA) with colluvial sediments providing nearly 42% of the TMA (Figure 1, Table 1). Erosional areas comprise 20% of the TMA; the dominant erosional regolith landform unit is "moderately weathered bedrock" and represents 15% of the TMA. Relict area comprise 3.4% of the TMA.

<table>
<thead>
<tr>
<th>REGOLITH LANDFORM UNIT</th>
<th>% OF TOTAL MAPPED AREA (TMA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELICT</td>
<td>3.4</td>
</tr>
<tr>
<td>EROSIONAL</td>
<td>20</td>
</tr>
<tr>
<td>Highly weathered</td>
<td>1.5</td>
</tr>
<tr>
<td>Moderately weathered</td>
<td>15</td>
</tr>
<tr>
<td>Slightly weathered</td>
<td>3.7</td>
</tr>
<tr>
<td>DEPOSITIONAL</td>
<td>77</td>
</tr>
<tr>
<td>Alluvial sediments</td>
<td>22</td>
</tr>
<tr>
<td>Aeolian sands</td>
<td>1.4</td>
</tr>
<tr>
<td>Dunefield</td>
<td>2.5</td>
</tr>
<tr>
<td>Colluvial sediments</td>
<td>43</td>
</tr>
<tr>
<td>Lacustrine</td>
<td>8.4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Figure 1: Simplified regolith diagram of the Wollubar-Enigma area. See back of report for full size detailed diagram.
An interpretation was made of the nature of the material expressed directly at the actual land surface (Table 2); this was possible for approximately 56% of the TMA at this level of investigation. These materials represent the source of regolith compositional information as determined by Landsat TM imagery. These surface materials do not indicate the full nature of regolith materials at depth. A complete explanation of the regolith materials and landforms comprising each unit is provided in the legend on the regolith landform map located at the back of this document.

<table>
<thead>
<tr>
<th>UNIT</th>
<th>% of TOTAL MAPPED AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Calcareous earths, soil carbonate, calcareous nodules</td>
<td>0.7</td>
</tr>
<tr>
<td>2. Lag:-variable composition, but dominantly gravel-sized lithic fragments</td>
<td>4.9</td>
</tr>
<tr>
<td>3. Lag gravels: dominantly quartzofeldspathic sand or granules, or mixtures</td>
<td>13</td>
</tr>
<tr>
<td>4. Ferruginous fragments - mixed composition: lateritic residuum, duricrust, Fe segregations, Fe sapphire and Fe-stained hardpan</td>
<td>7.3</td>
</tr>
<tr>
<td>5. Fine ferruginous gravel lags</td>
<td>29</td>
</tr>
<tr>
<td>6. Black, slightly magnetic, haematite- maghemite-rich ferruginous gravels</td>
<td>1.3</td>
</tr>
<tr>
<td>7. Unassigned</td>
<td>43</td>
</tr>
<tr>
<td>Total map area</td>
<td>100</td>
</tr>
</tbody>
</table>

4. REFERENCES
