The Cucumbi Kimberlite, NE Angola: Problems to Discriminate Fertile and Barren Kimberlites

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INTRODUCTION.

A classical key issue in exploration of diamondiferous kimberlites is the accurate use of typical diamond indicator minerals in order to discriminate among fertile and barren kimberlites. In fact, the conclusive criterion is the occurrence of diamond itself which proves the productivity of a given kimberlite. In a previous paper (Robles-Cruz et al., 2009), we pointed out that in the Catoca pipe, the use of ilmenite composition is not suitable to confirm the diamond grade. We have used a new set of samples in Cucumbi area to study the reliance of some of these parameters, in particular, the use of garnet composition as a guide in diamond exploration.

Cucumbi is located in Cacolo, Lunda Sul province, northeastern Angola. This area is notable because of the occurrence of diamondiferous kimberlites (fig. 1).

Cucumbi samples exhibit crater facies along the first 100 m, characterized by volcanoclastic rocks, and diatreme facies, showing typical tuffisitic kimberlite (Mitchell et al., 2009).

METHODOLOGY.

Thin and polished sections were studied using transmitted and reflected optical microscopy, followed by SEM-BSE-EDS analysis. Chemical analyses were obtained with EPMA.

GEOLOGICAL SETTING.

Angola has a complex geological history that can be represented by three main stages (De Carvalho et al., 2000; Fig. 1):

(1) An important Archaean orogeny, registered by the Central Shield, Cuango Shield and Lunda Shield, most of them composed by gabbro, norite and charnockitic complexes, which constitute the Angolan basement.

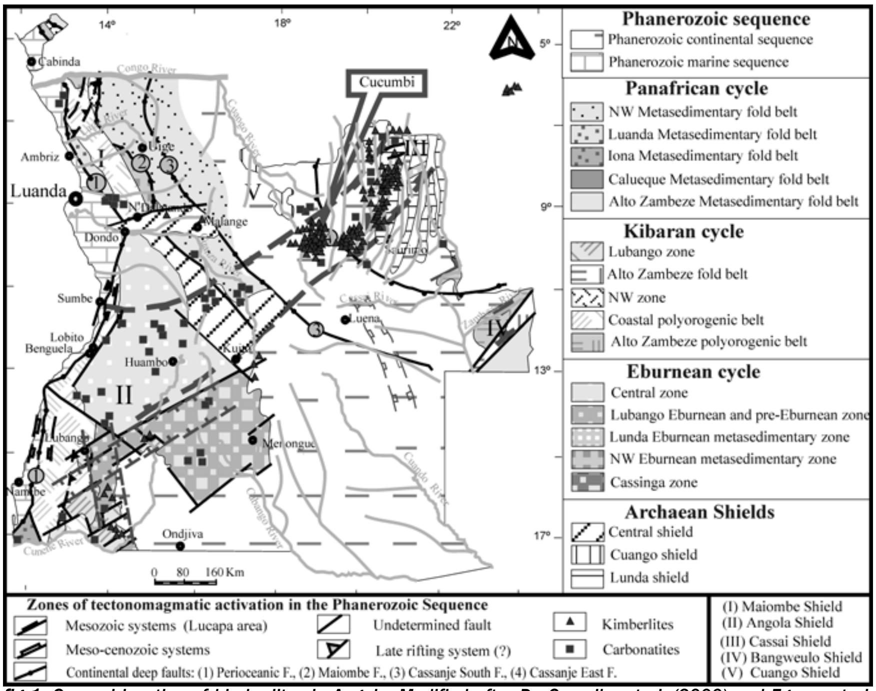

fig 1. General location of kimberlites in Angola. Modified after De Carvalho et al. (2000) and Egorov et al. (2007).

(2) Three main Proterozoic cycles, Eburnean-Paleoproterozoic, Kibaran-Mesoproterozoic, and Pan-African-Neoproterozoic; being the Eburnean the most important and characterized by volcanosedimentary groups, gneisses, migmatites, granites and syenites.

(3) Unconformably lying Phanerozoic sequences, which are the result of the Pangea formation and the consecutive breaking-up of Gondwana, that contributed to the formation of rift basins associated to fault systems which later allowed the apparition of marine sequences, the origin of the Karoo Supergroup, intraplate magmatism (alkaline, carbonatitic, kimberlitic) and marginal basins. The Lower Cretaceous regional extension determined the development of deep faults and grabens with trends NE-SW and NW-SE. The Lucapa structure corresponds to the first group, and the NE part concentrates most of the diamondiferous kimberlites in Angola, including Cucumbi, whereas the southwestern zone comprises important outcrops of undersaturated alkaline rocks and carbonatites (Reis, 1972). Other minor kimberlite fields are found in the SW Angola (Egorov et al., 2007).

PETROGRAPHY AND COMPOSITION

The Cucumbi samples exhibit all the main characteristic features of Tuffisitic Kimberlite TK (Figs. 2, 3). They are

palabras clave: Kimberlita, Mineral indicador, Diamante, Granate.	***key words:*** Kimberlite, Indicator mineral, Diamond, Garnet.

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generally massive, poorly sorted, clast-supported rocks with the following main components: anhedral olivine macrocrysts, pseudomorphosed by serpentine and smectite; other mega- and macrocrysts as garnet, ilmenite, clinopyroxene, and phlogopite, whether enclosed in a pelletal assemblage of serpentine or not, often pelletal lapilli, and an interclast groundmass in the matrix, mainly composed by serpentine, less common by chlorite, smectite and calcite. The size and distribution of mega- and macrocrysts is chaotic (Figs. 2, 3).

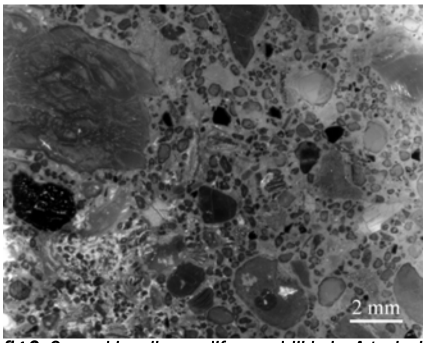

fig 2. *Cucumbi, a diamondiferous drill hole. A typical pattern of a tuffisitic kimberlite (TK) facies, with macrocrysts containing rounded pseudomorphosed olivine xenocrysts, rounded ilmenite xenocrysts and crustal rock xenoliths, all set in a groundmass of serpentine and phlogopite. Image from the scanned thin section.*

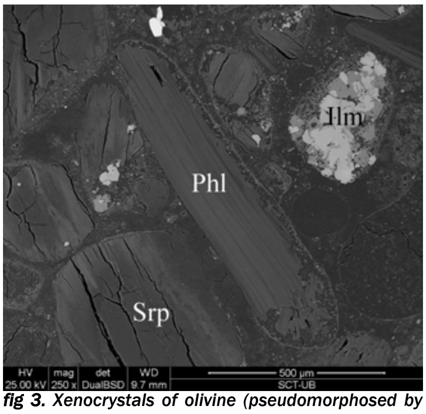

fig 3. *Xenocrystals of olivine (pseudomorphosed by serpentine (Srp)), phlogopite (Phl), ilmenite (Ilm) in a serpentine groundmass. SEM image, mode BSE.*

Magnesian ilmenite (9-13 wt.% MgO) is present as rounded mega- and macrocrysts (fig. 3), as part of xenoliths and as inclusions in phlogopite. In some cases macrocrysts of ilmenite are partially replaced along the borders by perovskite and spinel (Fig. 3). Ilmenite texture is usually either cumulus or homogenous. Symplectite textures are lacking in this kimberlite, in contrast with Catoca.

Garnet and clinopyroxene are usually present as mega- and macrocrysts, and only rarely as part of xenoliths.

Garnet composition is diverse. Using the garnet classification of Grütter et al. (2004), it may be stated (Fig. 4) that some garnet derive from lherzolite (G9) and others from pyroxenite and eclogite (G4, G5), only a few of them come from uncommon, unusual or "polymict" mantle lithologies.

DISCUSSION AND CONCLUSIONS.

Using the diagram of Grütter et al. (2004) to plot the garnet compositions from Cucumbi, it should be pointed out that all these compositions plot into the graphite domain, out of the diamondiferous field harzburgitic G10 facies. Therefore, this kimberlite could be classified as barren using only that criterion. However, the Cucumbi kimberlite has proven to be diamondiferous. In fact, similar problems were found in the Catoca pipe when using the composition of ilmenite (Robles-Cruz et al., 2009) or the composition of garnets.

Therefore, the garnet diagrams can be used to verify the minimum level of diamond content, but some kimberlites may contain diamond samples from deeper sources. Hence, it should be taken into consideration when using these diagrams to assess the potential of kimberlite fields.

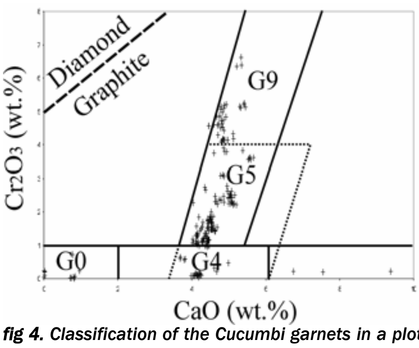

fig 4. *Classification of the Cucumbi garnets in a plot Cr_2O_3 versus CaO (wt.%), according with the compositional fields of Grütter et al. (2004).*

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