Bakubung Platinum Mine Geology

REGIONAL GEOLOGY

Regional Setting

The Wesizwe mining rights area is situated within the 2.06Ga to 2.058Ga aged Bushveld Complex which is understood to be the largest layered igneous complex in the world (Figure 1). Situated within the north-central Kaapvaal Craton, this massive Proterozoic intrusive body, or more likely a series of interconnected intrusives, has a surface area of approximately 67 000km² and consists of a mafic-ultramafic succession of layered and massive rocks (the Rustenburg Layered Suite (RLS)), a penecontemporaneous series of granitic rocks (Lebowa Granite Suite) and felsic extrusive rocks of the Rooiberg Group.

The true thickness of the mafic-ultramafic layered rocks in the Bushveld Complex varies from 7 000m to 12 000m. The Bushveld Complex was intrusively emplaced within (and exhibits a transgressive relationship to) the Transvaal Supergroup, a large sedimentary basin of late Archaean-Proterozoic age located within the north-central Kaapvaal Craton. The mafic-ultramafic layered rocks of the RLS outcrop in three main arcuate complexes or limbs namely the Western, Eastern and Northern Limbs which have been further subdivided into a set of geographic sectors based on the major geological characteristics of the RLS (Figure 1).

The similarity of geology across large areas within each of the three limbs particularly the sequence of igneous layering that includes both the Precious and Base Metal mineralized Merensky Reef and the UG2 Reef is probably indicative of simultaneous differentiation and replenishment of a basaltic magma under essentially identical conditions. The dip of the igneous layering is generally shallow (approximately 7° in the Wesizwe Exploration area) and towards the centre of the complex.

The RLS stratigraphy is divided into five major units which are, from lowest to highest, described below:

- The Marginal Zone comprises a heterogeneous succession of generally unlayered basic rocks dominated by norites. These rocks contain quartz and hornblende believed to be a result of contamination of the basic magmas by the enclosing host rocks. Sedimentary rock fragments are contained as xenoliths within the lowermost ranges of this zone.
- The Lower Zone is dominated by a series of ultramafic olivine-rich harzburgites and pyroxenites. The unit varies in thickness, having a trough-like geometry with the thinnest succession developed over structural highs in the basin floor.
- The Critical Zone is subdivided into lower and upper units; cycles in the Lower Critical Zone are entirely ultramafic in character and are dominated by pyroxenite with interlayered harzburgite and chromitite layers whereas the Upper Critical Zone represents a mixed mafic-ultramafic cyclic unit comprising layered pyroxenites, norites, anorthosites and chromitites. Significant economic concentrations of Platinum Group Elements (PGE (4)) are located within the Merensky and UG2 Reefs located within the upper portions of the Upper Critical Zone.
- The Main Zone is the thickest unit within the RLS. In general, approximately half the RLS stratigraphic interval is occupied by this zone. The Main Zone consists of gabbro-norites with some anorthosite and pyroxenite layering. Layering is not as well developed as in the Critical and Lower Zones.
- The Upper Zone is dominated by ferro-gabbroic lithologies. However, layered anorthosite and magnetite sequences are also present. There is no chilled contact with the roof rocks, which comprise rhyolites and granophyres.
The Merensky Reef

In the Western Limb, the Merensky Reef exhibits significant variations in lithology and PGE (4) grade. It was originally subdivided into the Rustenburg facies and Swartklip facies (south and north of the Pilanesberg Complex) respectively by Wagner (1929) based upon a number of differences including the abundance of olivine-rich cumulates and thinner pre-Merensky Reef units (UG1 and UG2) in the Zwartklip facies (Maier & Eales, 1997) (Figure 2).

The Merensky Reef Unit is the most regular and complete cyclic unit within the Critical Zone. The Merensky Reef is located between 60 to 100m below the top of the Critical Zone and grades upwards through the cycle into norite, a 'spotted' anorthosite and, finally, into a 'mottled' anorthosite (at the top of the cycle). Many variations to this profile have been observed throughout the Western Limb and the recognition of such differences has enabled the identification and classification of the various facies types observed and recorded at the Wesizwe exploration area.

The UG2 Reef

The UG2 Reef is generally underlain by a pegmatoidal feldspathic pyroxenite, with a diffuse basal contact and frequently a thin (2cm) chromitite stringer below the base of the main UG2 chromitite. The absence of this stringer would generally indicate the presence of potholing. Potholing where encountered appears less intense than in the overlying Merensky Reef.

The UG2 chromitite layer varies between 60 and 80cm in thickness and often displays a mottled appearance due to the presence of large “ghost” bronzite grains within the chromitite. The main chromitite is overlain by a relatively thick (up to 6m) porphyritic pyroxenite layer which contains (in its lower portion) up to three leader chromitite layers which are known to bifurcate and coalesce on a local scale (Viljoen M.J. et al (1986) and Leeb-Du Toit (1986)).
Figure 2: Western Limb of the Bushveld Complex; Wesizwe Platinum’s locality

GEOLOGY OF BAKUBUNG PLATINUM MINE

Merensky Reef

As a result of the geological observations made throughout the course of the Wesizwe exploration programme four broad types or facies of Merensky Reef have been recognised which have been named in accordance with the following descriptive nomenclature:

- Normal Reef

This facies is characterized by the occurrence of narrow (<1cm) upper and basal chromitite layers between which is a coarse-grained (>2cm) pegmatoidal feldspathic pyroxenite becoming more harzburgitic–troctolitic (olivine/feldspar assemblage) approaching the basal chromitite extending over an approximate 1.2m. The basal chromitite is underlain by a poikilitic anorthosite similar to that observed underlying the
Bastard Reef Pyroxenite and is barren of mineralization. The upper chromitite is overlain by approximately 3m of medium-grained (<5mm) feldspathic orthopyroxenites termed the Merensky Pyroxenite. Macroscopic Base Metal Sulphide (BMS) mineralization is located interstitially within the pegmatoidal feldspathic pyroxenite bounded by the upper and lower chromitites and displays local enrichment within and directly above the upper chromitite.

This facies type is similar to that described as occurring at the neighbouring Impala Platinum and Anglo Platinum operations although the average intersection width intersected across the Wesizwe project area is far greater. Figure 3 depicts the nature and average mineralized intersection widths of the Normal Reef as well as the other facies types.

**Figure 3: Merensky Reef facies types with location of mineralization (red vertical bar) and average mineralization widths**

- **Single Chromitite Reef**

  This approximately 0.14m thick facies type is similar in appearance to the Contact Reef observed and described at various platinum operations throughout the Bushveld Complex in that the pegmatoidal feldspathic pyroxenite is “compressed” to a few centimetres so that the usual two bounding upper and lower chromitites join to form a single chromitite layer. Occasional intersections have been observed where the upper-lower chromitite separation distance allows for the observation of the internal pegmatoidal feldspathic pyroxenite highlighting the gradational nature of this facies type close to the facies boundary. The chromitite(s) are underlain by poikilitic-spotted anorthosites and norites which comprise a severely "compressed" footwall stratigraphy. Whereas the footwall stratigraphy underlying the Normal facies is approximately 12m thick (to the regionally significant and consistent Footwall 6 Boulder Bed chromitite) the stratigraphic separation pertaining to this facies type is approximately 3m. The implication being that this is evidence of a regionally consistent transgressive feature of the Merensky Reef. Mineralization occurs in the underlying anorthosites and norites as well as in the overlying feldspathic pyroxenites giving rise to isolated mineralization widths in excess of 2m

- **Detached Reef**

  This approximately 10m thick facies type is similar in appearance to the Normal reef described above, with the significant difference being that the feldspathic pyroxenite pegmatoid which underlies the upper chromitite is in turn underlain by approximately 8m
of fine-grained (<2mm) orthopyroxenite with occasional coarse-grained phenocrysts of clinopyroxene. The basal chromitite is normally overlain by a 10-20cm wide pegmatoid of feldspathic pyroxenite which occasionally shows evidence of serpentinization. The basal chromitite is underlain by the same lithologies and to the same width as that underlying the Normal reef. Mineralization is localized to the pegmatoid beneath the upper chromitite and upper 20cm of the overlying Merensky Pyroxenite

- Normal Footwall Reef

This approximately 0.7m thick facies type is similar in virtually all respects to the Normal reef described above; a pegmatoid of feldspathic pyroxenite which displays a more harzburgitic-troctolitic character than described before bounded by upper and lower chromitite layers. However, the significant difference is that the basal chromitite would appear to be joined with the FW6 chromitite and the entire package is directly underlain by alternately layered olivine norites of the stratigraphically consistent Footwall 7. Significant PGE and BMS mineralization has been described from this unit and thus the width over which mineralization extends can be extensive (approximately 2m in places).

Since the last Mineral Resource update there has been a considerable amount of new drilling information added to the existing dataset (principally in the northwest region of Ledig). Wesizwe have attempted to utilize the structural model as (interpreted from the three dimensional seismic results) as a guide for the facies boundaries. (see Figure 4) The structural model coupled with re-interpretations of existing intersections has led to the currently believed facies distribution which now honours the concept of an eroding Merensky Reef being influenced by major structural features. An exclusion zone containing those drillhole intersections that displayed atypical Merensky Reef and UG2 Reef lithologies has been utilized by The Mineral Corporation to display the effect of large scale structural disturbances. With the addition of new drillhole information, principally from the far northwest area of Ledig, The Mineral Corporation has observed that whilst the stratigraphic relationships have remained relatively consistent the intersections do appear to have been affected by the major structural features to the immediate west and the presence of large scale Iron Replacement Ultramafic Pegmatoids (IRUP).
UG2 Reef

The extensive exploration undertaken by Wesizwe has allowed for the recognition of two consistent facies types for the UG2 Reef akin to the Merensky Reef facies varying according to the nature of the underlying footwall lithologies:

- **Normal Reef**

  The UG2 chromitite (UG2 Main Layer) (approximately 65cm thick) is underlain by a feldspathic pyroxenite pegmatoid (containing laterally discontinuous chromitite lenses and stringers) and is subsequently underlain by a poikilitic anorthosite and a series of leucocratic norites. This footwall sequence can attain a thickness of approximately 7m before encountering a single chromitite that overlies the UG1 Hanging-wall pyroxenite. The UG2 Main Layer is consistently overlain by three chromitite layers (ranging 10 - 20cm thick) locally termed “the triplets” which can vary in their parting distance to the UG2 Main Layer between 0.25 to 0.75m. Platiniferous mineralization is restricted to the chromitite layers with the intervening fine-grained orthopyroxenite being barren.

- **Regional Pothole Reef:**

  The UG2 Main Layer and triplets maintain similar characteristics to that described above, the major defining characteristic of this facies being the absence or reduction in width of the above described footwall stratigraphy with the UG2 Main Layer being directly underlain or close to the UG1 Hanging-wall pyroxenite. This relationship is characteristic of a pothole although in the Wesizwe exploration area the scenario is of such a lateral consistency as to be regionally significant and thus the term “Regional Pothole” is used to describe the reef. By reference to Figure 5 and the cross section of Figure 6 the transgressive nature of the UG2 as it progresses to the southwest can be recognized.
The same interpretative techniques have been employed for the re-interpretation of the distribution of the two identified facies of the UG2 Reef. The distribution of the Regional Pothole reef now appears to be potentially structurally controlled (at least in the eastern sector of the Exploration Area).

Isopach Data and Footwall Stability
Although full stratigraphic logs of the drillhole core in an electronic format was made available to The Mineral Corporation the drillhole core for the Merensky Reef and UG2 Reef intersections from the drillholes have been scrutinized and certain measurements of various stratigraphic units taken. This has been an on-going exercise throughout the course of the exploration programme and has been completed to allow The Mineral Corporation to formulate an independent interpretation of the reef types and the footwall stability. With each subsequent addition to the drillhole database there is often a re-interpretation and/or refinement to the facies distribution for each reef type. The estimation of the Mineral Resources is thus an iterative process dependent upon new geological, PGE (4) grade and structural information.

Based on the isopach data and style of mineralization discrimination of potholed Merensky and UG2 Reef intersections as opposed to the transgressive regional onlapping intersections is possible. Figure 6 depicts the transgressive nature of the Merensky Reef and drilling data from the PTM website indicates that the Merensky Reef to UG2 Reef and UG2 Reef to UG1 Reef middling distance decreases towards the southwest thinning to only a few metres. It is probable that the Merensky Reef subcrops against the Main Zone gabbro-norite towards the southwest of the project area as depicted in Figure 1. Due to the transgressive nature of the Merensky Reef towards the southwest of the project area the Single Chromitite facies is interpreted as a type of reef similar to that observed at the edge of a pot-hole but of a regional extent. Similarly the Normal Footwall facies is interpreted as a type of reef similar to that encountered at the base of a pothole again of regional extent. Due to the underlying footwall (various norites and anorthosites) being transgressed the dip of the reef in these two facies types is likely to be variable and not conducive to trackless mining i.e.
greater than 10°. The footwall of the Normal Merensky Reef (FW1) is generally a uniformly thick (±10m) poikilitic anorthosite and thus may be conducive to mechanized mining in areas where dips are less than 10°.
Figure 6: Transgressive nature of the Merensky Reef and UG2 Reef towards the south west; note that the vertical exaggeration is 20x that of the horizontal scale
The preliminary structural interpretation based on drillhole information has been superseded by the interpretation of a reflection seismic survey. The method used to develop the revised structural model was based on the following criteria:

1. The basal contact of both the Merensky Reef (the lower chromitite or its approximation) and UG2 Reef were modelled using seismic data (RDR Report No. 9580); interpretations of dips have been reconciled against core intersection angles of magmatic layering

2. The interpretation of seismic data was used to identify the location of faults with apparent vertical displacements of >8m.

3. Aeromagnetic and drillhole data were used to interpret the distribution of intrusive dykes and sills.

4. Drillhole results which became available subsequent to the seismic interpretation have been used to test the accuracy of the interpretation and where necessary to modify the modelled reef surfaces.

5. Modifications to the seismic interpretation were made in three areas:
   - In the northwestern corner of the prospect on the edge or outside the Mineral Resource area.
   - In the vicinity of the two planned shaft positions.
   - Along the southern boundary of the Mineral Resource area and the seismic survey area.

6. In order to provide some generalized data the modal strike directions for the faults were determined with traverse lines identified along which different parameters could be sampled. All directions mentioned are relative to true north and elevations are in metres above mean sea level (masl). Azimuths or strikes are recorded in degrees as three figures (e.g. 090° represents a strike due east). The orientation of planes is given as dip direction and dip unless otherwise stated (e.g. 090/20 represents a plane dipping due east at 20° from the horizontal). A similar notation is used for lineations. In this CPR younger intrusions are separated into three geometric groups to aid presentation: sills with dips <25° (as the drillholes are generally subvertical core intersection angles have been used as an uncorrected approximation of dip), bridging sills with dips in the range 25° to 65° and dykes with dips >65°.

7. Drillhole results which became available subsequent to the seismic interpretation have been used to test the accuracy of the interpretation and where necessary to modify the modelled reef surfaces.

8. The interpretation of seismic data was used to identify the location of faults with apparent vertical displacements of >8m.

9. Aeromagnetic and drillhole data were used to interpret the distribution of intrusive dykes and sills.

10. Drillhole results which became available subsequent to the seismic interpretation have been used to test the accuracy of the interpretation and where necessary to modify the modelled reef surfaces.

11. Modifications to the seismic interpretation were made in three areas:
   - In the northwestern corner of the prospect on the edge or outside the Mineral Resource area.
   - In the vicinity of the two planned shaft positions.
   - Along the southern boundary of the Mineral Resource area and the seismic survey area.

12. In order to provide some generalized data the modal strike directions for the faults were determined with traverse lines identified along which different parameters could be sampled. All directions mentioned are relative to true north and elevations are in metres above mean sea level (masl). Azimuths or strikes are recorded in degrees as three figures (e.g. 090° represents a strike due east). The orientation of planes is given as dip direction and dip unless otherwise stated (e.g. 090/20 represents a plane dipping due east at 20° from the horizontal). A similar notation is used for lineations. In this CPR younger intrusions are separated into three geometric groups to aid presentation: sills with dips <25° (as the drillholes are generally subvertical core intersection angles have been used as an uncorrected approximation of dip), bridging sills with dips in the range 25° to 65° and dykes with dips >65°.
Figure 7: Structural domains of the Pilanesberg Project.
Structural Domains

The structure of the project area has been subdivided into the following structural domains (Figure 7):

- The northern boundary of the Mineral Resource area is formed by the Caldera Fault which marks the southern limit of a zone of tilting to the north and a series of synthetic faults that have an apparent vertical downthrow to the north; as this domain falls outside the Mineral Resource area it is not considered in any detail;
- The Western Trough along the western margin of the project area is structurally complex changing its character along its length. In the north it is bounded by a series of north–south striking faults whilst in the centre it is characterized by an area of syn-intrusion up-dooming that has eliminated the mineralized reefs in places. In the south it has a steeply dipping slope to the west; the trough being deeper in the south than in the north. Only the simpler northern part of this domain falls within the northwestern corner of the Mineral Resource area. The western margin of this trough is formed by the Koedoesfontein Horst and the Koedoesfontein Fault which has;
  - its greatest apparent vertical displacement of 360m in the north decreasing regularly towards the south;
  - a dramatic difference in the thickness of various RLS on either side of the fault, indicating a dextral movement of approximately 1°300m.
  - The Elands Graben strikes 075° and passes through the south-central part of the Mineral Resource area; the planned position of both shafts falls within this domain; and
  - The plateau domain comprises a very open antiform that plunges shallowly towards 340°. This domain is transacted by the Elands Graben and can therefore be considered as comprising a northern and southern plateau.

Comparison between the Merensky Reef and UG2 Reef Structure

The overall pattern of the Merensky Reef and UG2 Reef surfaces are thought to be essentially subparallel and separated by approximately 35m (Figure 6). Moreover as the majority of the faults have steep dips the position of the faults does not vary significantly. For these reasons the structure of the Merensky Reef is addressed in the subsequent sections and most of the observations will apply to the underlying UG2 Reef.

Reef Dip and Elevation

Table 1 below summarises the elevation of the Merensky Reef and UG2 Reef intersected in drillholes from the project area.

Table 1: Summary of elevations of the reef horizons from the Mineral Resource area.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Merensky Reef</th>
<th>UG2 Reef</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum intersected elevation (mamsl)</td>
<td>439</td>
<td>393</td>
<td>In boreholes WF95 and WF73 for Merensky Reef and UG2 Reefs respectively. Both are located in the SE corner of the area (South Plateau)</td>
</tr>
<tr>
<td>Minimum intersected depth below surface (m)</td>
<td>587</td>
<td>633</td>
<td>Minimum elevation in Borehole WFA12 (SW part of area).</td>
</tr>
<tr>
<td>Minimum intersected elevation (mamsl)</td>
<td>161</td>
<td>123</td>
<td>Maximum depths in boreholes WF95 and WF73 for Merensky Reef and UG2 Reef respectively (where Elands Graben approaches Western)</td>
</tr>
<tr>
<td>Maximum intersected depth below surface (m)</td>
<td>885</td>
<td>920</td>
<td></td>
</tr>
</tbody>
</table>

The general elevations of the reef surfaces created from seismic data in the different structural domains are recorded in Table 2.
The structural model developed indicates that there could be considerable variation in the strike of the two reefs. The reefs attain their highest elevation in the southeast corner of the area and an elongate plateau plunges shallowly towards 340° (Figure 7). The regional plunge along this antiform ridge is approximately 2° but there are dip reversals along its length. The eastern limb to this structure has a dip that is generally <5° to east-northeast within the Mineral Resource area. The western limb is more erratic varying between 3° and 8° to the west-southwest.

The feature termed the Western Trough runs subparallel to the antiform but has a very irregular plunge to its axis. In the south the slope between the antiform and the trough steepens to as much as 25° in places.

The dip of the floor of the Elands Graben is similar to that described above ranging from 6° in the vicinity of the proposed position of the Ventilation Shaft to 24° on the slope adjacent to the Western Trough. The close structural contours on the southern slope of the Elands Graben indicate a dip of approximately 18° but this might be a regional slope induced by a number of small faults that could not be resolved from the seismic data rather than the actual dip of layering.

A histogram was calculated to describe the mode of the dips determined from the seismic interpretation which indicated a dip mode in the class 5° to 10° (Souque et al., 2008).

A study by Tshupe (2009) of variations in elevation between drillhole deflections of the Merensky Reef and UG2 Reef provide some idea of local variation in the dip of the reefs due to what is referred to as “rolling reef” or in extreme cases “goose-necking” (where a horizon is duplicated in the core). Differences in elevation of the reefs by more than 50cm between deflections (that have a horizontal separation of <3m) that could be attributed to anomalous dips were found in 14% of the drillholes. The fact that all of them were found on UG2 Reef intersections may not necessarily indicate that the Merensky Reef is more planar but could be due to the igneous layering being more apparent in the UG2 Reef.

**Potholes**

The location and extent of potholes cannot be accurately obtained from the surface drilling and seismic survey. The following points provide some information on the distribution of potholes:

- Four (2% of the total) and 14 (8% of the total) drillholes intersected localized potholes on the Merensky Reef and UG2 Reef respectively;
- Examination of the amplitude of the seismic signal can be used to identify potential potholes (Souque et al., 2008). These amplitude anomalies indicated on Figure 16 were identified on the sub-UG1 Reef seismic marker but in the seismic sections appear to have a significant vertical extent. Thus these features may have an expression on the Merensky Reef or UG2 Reef surfaces;

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**Table 2**

<table>
<thead>
<tr>
<th>Structural Domain</th>
<th>Merensky Reef (mamsl)</th>
<th>UG2 Reef (mamsl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Trough (NW)</td>
<td>250-350</td>
<td>160-270</td>
</tr>
<tr>
<td>Western Trough (SW)</td>
<td>&lt;100</td>
<td>&lt;80</td>
</tr>
<tr>
<td>Elands River Graben Floor</td>
<td>150-350</td>
<td>180-290</td>
</tr>
<tr>
<td>North Plateau</td>
<td>350-360</td>
<td>310-320</td>
</tr>
<tr>
<td>South Plateau</td>
<td>420-440</td>
<td>380-400</td>
</tr>
</tbody>
</table>
Some authors have concluded there is a loose spatial relationship between IRUPs and potholes. Consequently the features that indicate IRUPs have also been included on Figure 8 but no trend is evident.

Figure 8: A Map showing the distribution of IRUPs and potholes on the Merensky Reef and UG2 Reef surfaces. The aeromagnetic anomaly with an asterisk has an associated seismic amplitude anomaly.

The following points emerge from an inspection of Figure 8:

- With respect to the distribution of potholes intersected in drillholes at Merensky Reef elevation; one is located on the Southern Plateau, one in the Elands Graben and one on the Northern Plateau (the fourth falls in the Caldera Fault Zone, outside the Mineral Resource area). All of the potholes intersected at Merensky Reef elevation are located in the Eastern half of the Mineral Resource area;
- With regard to the potholes intersected in core at UG2 Reef elevation; three are grouped together on the Southern Plateau, two along the northern boundary of the Elands Graben and two on the Northern Plateau. Unlike Merensky Reef potholes, the three at UG2 Reef elevation are located in the western part of the Mineral Resource area;
- Only drillhole FG54 in the Elands Graben contains a pothole at both Merensky Reef and UG2 Reef elevation; and
- Of the interpreted potholes from seismic data only one is located on the Southern Plateau and two along the northern boundary to the Elands Graben, the majority being located in the northern part of the Mineral Resource area. None of these features coincide with the potholes intersected in core at Merensky Reef or UG2 Reef elevations.

Iron Replacement Ultramafic Pegmatoids (IRUPs)

Examination of Figure 8 highlights the poor correlation between aeromagnetic anomalies and the occurrence of IRUPs in close proximity to either the Merensky Reef or UG2 Reef. This is believed to be due to the more prominent aeromagnetic anomalies representing magnetic bodies that exist closer to surface. However, Souque et al. (2008) have noted that one of the
magnetic anomalies is coincident with anomalous seismic amplitudes at both Merensky Reef and UG2 Reef elevations. Some form of reef disturbance can therefore be anticipated in that area.

Following scrutiny of Figure 8 the following observations have emerged:

- The northeastern part of the Mineral Resource area is relatively devoid of IRUPs;
- The greatest density of IRUPs is anticipated in the Western Trough. Furthermore three out of the 6 drillholes that intersected IRUPs within 10m of the UG2 Reef fall in that area and the majority of the holes in the Western Trough have some IRUP in the Critical Zone lithologies;
- Increased abundances of IRUPs may also be found along the fault systems bounding the Elands Graben;
- There does not appear to be any relationship between the distribution of IRUPs at the Merensky Reef and UG2 Reef elevation;
- With respect to the relationship between IRUPs and potholes:
  - one drillhole (FG54 in the Elands Graben) contains both potholes and IRUPs in proximity to the Merensky Reef and UG2 Reef;
  - One intersected pothole is coincident with an aeromagnetic anomaly and two more are in close proximity;

A diagram of the distribution of IRUPs in the vertical profile has been prepared from the drillhole intersection data (Figure 9). The data has been depicted graphically and the following observations are pertinent:

- The average number of IRUPs intersected in a drillhole through a 50m package does not vary significantly being approximately 0.29 (i.e. one every 172m). The maximum number of 0.94 is located in the elevation interval 100 to 150m
- The average thickness of individual IRUPs is somewhat erratic but in general trends from approximately 3m near surface to about 4.5m at elevations of 850 to 500m. Below this there is a gradual (and erratic) decline to an average thickness of 3.2m at sea level;
- The average cumulative thickness of IRUPs in the 50m packages varies from approximately 0.9m near surface to 1.7m near sea level. In the interval where the majority of the Merensky Reef and UG2 Reefs are situated (200 to 400m – referred to as the “reef window”) the cumulative thickness varies from 0.93m to 1.97m per 50m package;
- If one considers only the subset of holes that contained IRUPs (but these do not define a distinct area), there appears to be a downward decrease in the cumulative thickness of IRUPs with an average width of 4.1m; ranging from 3.6m to 6.6m per 50m in the reef window.
Faulting

The strike of the faults interpreted from the seismic data that fall within the Mineral Resource area are summarized in Table 3. These orientation data are weighted according to the length of the faults (Figure 10).

Table 3  Summary of fault strikes extracted from the interpretation of the seismic data.

<table>
<thead>
<tr>
<th>Structural Domain</th>
<th>Mode 1</th>
<th>Mode 2</th>
<th>Mode 3</th>
</tr>
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<tbody>
<tr>
<td>All Domains</td>
<td>075</td>
<td>035</td>
<td>165</td>
</tr>
<tr>
<td>Western Trough</td>
<td>165</td>
<td>145</td>
<td>095</td>
</tr>
<tr>
<td>Elands Graben</td>
<td>075</td>
<td>055</td>
<td>035</td>
</tr>
<tr>
<td>North Plateau</td>
<td>065</td>
<td>085</td>
<td>-</td>
</tr>
<tr>
<td>South Plateau</td>
<td>035</td>
<td>095</td>
<td>065</td>
</tr>
</tbody>
</table>

Figure 9  Plot of the IRUP frequency, cumulative thickness and average thickness against elevation (m.a.m.s.l).
From Figure 10, it can be seen that a strike of 075° is the dominant strike of the faults which mirrors the grain of the Elands River Graben. The Plateau domains have a mode at a slight offset to this (065°). Similarly the spread to 095° is from the Western Trough as well as in the South Plateau.

The next most important fault strike direction (Mode 2 for all the data) is at 035° and is contributed to from both the South Plateau and the Elands Graben.

Mode 3 for all the data (165°) is dominated by the Western Trough. As noted in Section 3.5.1 the Koedoesfontein Fault has a dextral displacement and it is possible that other faults with this orientation also have strike-slip displacements.

These modes accord well with three of the fault groups defined by RDR (2008) in that faults tend to have steep dips. In addition seismic sections have indicated that some of the 095° striking faults have a flatter dip and are tentatively separated out as possible thrusts. Only one major “thrust” has been identified and is indicated on Figure 7.

A study of drillhole deflections by Tshupe (2009) provides some insight into smaller scale faulting below the resolution of the seismic survey. Of the 167 drillholes studied 8 (5% of the total) were found to have variations in the elevation of either the Merensky Reef or UG2 Reef in deflections that could be attributed to small scale faulting. In most instances these drillholes were close to larger faults interpreted from the seismic survey. Thus it would appear that faults with displacements of <8m are not extensively developed throughout the project area.
Intrusions

The Bushveld Complex is cut by a number of younger intrusions some of which can be delineated on the aeromagnetic data and have been intersected in some of the drillholes. No detailed petrographic work has been undertaken on these intrusions but at least two types are present with the field terms “doleritic” and “lamprophyric” (de Lange, 2009). In the following sections only the structural aspects of these intrusions are considered.

A comparison between the two types of intrusive within the interval from the Bastard Reef to the UG1 Reef shows the following:

- Dolerites make up more than 90% of the intrusions intersected;
- 41% of the dolerites intersected are sills and less than 15% are dykes;
- The majority of the dolerites have a true thickness <1m and dykes tend to be thinner than sills;
- Just over 70% of the lamprophyre intersections are dykes; and
- The majority of the lamprophyres have a true thickness of <0.5m.

Dykes

Aeromagnetic lineaments that could represent dykes are shown in Figure 11. The strike lengths of these aeromagnetic lineaments are summarized in Figure 12. This rose diagram was created by weighting the strike by the length of the lineaments and has modal strikes at 065°, 085° and 175°.

This dataset includes four strong and regionally continuous linear aeromagnetic anomalies which are interpreted as thick dykes with sub-vertical dips and two preferred orientations (Figure 13):

- Two dykes approximately 1.8km apart, strike northwest–southeast (155o); the dykes are reflected by strong negative magnetic anomalies;
- Two dykes spaced 3km apart have a north–south strike (175o); the magnetic signature of these dykes is not as strong and reflects as either negative or positive anomalies in different parts of the exploration area.

The relationship between these two sets of major dykes is presently unknown.
Figure 11: Map illustrating the distribution of aeromagnetic lineaments that could be dykes and the boreholes that intersected dykes.

Figure 12: Rose diagram for all dykes in the Mineral Resource area interpreted from aeromagnetic data; weighted according to dyke length.
Figure 13: Rose diagram for interpreted aeromagnetic lineaments interpreted as major dykes within the Mineral Resource area weighted according to lineament length

From the above it is clear that the major dykes are responsible for the north-south and north-northwest to south-southeast striking modes in Figures 12 and Figure 13. The strike of the interpreted dykes within the Elands Graben has been extracted from the data set and are portrayed in Figure 14. The north–south trend is still evident but is overshadowed by a mode at 065° with a minor mode at 095°. Thus the dykes in the Graben are expected to have a dominantly east-northeast to west-southwest strike.
Figure 14: Rose diagram for dykes interpreted from aeromagnetic data that fall within the Elands Graben.

An examination of the drillhole data shows that 45% of the drillholes in the Mineral Resource area have intersected dykes yielding a total of 220 dyke intersections. The majority of these bodies intersected at an acute angle (core intersection angles of <25°) were thin and only constitute 0.24% of the core drilled.

Inspection of Figure 11 does not reveal any clear pattern to the distribution of dykes. However, with respect to the early development of the mine it should be noted that a north–south corridor of dykes is interpreted to exist approximately 250m to the east of the proposed shaft positions. As noted in Section 3.5.6 these features may also have some associated strike-slip displacement.

Sills

The sills commonly comprise a package of sub-parallel thin sills rather than isolated thick sills. The distribution of true sills in the vertical profile is summarized in Figure 15 and Figure 16. This was prepared by calculating the number and thickness of sills in 50m intervals down all the drillholes and normalising this number by the total amount of drilling in that interval. The points have been plotted at the elevation of the base of the interval. A third parameter, average sill thickness, was obtained by dividing the cumulative thickness by the number of sills in the interval.

The following conclusions were drawn from the data:

- The normalised number of sills is relatively high from 500 to 950mamsl reaching a maximum at 700-750mamsl and 550-600mamsl for the entire drillhole set and subset of only the drillholes containing sills respectively;
- Below 500mamsl sill frequency diminishes significantly. At the elevation of the Merensky Reef and UG2 Reef (the "reef window" of 200 to 400mamsl) the average spacing
between sills ranges from 54-89m (0.56-0.92) and 21-28m (1.79-2.33) for the entire drillhole set and subset of only the drillholes containing sills respectively;

- The average cumulative intersection thickness of sills attains a maximum of 0.57m per 50m in the interval 800-850m amsl;
- The general reduction in cumulative thickness below this elevation is disrupted in the subset of holes with sills with an increase in the interval 100-250m amsl;
- In the “reef window” the cumulative intersection thickness of sills ranges from 0.29-0.32m and 0.93-1.01m per 50m for the entire borehole set and subset of only the drillholes containing sills respectively. The average sill intersection thickness in this interval is 0.34-0.35m; and
- The average thickness of individual sills in the “reef window” is approximately 0.3m but ranges from 0.29 to 0.83m.

Figure 15 Plot of normalized sill and bridging sill frequency against elevation. The blue lines represent the proportion of sills and bridging sills intersected relative to the total amount of drilling, whereas the brown lines represent the abundance in only the holes that intersected sills and bridging sills.
Figure 15 and Figure 16 also portray the same data for bridging sills (dashed lines) and the following conclusions have been drawn:

- Bridging sills are generally fewer in number than sills although in the “reef window” they are approximately equal in number;
- Bridging sills also show an irregular but overall downward reduction in their number, the greatest abundance yields a spike at 50 to 100 m amsl;
- The average intersection thickness of individual bridging sills is greater than that for sills (which is unsurprising due to their more oblique inclination to the core axis) with typical values of approximately 0.55 m to a maximum of 0.9 m. Bridging sills also seem to diminish in thickness with depth except for unusually thick intrusions between 100 and 200 m amsl;
- Similarly the cumulative intersection thickness of bridging sills exceeds that of sills in the subset of only the drillholes that intersected bridging sills. Values are typically around 1.1 m but there is a spike in the 50-100 m amsl package that attains a value of 2.07 m;
- The apparently greater variability in the thickness and cumulative thickness of bridging sills is believed to be spurious and a function of smaller data sets; and
- In the “reef window” the average individual bridging sill thickness ranges from 0.45-0.83 m. The cumulative thicknesses in this interval are 0.15-0.30 m and 0.73-1.41 m for the data set of all drillholes and the subset of drillholes containing bridges respectively.

In most instances the contacts between the sills and the host rock appear to be indurated. However, the less abundant lamprophyric dykes have been seen to deteriorate in core after exposure to atmospheric conditions.

Figure 17 and Figure 18 show the spatial distribution of the distance between the mineralised horizons and the first hangingwall sill for the Merensky Reef and UG2 Reef respectively.
Figure 17: Map illustrating where sills are likely to be found in close proximity to the Merensky and UG2 Reefs

Figure 18: Map illustrating where sills are likely to be found in close proximity to the UG2 Reef
Conclusions on the Structural Model

The seismic interpretation is relatively robust with most of the new drillholes intersecting the reefs within 5m of the seismic interpreted surface. Thus the modifications to the structural model are relatively small and most (but not all) of the proposed additional faults have displacements below the resolution of the seismic method. Two of the areas of significant deviation are on the margins of the seismic coverage and the Wesizwe drilling grid. Subtle changes to the structural model have been made in the vicinity of the proposed positions of the shafts that could have an early impact on mine planning. The Shaft Fault forming the northern boundary to the Elands Graben lies to the north of the planned shaft positions at the elevation of both the Merensky Reef and UG2 Reef. However, the fault zone is believed to have a dip to the south and therefore comes ever closer to the proposed shaft with increasing depth. The planned position of both shafts falls within the Elands Graben.

For the most part faults are generally steeply dipping and have three preferred strike directions of $075^\circ$, $035^\circ$ and $165^\circ$ (in order of importance). Faults with apparent vertical displacements of 8m or more define blocks that are typically 250 to 500m across. Faults with smaller displacements will be found within these blocks but in general cannot be resolved from the drilling or seismic information. There is a suggestion that the dykes may have small vertical displacements associated with them but particularly the north-south dykes may have significant strike-slip displacements. The greatest abundance of sills is located at elevations above that of the two reefs. Thus the risk of sills eliminating reefs or providing weak partings in the immediate hanging wall to the reefs is considered to be relatively low. Figures 19 and 20 depict the Structural plans for Merensky Reef and UG2 respectively.
Figure 19: Merensky Reef Structure Plan
Figure 20: UG2 Structure Plan
MINERAL RESOURCES

Mineral Resource Classification

The following considerations have been employed in the final classification of the Mineral Resources.

Structure

The structural model and subsequent 3D seismic survey of the project has identified a structurally complex area in the south-western corner of the project. Further, a number of drillholes in the extreme west of the project area have not had acceptable intersections of Merensky Reef or UG2 Reef as a result of IRUPs or faulting.

The area to the southwest has been interpreted by the 3D seismic survey as being a basement high of older Transvaal age lithologies into which the RLS was intruded and against which these lithologies now abut. It has been interpreted that both the Merensky Reef and UG2 Reef on-lap against this basement high at depth and thus no Merensky Reef or UG2 Reef occurs in this region.

The area to the far west of Ledig which abuts against the farm Koedoesfontein 94JQ has a number of faults, intrusives and IRUPs all of which have been intersected in the drillholes and which has been identified in the 3D seismic survey. As number of drillholes did not achieve reliable and identifiable intersections of either the Merensky Reef or UG2 Reef, it is for this reason that an “Exclusion Zone” has been created.

As a result these two areas have not estimated and are not included in the Mineral Resource. Cognizance is taken of the local structural complexity before upgrading any blocks to the Indicated or Measured category.

Boundary conditions

An overriding consideration is taken of the risk associated with the confidence of the boundary of the facies types before upgrading blocks from Inferred to Indicated Mineral Resources.

Kriging Efficiency

KE is calculated using the formula:

\[
KE = \frac{\text{Block Variance} - \text{Kriging Variance}}{\text{Block Variance}}
\]

KE has been chosen as the guideline for classification over other more stringent methods previously applied to this project due to the support given by the geological continuity of the two reefs from the 3D seismic survey.

Classification Process

All blocks within the Merensky Reef and UG2 Reef Mineral Resource area are considered to be in the Inferred category as a minimum and due to either a lack of data density or the effect of structure certain blocks within both the Merensky Normal Footwall and Detached facies remain in the Inferred category.

For the Merensky Reef Blocks with a KE >0.3 are deemed to be in the Indicated category and a KE >0.5 are deemed to be in the Measured category (Mwasinga, 2001).
Maps depicting the Mineral Resource classification of the Merensky Reef are shown in Figure 21 and for the UG2 Reef in Figure 22.

**Geological Losses**

A percentage geological loss has been applied to the tonnage estimate for each block. The geological loss is estimated by considering the geological losses encountered while drilling as a percentage of the completed holes. The percentage of geological losses encountered due to faulting, intrusive activity, IRUPs and potholing is below 25% in both the Merensky Reef and UG2 Reef however, based on the experience of The Mineral Corporation in dealing with other Merensky Reef and UG2 Reef projects in this area, a minimum geological loss of 25% is applied to the Merensky Reef and 27.5% to the UG2 Reef.

**Mineral Resource Estimates**

The estimated Mineral Resources for the various classifications, reef types and farm areas are contained in Table 4.
Figure 21: Merensky Reef Mineral Resource Classification Polygons
Figure 22: UG2 Reef Mineral Resource Classification Polygon
### Table 4: Mineral Resources

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