ENIGMA MINING LTD

EL28218 (EAST ARNHEM LAND)

ANNUAL and FINAL REPORT

For the period 28/03/11 - 27/03/15

Tenement/s  EL 28218  1:250 000 Sheet Name  Urapunga (SD5310)
Holder  Enigma Mining Ltd  1:100 000 Sheet Name  Moroak (5668)
Manager  N/A  Datum  GDA94-53
Operator  Enigma Mining Ltd

Keywords  Base maps, database, Sherwin Formation, Oolitic, pisolithic, literature review, historic data

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Distribution  TNG Limited (1)
Department of Mines & Energy (1)
EXECUTIVE SUMMARY

Exploration Licence 28218, was granted to Enigma Mining Limited (Enigma) on 28 March 2011 and covers an area of 19.94km². Enigma is a wholly owned subsidiary of TNG Ltd. The licence is one of two East Arnhem Land tenements the company holds.

EL 28218 is located approximately 150km ESE of Katherine via the Stuart and Roper Highways, and then on station tracks to the licence area. It lies within the Urapunga 250K mapsheet.

Enigma applied for the licences to undertake exploration for iron ore within the Sherwin Formation.

A literature review, compilation of existing data and a summary of the existing knowledge of the Sherwin Formation were prepared to enhance the knowledge of the area.

A helicopter reconnaissance trip was undertaken to assess the outcrop of ironstone across the tenure area. As expected from the reviews undertaken of historical exploration there was no evidence of ironstone outcropping within EL 28218 and for this reason the licence is being surrendered at the end of the fourth year of tenure.

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TABLE OF CONTENTS

1. INTRODUCTION 4
2. LOCATION AND ACCESS 4
3. TENURE 5
4. REGIONAL GEOLOGY 5
5. PREVIOUS EXPLORATION 7
6. TNG EXPLORATION 8
   6.1 Exploration Year 1 8
   6.2 Exploration Year 2 8
   6.3 Exploration Year 3 8
   6.4 Exploration Year 4 12
7. CONCLUSIONS AND RECOMMENDATIONS 12

FIGURES

Figure 1: Location of EL 28218................................................................. 4
Figure 2: Regional tectonic setting of the Roper Region.......................... 5
Figure 3: Regional geological setting of the EL 28218.......................... 6
Figure 4: Sample locations within EL 28218 and EL 28219.................. 7
Figure 5: Sherwin Formation ironstones within Enigma licences and throughout the Roper River region. .......................................................... 8
Figure 6: Schematic model for the development of SCOS-IF type (Clinton-type) iron ore deposits.................................................................10

TABLES

Table 1: EL 28218 tenement details.......................................................... 5
Table 2: Sherwin Creek Deposit C and Hodgson Downs Deposits X and W, higher-grade resources – October 2012........................................... 9
Table 3: JORC compliant mineral resource estimates from WDR’s Roper Bar Project (30% Fe cut-off). ..............................................................10

PLATES

Plate 1: Hematite-goethite ooliths and secondary hematite laths from Mount Fisher deposit. .................................................................11
Plate 2: Cemented oolitic ore sample from the Roper Bar area..................11
1. INTRODUCTION

Exploration Licence 28218, was granted to Enigma Mining Limited (Enigma) on 28 March 2011. Enigma is a wholly owned subsidiary of TNG Ltd. The licence is one of two East Arnhem Land tenements the company holds.

A literature review, compilation of existing data and a summary of the existing knowledge of the Sherwin Formation were prepared to enhance the knowledge of the area. A helicopter reconnaissance trip was undertaken across the tenure to assess the outcrop of ironstone within the tenement.

2. LOCATION AND ACCESS

EL 28218 is located approximately 150km ESE of Katherine via the Stuart and Roper Highways, and then on station tracks to the licence area (Figure 1). The licence falls in the south-western portion of the Urapunga (SD53-10) 1:250,000 mapsheet. It lies within the Goondooloo and Moroak Perpetual Pastoral Leases and is subject to native title.

![Figure 1: Location of EL 28218.](image-url)
3. TENURE

Exploration Licence 28218 covers an area of 19.94 km$^2$ in east Arnhem Land. Tenure details for EL 28218 are summarised in Table 1.

Table 1: EL 28218 tenement details.

<table>
<thead>
<tr>
<th>TITLE</th>
<th>PROJECT</th>
<th>AREA (blocks)</th>
<th>GRANT DATE</th>
<th>SURRENDER DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL 28218</td>
<td>East Arnhem Land</td>
<td>6</td>
<td>28/03/2011</td>
<td>27/03/2017</td>
</tr>
</tbody>
</table>

4. REGIONAL GEOLOGY

Exploration Licence 28218 occurs within the central part of the McArthur Basin on the northern edge of the Urupunga Fault Zone. Depositional geometries and the deformation history of the McArthur Basin were influenced by the northerly structural trends inherited from the underlying basement. Subdivision of the province into shelf areas and fault zones reflects its sedimentary and deformational history (Figure 2; Abbott, et al., 2001).

Figure 2: Regional tectonic setting of the Roper Region (from Abbott et al., 2001).
The Urapunga Fault Zone is situated over a reversely faulted basement high which separates the Bauhinia Shelf to the south, from the Arnhem Shelf to the north (Abbott, et al., 2001). A comparatively thin succession of McArthur Basin sediment accumulated in this area.

The local stratigraphy includes rocks of the Roper Group (Prk – Moroak Sandstone, Prv – Velkerri Formation, Pre – Bessie Creek Sandstone; Figure 3). The Roper Group is comprised of undivided quartz sandstones alternating with micaceous and glauconitic sandstones, siltstone and shales and the iron-rich Sherwin Formation which forms significant deposits in the Roper River area.

Dolerite sills (Pdd – Derim Derim Dolerite) intruded the Roper Group around 1300 Ma before the McArthur Basin was deformed.

Most of the tenement is covered by superficial sand, laterite and soils (Figure 3). Valleys of major drainages are aggrading and covered by extensive flats comprised of transported black soil. Regional lateritisation occurred in the early Tertiary after emergence of the Cretaceous sediments, followed by downwarping. The present day drainage, dominated by the Roper River, developed on this warped surface.

Figure 3: Regional geological setting of the EL 28218.
5. PREVIOUS EXPLORATION

The area has mainly been explored for diamonds. Ashton Mining Ltd (Ashton Mining, 1982) and Stockdale Prospecting have both held licences in the area in the 1980’s and early 1990’s.

Ashton identified a single chromite from the 87 samples taken (none within EL 28218) and this was found to be non-kimberlitic (Ashton Mining, 1983). No further exploration was undertaken.

Stockdale collected 223 samples in the region (Podolsky, 1990; two within EL 28218) and no kimberlitic indicators were returned. Stockdale also carried out limited geochemical exploration within their licence areas. Several anomalies were identified from the sampling programme (Podolsky, 1991) but further investigation downgraded the anomalies and the licences were surrendered (Podolsky, 1992). Sample locations are shown on Figure 4.

CRA Exploration Pty Ltd held EL 8942 in 1995. Auger drilling, loam and soil sampling and geophysical review were done within the project area. No targets were identified or specific exploration carried out within the boundaries of EL 28218.

EL 25692 was granted to Tianda Resources in 2007; the relinquished areas make up EL’s 28218 and 28219. During 2008 exploration focussed on ground truthing radiometric anomalies in the north western and southern parts of the tenement. These were field checked and appear to be related to black soil areas forming in valleys between the sandstone outcrops and as such no further work was recommended (Tianda Resources, 2009).
6. TNG EXPLORATION

6.1 Exploration Year 1

A literature review was undertaken during year 1 of tenure. It is attached in Appendix 1. A series of maps included in this review show the results of base metal exploration across the licence by Stockdale Prospecting in the early 1990’s.

6.2 Exploration Year 2

The introduction of a new Exploration Manager in mid-2012 resulted in the review of all projects. The review process involved the production of base maps and databases of historical data for each project.

The 1:10,000 A0 base maps, with topographic and geological backgrounds, produced for EL 28218 are included in Appendix 2. These maps are designed to be able to be used as a base for compilation of data in the field, with locations easily identifiable at the scale used.

All historical geochemical and diamond sampling data from the STRIKE system falling within EL 28218 and EL 28219 has been compiled into Excel Databases containing the relevant location and assay data, where available. These have been entered into the MRT software and are included in Appendix 3. Sample locations are shown in Figure 4.

6.3 Exploration Year 3

During 2013 Enigma applied for two additional exploration licences to the north and east of EL 28218 and EL 28219, which will substantially increase the amount or Sherwin Formation in the project area (Figure 5).

A summary of the existing knowledge of the Sherwin Formation was prepared to enhance the knowledge of the area.

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Figure 5: Sherwin Formation ironstones within Enigma licences and throughout the Roper River region.
Iron Ore Exploration

Iron ore was first discovered in the NT in the McArthur Basin in 1911. Murphy’s prospect near Roper Bar is a series of concordant siliceous lenses up to 100m long and 7m thick, containing massive to disseminated hematite in arkosic sandstone (Ahmad et al., 2013). The Kipper Creek iron prospect was discovered 11.5km ENE of Murphys by the Carpentaria Exploration Company in the 1960’s. Oolitic (Clinton-type; Pratt, 1993), ironstone outcropped in the area and shallow drilling intersected two ironstone beds – the lower being oolitic hematite with interstitial siderite (40.4% Fe) and the upper oolitic and pisolith with siderite and calcite cement (31.0% Fe; Williams, 1962).

BHP moved into the area in 1955 and investigated the region further. This led to the discovery of Hodgson Downs (Deposits T, U, V, and W), Mount Fisher (Deposit M) and Sherwin Creek (Deposits A, B, C, and E). Diamond drilling, bulk sampling and metallurgical testing was undertaken and Canavan (1965) estimated iron ore resources of 200Mt grading 27-33% Fe at Sherwin Creek and 200Mt grading 37-52% Fe at Hodgson Downs (Ferenczi, 2001).

In 2010 Sherwin Iron once again undertook exploration across the BHP prospects. Exploration infill drilling conducted by Sherwin Iron during 2013 has resulted in significant resources being reported at Deposits C, W and X (Table 2, Sherwin Iron, Annual Report, June 2013).

### Table 2: Sherwin Creek Deposit C and Hodgson Downs Deposits X and W, higher-grade resources – October 2012.

<table>
<thead>
<tr>
<th>Deposit / Category</th>
<th>Category</th>
<th>Cut-off (Fe %)</th>
<th>Tonnes (Mt)</th>
<th>Fe (%)</th>
<th>Al₂O₃ (%)</th>
<th>SiO₂ (%)</th>
<th>P (%)</th>
<th>LOI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sherwin Creek C Deposit</td>
<td>Indicated</td>
<td>55</td>
<td>18.34</td>
<td>58.3</td>
<td>1.07</td>
<td>12.36</td>
<td>0.03</td>
<td>2.47</td>
</tr>
<tr>
<td>Sherwin Creek C Deposit</td>
<td>Inferred</td>
<td>55</td>
<td>0.08</td>
<td>57.6</td>
<td>1.52</td>
<td>12.68</td>
<td>0.02</td>
<td>2.91</td>
</tr>
<tr>
<td>Sherwin Creek Higher Grade Total</td>
<td></td>
<td>Sub Total</td>
<td>55</td>
<td>18.42</td>
<td>58.3</td>
<td>1.07</td>
<td>12.36</td>
<td>0.03</td>
</tr>
<tr>
<td>Hodgson Downs X Deposit</td>
<td>Indicated</td>
<td>55</td>
<td>8.15</td>
<td>57.7</td>
<td>2.11</td>
<td>12.14</td>
<td>0.09</td>
<td>2.62</td>
</tr>
<tr>
<td>Hodgson Downs W Deposit</td>
<td>Inferred</td>
<td>55</td>
<td>0.85</td>
<td>56.1</td>
<td>2.58</td>
<td>11.04</td>
<td>0.10</td>
<td>2.37</td>
</tr>
<tr>
<td>Hodgson Downs Higher Grade Total</td>
<td></td>
<td>Sub Total</td>
<td>55</td>
<td>13.05</td>
<td>57.3</td>
<td>2.36</td>
<td>11.78</td>
<td>0.08</td>
</tr>
</tbody>
</table>

**Note:** The Mineral Resource estimates were carried out in accordance with the guidelines of the JORC Code (2012) by Sherwin’s internal consultant, which was audited and signed off by Coffey Mining.

Bulk sampling and extraction of DSO from Deposit C began in 2013 with plans to move onto areas X and W. The current proposed mining development in Area C will be developed in two stages. Stage 1 is the initial DSO project development to generate cash flow, and Stage 2 is processing the low-grade ore, or selling it directly (Sherwin Iron, 2013).

Additional exploration, particularly from the Mount Scott area will significantly add to the current resources defined in the area.

Southeast of the original BHP work, Western Desert Resources (WDR) has established JORC compliant (2004) resource estimates (Table 3) within the Roper Bar Project Area (Figure 5). WDR sent its first shipload of ‘Roper Red’ ore to China in December 2013 (WDR, 2013b). The Mountain Creek Project Area is also within WDR tenure and provides additional resource potential.
Table 3: JORC compliant mineral resource estimates from WDR’s Roper Bar Project (30% Fe cut-off; From WDR, 2013a).

<table>
<thead>
<tr>
<th>DEPOSIT AREA</th>
<th>Classification</th>
<th>Mt</th>
<th>Fe %</th>
<th>SiO₂ %</th>
<th>P %</th>
<th>Al₂O₃ %</th>
<th>LOI %</th>
<th>Published</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area D</td>
<td>Inferred</td>
<td>90.7</td>
<td>37.2</td>
<td>31.5</td>
<td>0.008</td>
<td>3.2</td>
<td>9.6</td>
<td>Oct-09</td>
</tr>
<tr>
<td>Area D (north)</td>
<td>Inferred</td>
<td>116.5</td>
<td>40.3</td>
<td>26.3</td>
<td>0.002</td>
<td>2.2</td>
<td>11.0</td>
<td>Feb-11</td>
</tr>
<tr>
<td>Area E (south)</td>
<td>Inferred</td>
<td>17.5</td>
<td>36.1</td>
<td>30.8</td>
<td>0.003</td>
<td>2.4</td>
<td>12.4</td>
<td>Jun-12</td>
</tr>
<tr>
<td>Area E (south)</td>
<td>Indicated</td>
<td>75.8</td>
<td>38.7</td>
<td>29.9</td>
<td>0.005</td>
<td>2.6</td>
<td>9.9</td>
<td>Jun-12</td>
</tr>
<tr>
<td>Area E (east)**</td>
<td>Inferred</td>
<td>27.6</td>
<td>41.0</td>
<td>26.3</td>
<td>0.004</td>
<td>1.8</td>
<td>10.2</td>
<td>Jun-12</td>
</tr>
<tr>
<td>Area E (east)**</td>
<td>Indicated</td>
<td>15.6</td>
<td>41.2</td>
<td>26.3</td>
<td>0.004</td>
<td>1.9</td>
<td>10.0</td>
<td>Jun-12</td>
</tr>
<tr>
<td>Area E (east)**</td>
<td>Measured</td>
<td>28.3</td>
<td>42.2</td>
<td>26.4</td>
<td>0.004</td>
<td>2.0</td>
<td>8.9</td>
<td>Jun-12</td>
</tr>
<tr>
<td>Area F (east)</td>
<td>Inferred</td>
<td>216.1</td>
<td>41.3</td>
<td>31.0</td>
<td>0.004</td>
<td>2.9</td>
<td>4.9</td>
<td>Apr-13</td>
</tr>
<tr>
<td>Area F (east)</td>
<td>Indicated</td>
<td>15.7</td>
<td>47.3</td>
<td>24.9</td>
<td>0.006</td>
<td>2.7</td>
<td>3.0</td>
<td>Apr-13</td>
</tr>
<tr>
<td>Area F (east)**</td>
<td>Measured</td>
<td>7.7</td>
<td>50.0</td>
<td>20.8</td>
<td>0.005</td>
<td>3.4</td>
<td>2.7</td>
<td>Apr-13</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>611</td>
<td>40.3</td>
<td>29.2</td>
<td>0.004</td>
<td>2.6</td>
<td>8.1</td>
<td></td>
</tr>
</tbody>
</table>

* Includes DSO grade of 30.8Mt @ 59.0% Fe, 9.9% SiO₂, 2.5% Al₂O₃, 0.01% P and 2.0% LOI
** Includes DSO grade of 16.6Mt @ 54.2% Fe, 15.9% SiO₂, 1.2% Al₂O₃, 0.01% P and 4.0% LOI

Oolitic Ironstone Deposits

Oolitic ironstones are massive stratiform units within marine terrigenous clastic sediments. Kimberley (1978) has named them sandy-clayey and oolitic, shallow-inland-sea iron formations or SCOS-IF’s, also known as Clinton-type oolitic ironstones (Ferenczi, 2001). The ironstones are usually interbedded with shale and quartz sandstones which were deposited in an agitated, shallow marine depositional environment. The main minerals are goethite, hematite, limonite, siderite, chamosite, greenalite and traces of magnetite (Ferenczi, 2001).

Many theories have been published on the origin of oolitic ironstones (See Kimberley 1978 and 1989), but the most appropriate model seems to involve the mechanical accretion of iron-rich gelatinous coats onto nuclei of fine quartz or rock fragments on the seafloor during periods of reduced sediment influx. The iron-rich solutions may have been derived from volcanogenic or hydrothermal processes (Ferenczi, 2001). During marine transgressions the iron-rich (deeper) waters occupied a shallow shelf or embayment (Figure 6) that allowed extensive production of chamositic and hematitic ooids.

Mesoproterozoic iron ore deposits in the Roper River region are examples of this type of iron mineralisation.

![Figure 6: Schematic model for the development of SCOS-IF type (Clinton-type) iron ore deposits (from Ferenczi, 2001).](attachment:image.png)
**Sherwin Formation**

The Sherwin Formation is characterised by the presence of massive oolitic to pisolithic ironstone (Plate 1, 2), but is dominated by interbedded medium to very coarse ferruginous, ripple marked sandstone, siltstone and mudstone. The upper boundary is defined as the last occurrence of oolitic ironstone (Ahmad et al., 2013). Massive ironstone beds are typically 1-4m thick and are often exposed at the top of cliff faces. At least four distinct ironstone beds have been identified within the Sherwin Formation (Ahmad, et al., 2013) and it is the soft, ochreous oolitic ironstone near the base of the formation that has better economic potential than the harder, upper ironstone beds which contain less iron and more silica (Ferenczi, 2001).

Sedimentary features within the Sherwin Formation suggest that it was deposited as an offshore bar in an active shoal environment (Figure 6) that transgressed over lagoonal mud and beach sand (Moroak Sandstone; Ferenczi, 2001).

![Plate 1: Hematite-goethite ooliths and secondary hematite laths from Mount Fisher deposit (From Ferenczi, 2001).](image)

![Plate 2: Cemented oolitic ore sample from the Roper Bar area (A. Wygralak collection; From Ahmad et al., 2013).](image)
6.4 Exploration Year 4

In August 2014 explorations licences 30207 and 30208 were granted to the north and east of EL 28218. A helicopter reconnaissance trip was undertaken to assess the outcrop of ironstone across the tenure area. As expected from the reviews undertaken of historical exploration there was no evidence of ironstone outcropping within EL 28218 and for this reason the licence is being surrendered at the end of the fourth year of tenure.

7. CONCLUSIONS AND RECOMMENDATIONS

Due to the lack of ironstone outcrop within the licence area and the current market conditions the licence has been surrendered at its fifth anniversary.

REFERENCES


