DISCOVERY OF THE KX36 KIMBERLITE

S. Lobatlamang, M. Brennan, J. Davidson and A. Rogers
Petra Diamonds Botswana (Pty) Ltd

INTRODUCTION

The KX36 kimberlite pipe is situated in the southeastern part of Central Kalahari Game Reserve (CKGR), Botswana, approximately 60 km from the known Gope and Kikao kimberlite fields (see figure 1). The kimberlite is covered by 75m of Kalahari sand, has a surface area of 3.6 Ha at the base of the sand cover and was discovered by Petra Diamonds Botswana (Pty) Ltd in 2008. Application of modern geophysical techniques (Ultra hi-resolution low level flying Xcalibur magnetics) and improved sampling method led to the discovery of KX36. The kimberlite was emplaced into the Karoo Supergroup, which comprised the older sedimentary rocks (300 – 185 Ma) overlain by the flood basalts (185Ma). The Karoo Supergroup rocks are overlain by approximately 80m of Kalahari Group sediments.

HISTORICAL EXPLORATION

The Central Kalahari Game Reserve has seen considerable exploration from the late 1970s up to this date. The presence of thick Kalahari sands (in excess of 80 metres in places) and the magnetically noisy Karoo basalt immediately beneath make the CKGR a challenging environment as far as diamond exploration is concerned. Several companies, including Falconbridge Exploration Botswana (Pty) Ltd, Seltrust/Tinto Botswana Exploration and De Beers Prospecting Botswana (Pty) Ltd have held the ground in and around the KX36 kimberlite prior to its final discovery by Petra Diamonds Botswana (Pty) Ltd.

Seltrust Botswana Exploration–PLs24/81 and 37/88

In the early 1980s Selection Trust Botswana (Pty) Ltd (“Seltrust” and later changed to “Tintobex” after the merger with Tinto Botswana Exploration) held the ground around KX36 under Prospecting licence 24/81 which eventually expired at the end of its 7 year tenure. Following the expiry of PL24/81, Seltrust re-applied for the area under a group of contiguous prospecting licences 37-38/88 (See figures 2 & 3).

The entire area was covered with a 2 kilometre grid of heavy mineral sampling. 400 kilograms of deflation...
material were collected at each sampling point. Positive samples of mainly singleton garnets and chromites were followed up with a more detailed, 1km by 1km sampling grid. Ground gravity and ground magnetics were also carried out in the area, but drilling missed KX36.

![Diagram](image1)

Fig. 2. Land tenure around KX36 as of July 1984 (Source: Petra Diamonds Botswana).

![Diagram](image2)

Fig. 3. Land tenure around KX36 as of July 1989 (source: Petra Diamonds Botswana)

De Beers Prospecting Botswana (Pty) Ltd – PL89/99

De Beers Prospecting Botswana (Pty) Ltd (Debot) later acquired the ground around the KX36 kimberlite in the late 1990s under prospecting licences 89-90/99 (See figure 4). Granted on the 1st of July 1999, the seven year tenure of PLs 89-90/99 ended on the 31st of December 2006.

Debot carried out reconnaissance soil sampling at a 1km interval between February and March 2000. At each site, 100 litres of pre-screened deflation material was collected and screened on site to -1.000mm and +0.425mm. The results showed sparse recoveries of mainly singleton garnets. Follow-up sampling on one of the garnets, which happened to be over the KX36 pipe, produced two more peridotitic garnets (G9 and G10). No further work was done thereafter and the ground was later relinquished on the basis of what was interpreted as background recoveries.
Exploration undertaken by Petra Diamonds Botswana (Pty) Ltd – PL224/2007

Petra Diamonds Botswana (Pty) Ltd first acquired the ground around KX36 in 2007 under prospecting licence 224/2007. Prospecting licence 224/2007 was part of a group of contiguous licences internally referred to as the “Kukama East block”. Extensive exploration work carried out by Petra Diamonds Botswana led to the discovery and evaluation of KX36 and included:

- Acquisition of 51,760 line kilometres of Xcalibur’s high resolution magnetic data. Data was acquired at a line spacing of 100 metres and a nominal flight height of 20 metres.
- Acquisition of 4,226 line kilometres of electromagnetic and magnetic data (SkyTEM). The survey was carried out at a line spacing of 125 metres and nominal flight height of 30 metres.
- Acquisition of 17,700 ground gravity stations and 1,666 mag line kilometres. Ground gravity was conducted at a line spacing of 100 metres and station spacing of 50 metres. Ground magnetics was carried out at a line spacing of 50 metres and a station interval of 25 metres.
- Collection of 7750 heavy mineral samples (3100 tons of pre-screened deflation material). Samples were collected at 250m spacing and a follow up was conducted at 125m sample spacing. The sample material was screened on site to -2.000 and +0.425mm.

EVALUATION

Mineral chemistry

Following the discovery of KX36, 2,384 grains from the kimberlite were analysed for preliminary diamond bearing potential of the pipe. The mineral chemistry results (Garnets and chromites) indicate KX36 as being diamondiferous (See figures 6-10). Although KX36 is a group 1 kimberlite, very few ilmenites (5) with exceptional quality (high diamond preservation potential) were recovered from the core.

Petrography

A total of 55 core samples from KX36 kimberlite were sent to Dr. Mike Skinner (Consulting Geologist) for petrographic analysis between 2008 and 2012. KX36 kimberlite was described as an ilmenite-deficient Group 1, macrocrystic hypabyssal phlogopite – monticellite kimberlite.

Petrographic analysis revealed the existence of two principal types of kimberlite facies that can be classified as coherent (hypabyssal) macrocrystic kimberlite and coherent (transitional) macrocrystic kimberlite. The matrix varies from uniform to segregation-textured and comprises mainly of calcite and serpentine, with minor chlorite.

Figure 5. Land tenure around KX36 as of August 2017 (source: Petra Diamonds Botswana)
Microdiamonds analysis

Microdiamonds analysis (MiDA) of KX36 was done between 2011 and 2013 on 1233 kg of core, producing a total of 833 stones. Microdiamond results were modelled by Mr Johannes Ferreira, an independent consultant (associated with MSA) with more than 30 years of experience in diamond content modelling of primary diamond deposits worldwide. Mr Ferreira estimated the undiluted +1mm grade of KX36 at 130 cpht, assuming 100% recovery of all +1mm diamonds. Initial results were regarded as highly positive, with indications of a reasonably coarse diamond size distribution, implying that average diamond value for this deposit would be positively affected by the presence of a large proportion of coarse stones in a normal production parcel.
LDD Bulk sampling

Two phases of Large Diameter (24”) Drilling (LDD) were carried out at KX36 between 2012 and 2015. Phase 1 comprised 5 LDD holes for a total of 1,106t of ore and Phase 2 with 10 LDD holes for a total of 2,053t.

The Phase 1 LDD sample gave a recovered +1mm grade of 33 cpht. Although the size frequency distribution (SFD) is significantly finer compared to the MiDA-modelled SFD, the presence of large stones in the +17 sieve categories was encouraging and gave support to the MiDA modelled SFD. It is known that large diameter drilling can result in significant diamond breakage and diamond mass loss, thus reducing macro +1mm grades. In addition there was no re-crush circuit on the processing plant to liberate locked stones from the coarse DMS floats.

The Phase 2 LDD sample gave a recovered +1mm grade of 41cpht. The grade increase compared to Phase 1 was related to crushing modifications in the plant.

Tests undertaken using ceramic diamond simulant tracers introduced into the LDD drill holes revealed significant breakage and mass loss of the tracers, supporting the fact that the LDD grade analysis is likely to have underestimated the diamond grade. Only 5% of the large 15mm tracers were recovered in the sort house unbroken. The mass loss of the tracers ranged between 33 to 41%. Importantly, there were no large (+17 sieve sizes) diamonds recovered from the sampling programme. This is interpreted as anomalous and can be attributed to a number of factors such as breakage from drilling, plant operational procedures and other factors.

At the end of the Phase 2 programme, 24.3 tonnes of available core were processed and produced a recovered +1mm grade of 48 cpht. Importantly, larger diamonds were recovered and, taking into account the small sample size and hence the small number of stones recovered, the stone recoveries in the coarser sieve sizes approach the MiDA modelled SFD.

SFD modelling of all available data has been carried out internally by Petra Diamonds, taking into account the coarser SFD implied by the MiDa modelling, and the improved recoveries in the coarser sieve sizes in the LDD ph1 and core sampling data compared to LDD ph2 (figure 11). This has been used to generate what Petra believes to be a more realistic SFD for KX36, believed to be more representative of what the true SFD would look like unaffected by diamond losses and breakage introduced primarily by the LDD sampling method. The SFD modelling has been used to generate the following global grade estimates for KX36.

<table>
<thead>
<tr>
<th>Model Recoverable +1mm Grade</th>
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<tr>
<td>Realistic case: 57 cpht</td>
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<tr>
<td>Upside case: 76 cpht</td>
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Fig. 11.Log-log grade size plot, with grade expressed in stones per hundred tonnes per unit interval per sieve class.
The SFD curves for the realistic and upside cases have been used to create revenue models for KX36 with price estimates as follows. The Model 2016 price estimate is:

- Realistic case: $97/ct
- Upside case: $107/ct

These price and grade estimates from the new SFD modelling are being used for economic studies going forward, to highlight the potential under-estimation of the economic potential of KX36 based on LDD sampling alone.

CONCLUSIONS

An extensive amount of work has been carried out on the KX36 kimberlite pipe since its discovery in 2008. Technical assessment of the diamond data from the LDD programmes indicate significant diamond breakage resulting in mass loss which has led to potential under-estimation of the overall grade and value. A recent pre-feasibility study (PFS) undertaken by Petra indicates that the KX36 project shows significant economic potential if the Petra in-house realistic and upside grades and values can be achieved.