COMPETITIVE PLATINUM-GROUP-METAL (PGM) SUPPLY FROM THE EASTERN LIMB, BUSHVELD COMPLEX: GEOLOGICAL, MINING, AND MINERAL ECONOMIC ASPECTS

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An analysis of South African PGM production potential to prolong global competitiveness.

Can the Eastern Limb, Bushveld Complex, be considered, by investors, in preference to the Western Limb?
The Bushveld Complex

- Two distinct geographical portions: western and eastern limbs
- Main mineralized horizons: Merensky Reef and UG2
- (For the purposes of this discussion the northern limb and the Platreef is excluded)
Total South African PGM production and associated market share (1975–2009)

(Data source: Johnson Matthey, Raw Materials Group)
Gold and PGM sector South African GDP contribution

(Data source: Chamber of Mines)
Legislative impact on market share

![Graph showing market share over time for different producers.]

- **AngloPlatinum**
- **Impala Platinum**
- **Lonmin**
- **All other producers**
- **Total production tonnes**

The graph illustrates the percentage and production tonnes for each category from 1984 to 2008.
This work provides

Integration of diverse data sources to provide a holistic, and strategic, view of the South African PGM landscape, with specific reference to the eastern limb, Bushveld Complex.

There is an overall lack of cumulative studies, in the public domain, that strategically appraise the South African PGM production sector.
Core conditions → underlying criteria

Mineral Economics →
- Long-run demand/supply
- Economically competitive

Resource/Reserves →
- Sufficient size and grade
- Supply-pipe line

Mining - related →
- Largely mechanized, cost effective and safe

“Above-ground” risks →
- Adequate water and power
The long-run forecast of demand and supply dynamics underpin a continued need for PGM production.
Global PGM demand per use sector (2010)

(Data source: Johnson Matthey)
Mineral basket comparison

**Western Limb**
- Pt: 63%
- Pd: 29%
- Rh: 6%
- Au: 2%

**Eastern Limb**
- Pt: 50%
- Pd: 40%
- Rh: 8%
- Au: 2%
Long–run demand and supply trends

- Global demand for PGM’s is forecast to be sustained – underpinned by auto catalyst and jewellery sector demand growth (especially from China)

- The world needs PGM’s

- Can South Africa remain the number one global supplier?
Criteria 2

The eastern limb contains deposits of sufficient size, and grade, to support mineral production.
MR Resources versus grade
UG2 Resource versus grade

The graph shows the UG2 Resource (Mt) on the x-axis and UG2 4E g/t on the y-axis. Two distinct groups are represented by different colors: East Limb (blue diamonds) and West Limb (red squares). The data points indicate a correlation between the resource and grade for each limb.
An eastern limb supply pipeline, comprising all phases of the mineral resource value chain is currently present.
## PGM pipeline per development phase

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Initial Expl.</td>
<td>18</td>
<td>20</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Adv Expl.</td>
<td>13</td>
<td>17</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Pre-Feasibility</td>
<td>7</td>
<td>9</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Feasibility</td>
<td>9</td>
<td>6</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Construction</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>SUM</strong></td>
<td><strong>53</strong></td>
<td><strong>55</strong></td>
<td><strong>16</strong></td>
<td><strong>24</strong></td>
</tr>
</tbody>
</table>

* Total includes North
And pipeline resource tonnes
Criteria 4

Initial mining of the eastern limb will be at shallow to intermediate depth facilitating largely mechanized operations that are cost effective and safe.
Conventional versus mechanized mining
## Principle choice of mining method

<table>
<thead>
<tr>
<th>Mining method</th>
<th>Prevalence</th>
<th>West</th>
<th>East</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanized – Bord and Pillar; XLP</td>
<td>26%</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Hybrid – Mechanized tramming, conventional stoping</td>
<td>48%</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Conventional – longitudinal breast, with handheld rock drills, material removal via box-holes using scrapers, rail hoppers</td>
<td>26%</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
## Mining costs per method

<table>
<thead>
<tr>
<th>Mining method</th>
<th>USD/m²</th>
<th>USD/tonne mined</th>
<th>USD/equiv reef oz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>643-357</td>
<td>50-92</td>
<td>857-1643</td>
</tr>
<tr>
<td>Hybrid</td>
<td>472-542</td>
<td>57-93</td>
<td>1114-1643</td>
</tr>
<tr>
<td>Mechanized</td>
<td>257-414</td>
<td>39-42</td>
<td>886-1000</td>
</tr>
<tr>
<td>Open-pit</td>
<td>9-14</td>
<td>357-428</td>
<td></td>
</tr>
</tbody>
</table>
Mining safely

Western Limb – 1 fatality for 3.3 million tonnes broken

Eastern Limb – 1 fatality for 4 million tonnes broken
Criteria 5

The production of PGM’s on the eastern limb is economically competitive, relative to the continuation of western limb production.
## Cumulative cash costs – existing operations

<table>
<thead>
<tr>
<th></th>
<th>West</th>
<th>East</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average (USD/oz)</td>
<td>1,264</td>
<td>1,355</td>
</tr>
<tr>
<td>Range (USD/oz)</td>
<td>638 – 1,661</td>
<td>696 – 2,575</td>
</tr>
</tbody>
</table>

![Cost ($) vs % Share graph]
Criteria 6

Adequate power and water supply exists to support mine development on the eastern limb
Western versus Eastern limb infrastructure
### Power and water supply

<table>
<thead>
<tr>
<th>2009</th>
<th>West</th>
<th>East</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (MJ/t ore)</td>
<td>524</td>
<td>346</td>
</tr>
<tr>
<td>Water (M³/t ore)</td>
<td>1.26</td>
<td>1.35</td>
</tr>
</tbody>
</table>

*Data Source: Mudd (2010)*

- Reality: Impact of global economic downturn has resulted in financing and development delays for: de Hoop Dam, Medupi power station
- With increased production there will be constraints
Regional development prospects

• Four main “regions”

• Contiguous lease area synergies

• Especially for water and power supply delineation
Our strategy going forward is to consolidate the eastern limb of the Bushveld complex … The consolidation will not just be through rights and properties, but also collaboration on the provision of services including health and training, and procurement, so that we have a critical sphere of influence on the eastern limb, which has still to be developed as comprehensively as the western limb (April 7, 2011).

We want to consolidate and start growing the eastern limb through existing and new partnerships. We’re also working on collapsing the farm fences and realising value across them through co-operation”
Outcomes

- The most inhibiting production constraints are “above-ground” risks.

- Great potential exists for regional planning and co-operation: contiguous lease area synergies, regional geological (pothole) investigations; also consider lessons from the western limb and Witwatersrand.

- The eastern limb is considered **moderately** viable to produce PGM’s in preference to the western limb.

- South Africa could remain globally competitive in the supply of PGM’s if the above ground risks are mitigated successfully.
THANK YOU