# Kimberlite Terminology: What's in a Word?

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## 1 Introduction

Reliable evaluation and successful mining of primary diamond deposits, mainly kimberlites, is founded on robust mineral resource estimates. These are based on three dimensional geological models developed through the description, classification and interpretation of rocks, information which is communicated using words. For reliable results, the accuracy and relevance of the words used is critical. Kimberlite terminology has evolved over more than four decades, originally based mainly on the Kimberley area of South Africa. Kimberlites have attributes not adequately addressed by standard terminology and the inconsistent use or misuse of key terms indicated that a re-evaluation was necessary. A decade-long assessment by an experienced working group resulted in a rationalisation and improvement of terminology applied in the investigation of the complex and unusual rocks encountered during diamond exploration and mining.

## 2 Key Principles and Objectives

The terminology is presented in a Glossary (Scott Smith et al., in preparation) which clarifies >300 words used in kimberlite geology investigations. As far as possible kimberlite terms are aligned with those of mainstream geology, while terminology applicable to the economics of diamond deposits is recommended. The terminology is summarised and presented in a practical, systematic framework, or scheme, intended to assist in the description, recognition and understanding of rocks (Scott Smith et al., 2013). The scheme has five stages (Table 1) and is based on progressively increasing levels of interpretation building upon a series of descriptors that are applied independently of, and prior to, genetic classifications. Stage 1, the descriptive stage, is based mainly on observations and requires only limited genetic interpretation whereas Stages 2 to 5, when possible, involve classification into specific rock types based on increasing degrees of genetic inference. Stage 1 is considered to be the most critical part of the nomenclature scheme because it provides the evidence, or foundation, for the interpretations undertaken in Stages 2 to 5. Importantly, Stage 1 also provides the basic

Table 1. The Scheme: A systematic framework for the description, classification and interpretation of kimberlites.

| Stage 1 | Stage 2 | Stage 3a | Stage 3b | | Stage 4 | Stage 5 |
|---|---|---|---|---|---|---|
| **PROGRESSIVE INTERPRETATION** | | | | | | |
| **Rock Description** | **Petrogenetic Classification** | **Textural-Genetic Classification** | | | **Intrusive / Volcanic Spatial Context** | **Genetic / Process Interpretation** |
| **Alteration:** intensity; distribution; mineralogy; imposed textures; preservation; timing; xenolith reaction<br>**Structure:** e.g. massive; inhomogeneous; layered; flow zoned; laminated; cross-bedded; jointed<br>**Texture:** component distribution; shape; size distribution (e.g. well sorted; inequigranular); packing; support (e.g. clast or matrix supported)<br>**Components:** compound clasts (e.g. xenoliths, magmaclasts, autoliths, accretionary clasts); crystals (e.g. olivine macrocrysts, crustal xenocrysts); interstitial matrix | **Parental Magma Type:** e.g. kimberlite; lamproite; melnoite; alnoite; olivine melilitite | **Coherent:** *[descriptors]* coherent *kimberlite* (CK) | **Intrusive:** *[descriptors]* intrusive coherent *kimberlite* (ICK) <u>or</u> hypabyssal *kimberlite* (HK) | | e.g. intra-crater ICK sheet; non-volcanic HK plug; sub-volcanic root zone-fill | e.g. composite flow-differentiated hypabyssal sheet; intrusive plug |
| | | | **Extrusive:** *[descriptors]* extrusive coherent *kimberlite* (ECK) | | e.g. intra-crater ECK; extra-crater ECK | e.g. fountain-fed clastogenic lava lake; effusive lava flow |
| | | **Volcaniclastic:** *[descriptors]* volcaniclastic *kimberlite* (VK) | **Pyroclastic:** *[descriptors]* pyroclastic *kimberlite* (PK) <u>or</u> *[descriptors] kimberlitic* [standard pyroclastic rock name] | **Kimberley-type:** *[descriptors]* Kimberley-type pyroclastic *kimberlite* (KPK) | e.g. pipe-fill KPK; subsurface diatreme-fill KPK; crater-fill KPK | e.g. fluidised; column collapse |
| | | | | **Fort à la Corne-type:** *[descriptors]* Fort à la Corne-type pyroclastic *kimberlite* (FPK) | e.g. vent-proximal FPK, intra-crater FPK; crater rim FPK; distal extra-crater FPK | e.g. spatter; fallout; base surge; pyroclastic flow |
| | **Mineralogical Classification:** e.g. monticellite; phlogopite; carbonate | | **Resedimented Volcaniclastic:** *[descriptors]* resedimented volcaniclastic *kimberlite* (RVK) <u>or</u> *[descriptors]* resedimented *kimberlitic* [standard sedimentary rock name] | | e.g. pipe-fill RVK; intra-crater *kimberlitic* sediments; distal extra-crater RVK | e.g. grain flow; debris flow; mass flow; lacustrine; reworked crater rim; alluvial fan; turbidite |
| | | | **Epiclastic Volcanic:** *[descriptors]* epiclastic volcanic *kimberlite* (EVK) <u>or</u> *[descriptors]* epiclastic *kimberlitic* [standard sedimentary rock name] | | e.g. pipe-proximal EVK; epiclastic volcanic *kimberlitic* sediment | e.g. lithified crater rim scarp slope mass wasting |
| **Example names:** uniform, xenolith-poor, medium-grained, olivine macrocryst-rich rock; massive, xenolith-rich, fine to medium-grained, olivine-poor rock; cross-bedded microcrystic rock | **Example names:** olivine macrocryst-rich carbonate phlogopite monticellite kimberlite; leucite lamproite; olivine macrocryst-poor phlogopite orangeite | **Example names:** xenolith-poor, flow zoned, variably macrocrystic CK; xenolith-rich, well bedded VK | **Example names:** macrocryst-poor ICK; uniform macrocrystic HK; flow banded crystal-poor ECK; thickly bedded PK; massive unsorted very macroxenolith-rich KPK; graded xenolith-poor olivine pyrocryst-rich FPK; cross-bedded very fine-grained crystal-dominated RVK; well sorted resedimented *kimberlitic* sandstone; poorly sorted EVK; bedded *kimberlitic* lapilli tuff | | **Example names:** steep discordant HK sheet; diatreme-fill massive xenolith-rich KPK; crater-fill mega-graded olivine pyrocryst-dominated FPK | **Example names:** graded, olivine pyrocryst-rich FPK fallout deposit; *kimberlitic* lacustrine mudstone; clast supported, very xenolith-rich RVK mass flow deposit |

information required for the definition and internal subdivision of kimberlites into different lithological units and phases of kimberlite that are used in the development of economically relevant geological models. Stages 2 to 5 permit a greater understanding of any kimberlite and higher degrees of confidence in the geological model based on Stage 1, resulting in improved predictions of diamond distribution.

## 3 The Scheme

The scheme (Table 1) is applied progressively, with an overall broadening of the scale of observation (i.e. incorporation of smaller and larger scale observations), increased sample density, greater integration of other data and higher levels of interpretation as investigations proceed from Stages 1 to 5. The scheme focuses on the most common primary source of diamonds, kimberlite, but it is applicable to other parental magma types (e.g. lamproite).

*Stage 1* of the scheme is rock description and involves only limited genetic interpretation. A conceptual framework for the most critical part, the components, is presented in Figure 1.

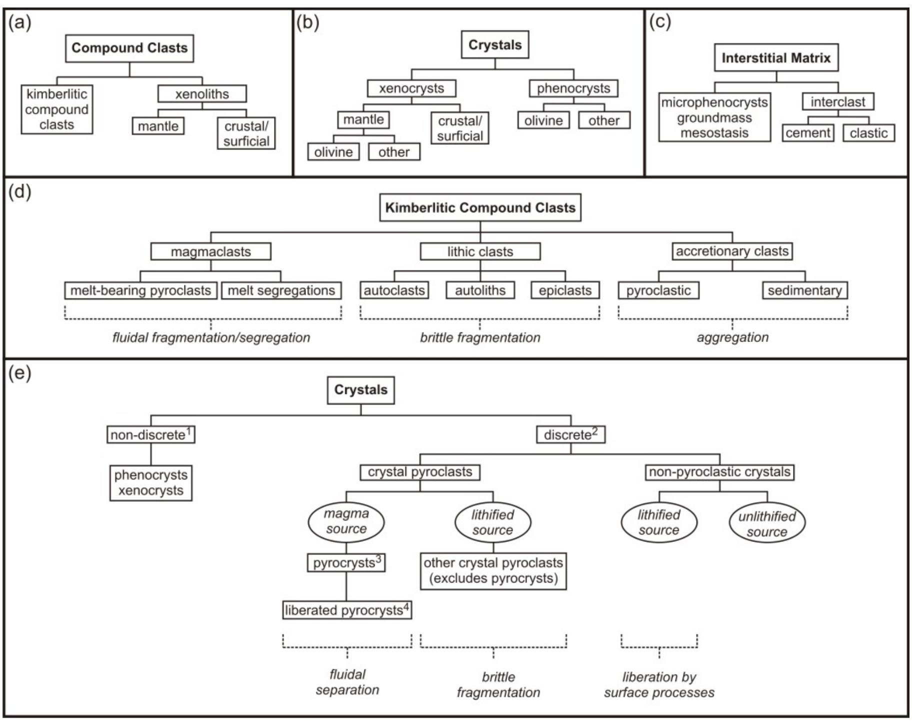


Figure 1. Conceptual framework for the description of kimberlite components. The components are ascribed to three main classes (a) compound clasts, (b) crystals, and (c) interstitial matrix (listed in order of decreasing size). Further subdivision is based on composition and origin. Notes for (e): (1) occur within solidification products of original host melt (includes crystals in magmaclasts); (2) kimberlitic and non-kimberlitic crystals separated from a former host melt, a former lithified source or derived from a former unlithified source; (3) crystals separated by pyroclastic emplacement processes from the original host kimberlite melt but not necessarily from exsolved magmatic fluids; (4) pyrocryst that has been completely separated from the original host kimberlite magma including both melt and exsolved magmatic fluids.

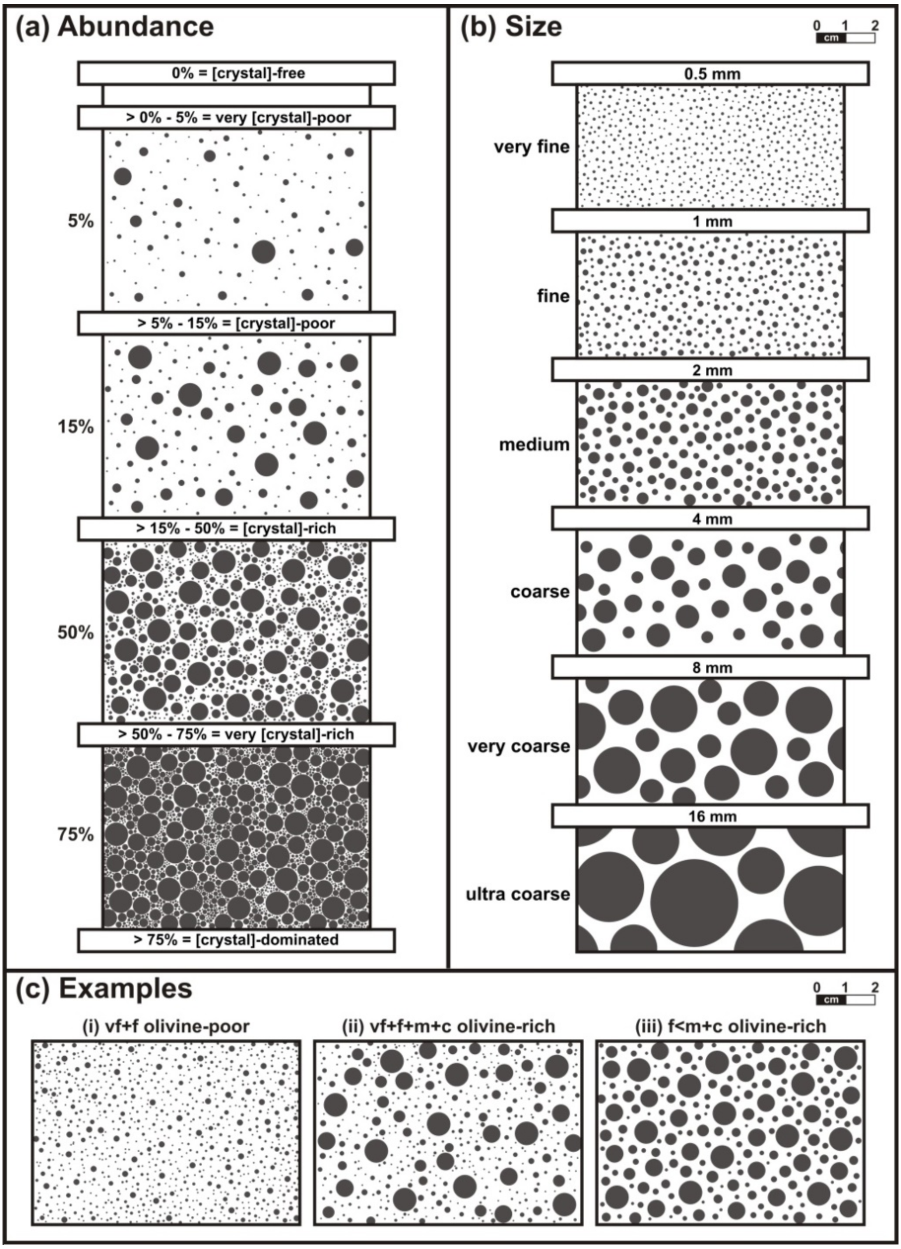


Figure 2. Diagrammatic guide to the abundance and size descriptors for crystals in kimberlite; for magmaclasts, substitute [magmaclast] for [crystal]. Only >0.5 mm crystals that are observable with the naked eye are depicted. The black circles mimic the characteristic round shape of olivine macrocrysts and many magmaclasts. It is implicit in the use of any size terms >1 mm for olivine that they are macrocrysts. (a) Crystal abundance classes are shown inside the white bars, and between them the cut-offs are illustrated using a range of crystal sizes. (b) Crystal size class cut-offs are shown inside each white bar and illustrated between. (c) Schematic example rocks are illustrated with abbreviated olivine size and abundance. See Tables 2 to 5 in Scott Smith et al. 2013).

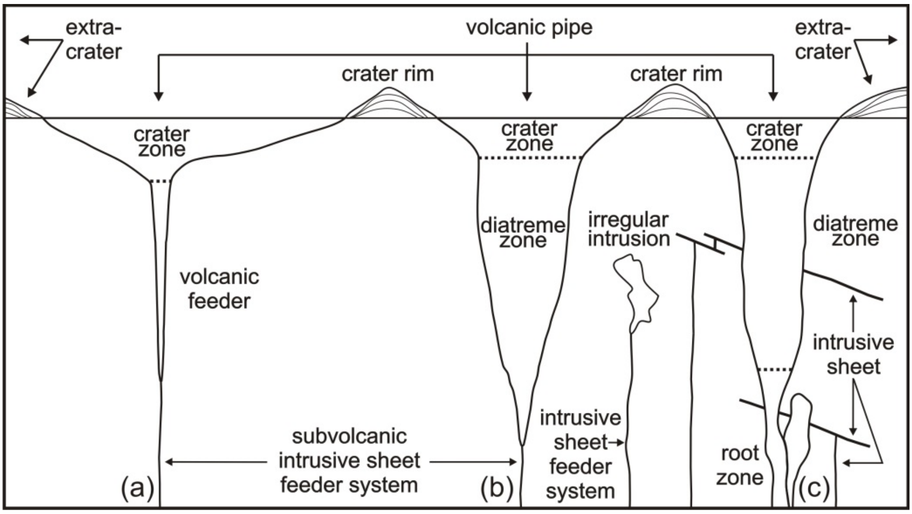


Figure 3. Diagrammatic guide to terminology for kimberlite body morphology and pipe zones. Body outlines (a), (b) and (c) from Figure 4 in Scott Smith (2008). Note the term diatreme zone is used irrespective of the nature of the infill (compare both diatreme zones in this figure with contrasting types of infill shown in Figure 4 in Scott Smith, 2008).

Broad abundance and size descriptors for crystals and magmaclasts are illustrated in Figure 2. Comparable descriptors for xenoliths are presented in Tables 2 and 3 of Scott Smith et al. (2013). These descriptors are specific to kimberlites, designed to make them more relevant to the economics of diamond deposits. For example, the sizes and abundances of the olivine crystals depicted in Figure 2(c) indicate an increase in the degree of economic interest from (i) to (ii) to (iii), assuming that they are predominantly mantle-derived. Where possible, the subsequent Stages 2 to 5 involve classification and higher levels of interpretation. *Stage 2* is the petrogenetic classification into parental magma type and mineralogical type. *Stage 3* is the textural-genetic classification of kimberlites. *Stage 4* incorporates an assessment of the spatial relationship to, and the morphology of, the kimberlite body from which the rocks under investigation derive (Figure 3). *Stage 5* involves more detailed genetic interpretation with more specific classification based on the mode of formation.

The scheme (Table 1) is effectively a guide of how to undertake a geological investigation of a kimberlite during resource estimation. The accurate and consistent use of relevant words is an essential part of this process. The level to which the scheme can be applied, and thus the degree of confidence in the outcome, depends not only on the nature of the rocks but also the experience of the user and the degree of detail of the investigation.

## References

Scott Smith B.H. 2008. Canadian kimberlites: geological characteristics relevant to emplacement. Journal of Volcanology and Geothermal Research, 174, 9-19.

Scott Smith, B.H., Nowicki, T.E., Russell, J.K., Webb, K.J., Mitchell, R.H., Hetman, C.H., Harder, M., Skinner, E.M.W. and Robey, J. v. A., 2013. Kimberlite terminology and classification. Proceedings of 10th International Kimberlite Conference, Volume 2, Special Issue of the Geological Society of India, 1-17.

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