Geology of KX36 Kimberlite, Central Botswana

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Introduction

KX36 kimberlite pipe is situated in the southeastern part of Central Kalahari Game Reserve (CKGR), Botswana, atleast 60 km from the known Gope and Kikao kimberlite fields (Figure 1). The kimberlite appears to be the only one in the area, a very unusual scenario as most kimberlites occur in clusters. KX36 kimberlite is a single lobed pipe with a surface area of approximately 5ha with circular – subcircular plan views and steep margins. 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.

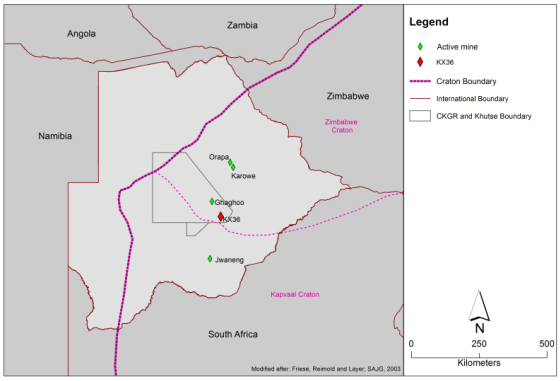

Figure 1: Location Map showing the position of KX36 kimberlite in the Central Kalahari Game Reserve, Botswana.

General Kimberlite Geology

KX36 pipe is dominated by three main facies/units of kimberlite, which have been interpreted as (a) Black 1 Coherent Kimberlite (Black 1 CK), (b) Black 2 Coherent Kimberlite (Black 2 CK) and (c) Green Coherent Kimberlite (Green CK). In general, the difference between the different units within the kimberlite is very subtle. All the three units have the same type of mantle peridotites (constituting less than 1% in each unit) and crustal xenoliths, with the latter averaging 10% across all the units (in hand specimen).

Black 1 Coherent Kimberlite (Black 1 CK)

Black 1 coherent kimberlite is described as a greyish black, coherent, macrocrystic kimberlite with distinctive red, altered olivine macrocrysts. The kimberlite is also charecterised by pervasive secondary sub-horizontal calcite veining which tends to break into thin discs along these veins (see figure 2 below). Downhole geophysical logging shows this unit to be relatively magnetic and highly conductive.

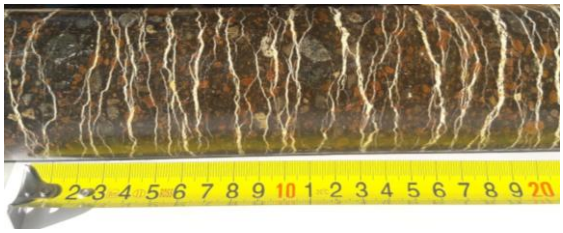

Figure 2: Core picture Showing Black 1 coherent kimberlite from KX36 Kimberlite.

Black 2 Coherent Kimberlite (Black 2 CK)

Black 2 coherent kimberlite is also a greyish black, highly olivine macrocrystic kimberlite with the olivines showing a relatively lower degree of alteration compared to Black 1 coherent kimberlite (see figure 3 below). This unit is more competent than Black 1 coherent kimberlite and does not seem to break into thin discs even when intensely veined by secondary calcite. Downhole geophysical logging shows Black 2 coherent kimberlite to be relatively magnetic and has a higher density (similar to that of basalt) than the Black 1

coherent kimberlite. Black 2 and Black 1 coherent kimberlites are generally similar and may actually be one and the same thing except for the subtle differences that may be attributed to secondary features.

Figure 3: Core picture Showing Black 2 coherent kimberlite from KX36 Kimberlite.

Green Coherent Kimberlite (Green CK)

Green coherent kimberlite is a green grey competent, highly macrocrystic coherent kimberlite with a distinctive green matrix and large brown olivines (see figure 4 below). This unit is generally conductive and less magnetic than Black 1 and Black 2 coherent kimberlites .

Figure 4: Core picture Showing Green coherent kimberlite from KX36 Kimberlite.

Mantle Xenoliths

Peridotite mantle xenoliths, mainly garnet lhezolite and garnet harzburgite (see figure 5) can be observed in all types kimberlite facies with the latter slightly more abundant. In general peridotite mantle xenoliths constitute not more than 1% in each kimberlite type.

Figure 5: Core picture showing garnet harzburgite in Green coherent kimberlite from KX36 Kimberlite.

Crustal Xenoliths

Crustal xenoliths comprise basement granitoids, rare feldspar porphyry, marid and basalt, which is the most common crustal xenolith within KX36 kimberlite. Crustal xenoliths abundance as counted on total core is generally not more than 10% with an average size of about 5cm. Basalt xenoliths of up to 1metre have been observed in places. It is worth noting that there is no correlation between crustal xenolith abundance, type or size between the different kimberlite facies.

KX36 Petrography

A total of 55 core samples from KX36 kimberlite were sent to Dr. Mike Skinner for petrographic analysis between 2008 and 2012. KX36 kimberlite can generally be described as an ilmenite- deficient Group 1, macrocrystic hypabyssal phlogopite - montecellite kimberlite. The kimberlite comprises numerous and highly complex textures on a microscopic scale, as is typical of hypabyssal kimberlites. It is also crosscut by secondary carbonate veins. The country rock xenoliths are usually altered to varying degrees. Typically, the macrocrystic olivine is completely altered, but the serpentinized pseudomorphs after olivine clearly preserve the original macrocrystic texture. The groundmass of the kimberlite is typically fine-grained, crystalline, and invariably micaceous (phlogopite). Based on the grain size of the groundmass (euhedral opaque spinels up to 0.07 mm), this kimberlite was petrographically rated as high interest with respect to diamond potential.

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.

Hypabyssal kimberlite (Black 1 and Black 2 CK)

The most common type of the hypabbyssal facies is a variably altered monticellite-phlogopite kimberlite with variable proportions of country rock xenoliths ranging from 8 to 20 vol.%, far more than what is observed in hand specimen, indicating that

there are abundant very small (1mm) crustal xenoliths.

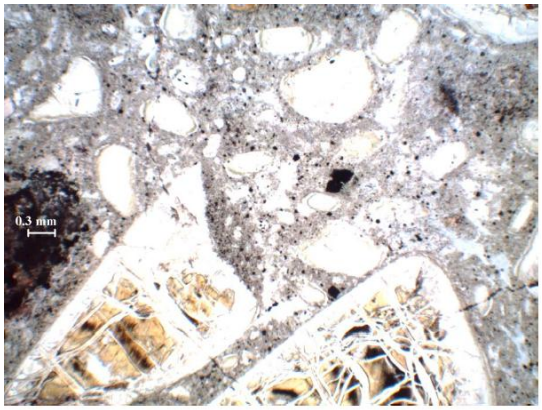

Figure 6: photomicrograph – serpentinized olivine grains and dark basalt xenoliths set in a uniform groundmass consisting of fine green monticellite pseudomorphs, opaque spinels and serpentine (white).

Transitional Kimberlite (Green CK)

Two subtypes of transitional hypabyssal kimberlite have been identified in KX36. The one type, which is dominant, is characterized by segregationary structures, the presence of common to abundant microlitic diopside, and relatively abundant country rock xenoliths (from 16 to 28 vol.%) (see figure 7). The other transitional type is characterized by prominent, larger sized, globular segregationary structures, with no microlitic diopside, and few country rock xenoliths (see figure 8).

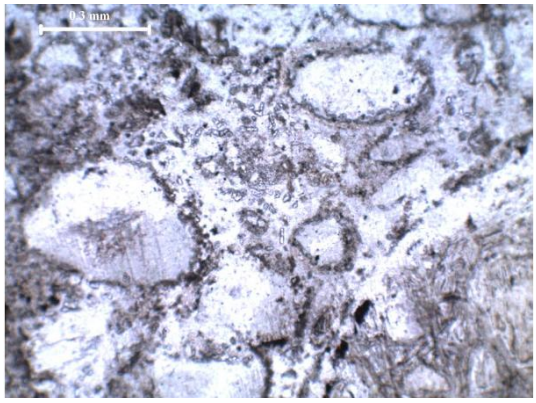

Figure 7: Altered olivine grains mantled by very fine grained microlitic diopside that also occurs within the general groundmass.

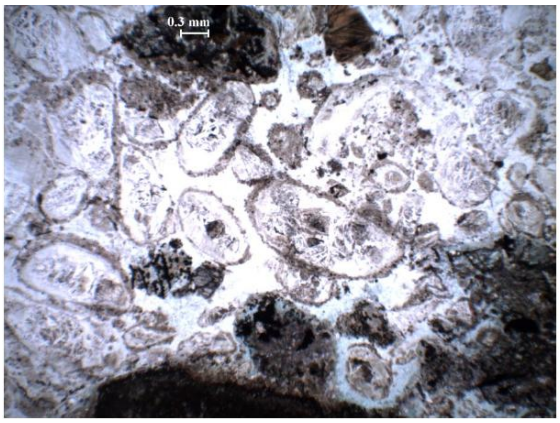

Figure 8: "Globules" of altered olivine grains and dark basalt xenoliths mantled by fine groundmass segregated by fine clear serpentine – Globular segregationary texture.

Conclusions

Petrographic analysis reveals that KX36 comprises two major kimberlite types. The first major type is the Black Coherent hypabyssal type that is essentially a montecellite-phlogopite kimberlite. In hand specimen, Black coherent kimberlite is further subdivided into two subtypes - Black 1 coherent kimberlite and Black 2 coherent kimberlite, where Black 2 coherent kimberlite is the less altered type. The second major type is the transitional Green coherent kimberlite, distinguished in thin section by having a segregationary texture with common to abundant microlitic diopside.

Black 1 coherent kimberlite appears to be mostly restricted to the top part of the kimberlite and seems to be volumetrically small compared to Black 2 and Green coherent kimberlite. It is also evident that Green coherent kimberlite is a later phase as it appears to cut through Black 2 coherent kimberlite.

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