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The River Ranch Kimberlite, Zimbabwe

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Introduction

The River Ranch kimberlite is a located at 22° 10' 14.65" S 29° 52' 50.53" E in southern Zimbabwe, approximately 12 km to the west of the town of Beitbridge. A diamond was recovered from a stream sample in 1969 and approximately 1 km upstream from the diamond-positive sample, the kimberlite was discovered in 1975.

The kimberlite is a 5.2 hectare diatreme from which the original surficial crater facies material has been removed by erosion. Proof of the prior existence of crater facies development is provided by down rafted blocks of epiclastic and pyroclastic rocks exposed in the diatreme during open pit mining operations.

The River Ranch kimberlite intrudes Archean metasediments of the Beitbridge Group (Watkeys, 1979) and a diabase of at least Waterberg (c. 1800 Ma) in age. The age of the River Ranch kimberlite is poorly constrained. Post emplacement the kimberlite was intruded by Karoo-aged tholeiitic dolerite dykes and the kimberlite is therefore considered to be pre-Karoo in age, possibly similar to the Venetia kimberlite cluster which has a Rb-Sr phlogopite whole rock age of 544 +/- 4 Ma age (Allsopp et al, 1995).

The River Ranch occurrence is classified as a Group I kimberlite although the definitive isotopic evidence is lacking due to pervasive alteration of the exposed rocks. The absence of megacrystic and groundmass ilmenite and the presence of groundmass diopside are unusual for Group I kimberlites. However, the presence of monticellite and the low abundance of phlogopite argue against a Group II classification.

Geology

At least six intrusive phases and two crater facies phases have been recognised in the diatreme through careful mapping at the current level of the diatreme and confirmed by petrographic observations, particularly variations in groundmass mineralogy. The **mantle-rich TKB** is characterised by an unusual abundance of garnet-bearing mantle xenoliths. It occurs at the margins of the diatreme and was identified at five localities. This phase is interpreted as the oldest among all the intrusive phases. Only relics of it still remain on the diatreme margins after successive eruptions of the younger phases have replaced it in the central areas of the pipe. The **Western Tuffisitic Kimberlite** occurs in the western lobe of the diatreme. This phase contains less than 15 volume percent crustal and mantle xenoliths. The **Central TKB** is characterised by an abundance of crustal xenoliths which include granite, paragneiss, and/or amphibolite and cognate fragments of kimberlite. Mantle xenoliths are very rare. All the incorporated fragments constitute more than 15 volume per cent of the kimberlite. The **Eastern Tuffisitic Kimberlite** constitutes the largest single phase in the diatreme at surface. It is devoid of any granitic or paragneissic xenoliths which are often observed in other phases in the western lobe. The minor crustal xenoliths within it are mainly amphibolitic. The **ETK** is further characterised by an abundance of highly altered xenocrystic

olivines which may be up to 50mm in diameter and are normally pale brown to khaki-green in colour. Mantle xenoliths are rarely observed.

The **Sandy and Crystal Tuffs** can be distinguished from each other by one aspect, the crystal tuff is pyroclastic with numerous pelletal lapilli and highly altered olivines which are set in a clay matrix. The pellets are cored by either country rock fragments or altered olivines. The altered olivines are generally less than 3mm in diameter and comprise 30-40% of the rock. The sandy tuff is epiclastic and possibly represents reworked crystal tuff. Flat and rounded small pieces (less than 15mm) of lithified shale material have been identified in the sandy tuff. There are very few pelletal lapilli and olivines in the sandy tuff. Both graded bedding and cross-bedding have also been identified. Both phases occur as scattered blocks within the other diatreme phases.

The **Tuff-Bearing Breccia** (TBB) occurs along the western lobe of the pipe in close association with the sandy and crystal tuffs. It incorporates fragments of the sandy and crystal tuff together with the granitic, paragneissic and amphibolitic fragments found in the other TKs and TKBs. The tuff xenoliths can be in excess of one metre in diameter. This phase is younger than the rest of the diatreme phases since it contains xenoliths of the older phases.

The **Hypabyssal Kimberlite** phase is localised at the north-west comer where the extended limb of the pipe joins the rest of the diatreme. Its contact with country rock dips negatively into the country rock to the west. The hypabyssal phase is thought to have come up through a zone of weakness at the margins of the pipe at a very late stage. The kimberlite is almost devoid of mantle or crustal xenoliths and of any precursor kimberlites. It is characterised by abundant olivine macrocrysts.

Xenoliths

Mantle xenoliths at River Ranch are particularly common in the mantle-rich TKB in the northern side of the diatreme. All the xenoliths have been extensively altered by secondary processes to such an extent that no olivine or orthopyroxene has survived. Even the more resistant garnet and clinopyroxene have been altered, although remnants have survived in most xenoliths. Chromite also survives but is never more than an accessory mineral. The majority of the mantle rocks seen in the River Ranch pit are garnet lherzolites. No mantle derived eclogites or websterites have been found.

Macrocrystic Garnets

Mantle-derived garnets with a diameter of +0.425 – 2mm were collected from the run-of-mine production. Major element analyses were obtained on a Cameca Camebax Micro beam electron microprobe at the Department of Geological Sciences, University of Cape Town. The compositions of the garnets were classified according to the garnet classification scheme of Grütter et al. (2006). No eclogitic or websteritic garnets were identified, consistent with the River Ranch diamond inclusion garnets (Kopylova et al., 1995). A total of 137 garnets were analysed. It was found that the garnet population consisted of 12.4% G10, 8.0 % G10D, 40.1% G9, 24,1% G11, 1.5% G12 and 13.1% G1 garnets and a single garnet (G9LM) with a composition similar to the garnets from deformed garnet lherzolites 9boyd and Nixon, 1975). Over 90% of the G9 garnets (G9D) had compositions consistent with G9 garnets recovered from diamonds globally (Figure 1).

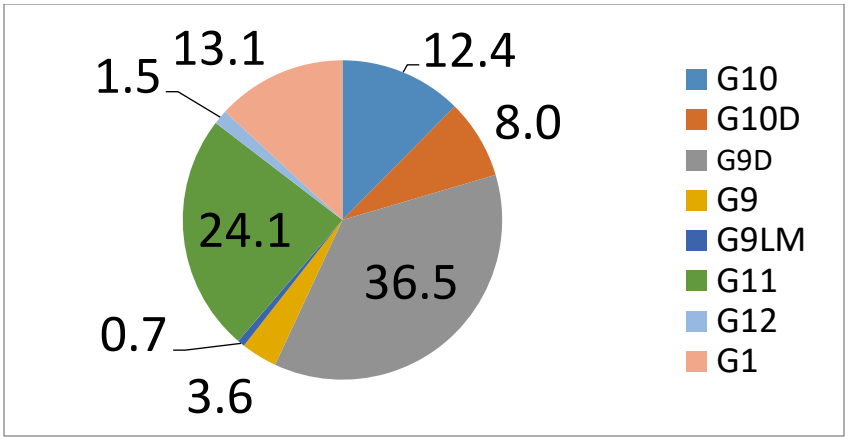

Figure 1: Pie diagram of macrocrystic garnet population presented in percentages.

Diamonds

The diamonds were recovered during evaluation and regular production processes. The evaluation plant consisted of three 10 ft rotary pans with a grease recovery section. The final processing plant consisted of a 200 tph DMS plant with a rotary pan section to recover the -2mm diamonds. Diamonds were recovered through X-Ray fluorescence equipment and grease.

A total of 10531 diamonds were screened with Pierre screens into different sizes and individually inspected for physical characteristics. The predominant colours are brown (50.9%), white (26.1%) and grey (21.2%) with a small component of yellow (1.7%). Pink and green diamonds were observed as rare colours. The brown diamond population increases in dominance as size increases. White and grey diamonds are mostly represented in the smaller screen sizes. Yellow diamonds occur mostly in the upper size ranges. Morphologically, fragments constitute the largest population with 47.8%. The dodecahedral shaped diamonds contribute the second largest population with 34.3%. Macles and polycrystalline diamonds constitute 6.2% and 6.0% respectively while the octahedral population constitute the least with 5.7%. The +2 carat diamonds contributed to more than 50% of production value.

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