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A new approach to kimberlite facies terminology using a revised general approach to the nomenclature of all volcanic rocks and deposits: descriptive to genetic.

Ray Cas [1]**, Lucy Porritt** [1]**, Adrian Pittari** [1] **and Pat Hayman** [1]
[1] *School of Geosciences, Monash University, Clayton, Victoria, Australia, 3800.*

Introduction

Although kimberlite pipes/bodies are usually the remains of volcanic vents, in-vent deposits, and sub-volcanic intrusions, the terminology used for kimberlite rocks has largely developed independently of that used in mainstream volcanology. Existing kimberlite terminology is not descriptive and includes terms that are rarely used, used differently, and even not used at all in mainstream volcanology. In addition, kimberlite bodies are altered to varying degrees, making application of genetic terminology difficult because original components and depositional textures are commonly masked by alteration. This paper recommends an approach for developing terminology for kimberlite rocks that is consistent with usage for other volcanic successions, and follows the approach of Cas et al. (2008).

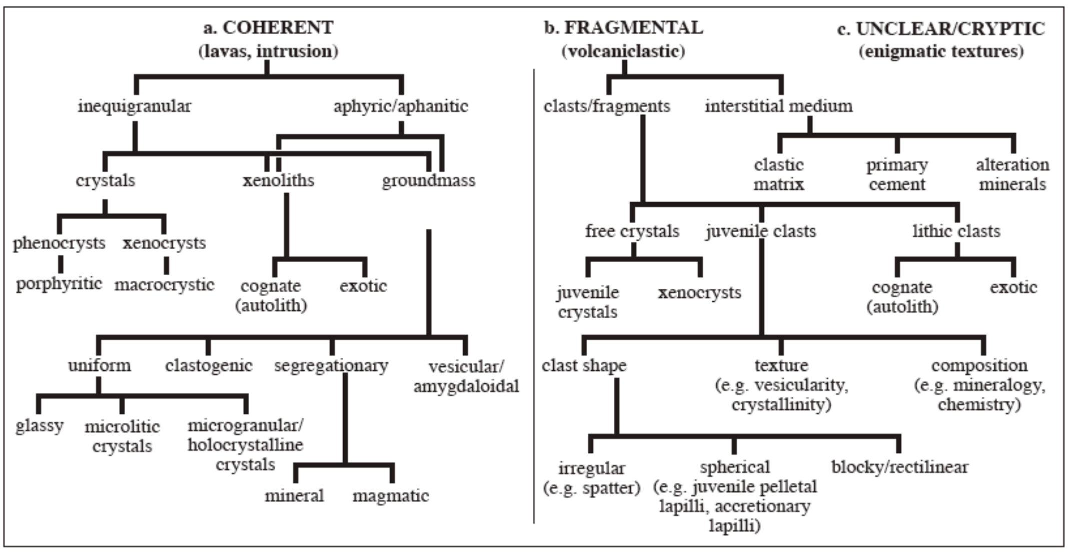
In modern terrains the eruption and emplacement origins of deposits can often be readily deduced, but this is often not the case for old, variably altered and deformed rock successions. A staged approach is required whereby descriptive terminology is developed first, followed by application of genetic terminology once all features, including the effects of alteration on original texture and depositional features, together with contact relationships and setting, have been evaluated. Because many volcanic successions consist of both primary volcanic deposits as well as volcanic sediments, terminology must account for both possibilities.

Approach to classification

Cas et al. (2008) have proposed a systematic approach to the documentation of the depositional facies characteristics of the deposits of kimberlite bodies, including components, textural features and depositional structures. This initial descriptive approach allows descriptive facies names to be applied, which can then be developed into genetic terms. Development of terms requires distinct stages of observation and interpretatiion as follows:

1. In the first instance, the components and groundmass features of coherent kimberlite versus matrix features of fragmental kimberlite need to be documented (Table 1). Different approaches are required for coherent and fragmental kimberlites because they each have distinctive textural features. Coherent kimberlite can be emplaced as subsurface crustal intrusions (= hypabyssal setting), in-vent intrusions and even as

Table 1. Components and textural elements of coherent and fragmental kimberlite (from Cas et al. 2008, Table 1)



lavas, and all three can be texturally similar. the term coherent is preferred to hypabyssal, To avoid confusion between level of emplacement and textural character, the term coherent is preferred to hypabyssal . 2. The size of crystals in coherent rocks and the size of clasts in fragmental rocks are described using recommended size classification tables and descriptive size terms (Table 2).

Table 2. a. Crystal size terms, and b. fragment size terms for coherent and fragmental kimberlite (from Cas et al. 2008, Table 2).

a

<0.0625mm	microlites, microcrystals
0.0625 - 0.25 mm	fine crystals
0.25 - 0.5 mm	medium crystals
0.5 - 1 mm	coarse crystals
1 - 2 mm	very coarse crystals
2 - 4 mm	extremely coarse crystals
4 - 8 mm	large crystals
8 - 16 mm	very large crystals
16 - 32 mm	extremely large crystals
>32 mm	extraordinarily large crystals (e.g. spinifex, pegmatite crystals)

b

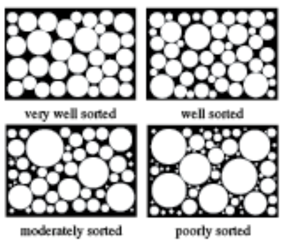
< 0.0625 mm	clay/silt size fragmental deposit/rock
0.0625 – 0.125 mm	very fine sand size fragmental deposit/rock
0.125 – 0.25 mm	fine sand size fragmental deposit/rock
0.25 –0.5 mm	medium sand size fragmental deposit/rock
0.5 – 1 mm	coarse sand size fragmental deposit/rock
1 – 2 mm	very coarse sand size fragmental deposit/rock
2 – 4 mm	grit/granule size fragmental deposit/rock
4 – 8 mm	very fine pebble size fragmental deposit/rock
8 – 16 mm	fine pebble size fragmental deposit/rock
16 – 32 mm	medium pebble size fragmental deposit/rock
32 – 64 mm	coarse pebble size fragmental deposit/rock
64 – 256 mm	cobble size fragmental deposit/rock
> 256 mm	boulder size fragmental deposit/rock

3. Levels of sorting in fragmental rocks are described using standard sorting classes applied in sedimentology. Using sorting textural class names applied to clastic carbonates (mudstone = all clay-silt size particles; wackestone = mudstone with dispersed framework grains; packstone = grain-supported framework with mud-size matrix; grainstone = grain-supported framework without mud-matrix) provides insights into physical eruption and depositional processes and their sorting efficiencies (Table 3).

Table 3: sorting classes and textural sorting class names (from Cas et al. 2008, Table 3).

a

Standard deviation	
< 0.35ϕ	very well sorted
0.35 – 0.50ϕ	well sorted
0.50 – 0.71ϕ	moderately well sorted
0.71 – 1.00ϕ	moderately sorted
1.00 – 2.00ϕ	poorly sorted
2.00 – 4.00ϕ	very poorly sorted
> 4.00ϕ	extremely poorly sorted



b

Mudstone	<10% grains, fine ash/mud dominant
Wackestone	>10% grains, fine ash/mud-supported
Packstone	grain-supported, interstitial fine ash/mud
Grainstone	grain-supported, lacks interstitial fine ash/mud

4. Assessment of crystal shapes and particle rounding are considered next.
5. Assess the crystal abundance using the ranges listed in Table 4.
6. Assess the abundance of vesicles. Use the same abundance terms for coherent kimberlite and clasts in fragmental kimberlite (Table 5).
7. Combine components, and various textural fetures to produce a descriptive petrological term (e.g. serpentine altered, moderately macrocrystic, coarse, non-vesicular, monticellite kimberlite; serpentine-carbonate altered, poorly sorted, moderately crystal rich, olivine-uncored pelletal lapilli, grain supported, coarse sand-size packstone)

Table 4. Crystal abundance classes (from Cas et al. 2008, Table 5).

0%	aphyric/crystal free
<10%	crystal-poor
10 - 25%	moderately crystal-rich
25 - 50%	crystal-rich
50 - 80%	very crystal-rich
>80%	extremely crystal-rich

Table 5. Vesicle abundance classes (from Cas et al. 2008, Table 6; after Houghton and Wilson 1989).

0%	non-vesicular
0 - 20 %	very poorly vesicular
20 - 40%	poorly vesicular
40 - 60%	moderately vesicular
60 - 80%	very vesicular
>80%	extremely vesicular (reticulite)

8. Describe the principal emplacement/depositional structures and unit thickness.
9. Describe the contact relationships between units (conformable, intrusive, faulted).
10. Apply appropriate genetic size terminology to fragmental deposits after deciding if the origin is pyroclastic, autobrecciation, quench fragmentation, hydraulic fracturing or sedimentary epiclastic (Table 6).
11. Interpret the emplacement setting (extra-vent; intravent) and emplacement/depositional process (Table 7).

12. Apply a genetic term, if possible, that combines key descriptive facies features with emplacement origins and setting (e.g. crater zone, thin, tabular, moderately crystal-rich, macrocrystic, non-vesicular, olivine-phlogopite, orangeite dyke; intra-vent, massive, olivine rich, lapilli-tuff, column collapse deposit; diatreme zone, well-sorted, diffusely bedded, olivine sandstone turbidite; extra-vent, thinly bedded, well-sorted, crystal-rich, olivine, very coarse tuff, fallout deposit).

Table 6. Genetic terminology for different types of fragmental kimberlite based on fragmentation style and grainsize (from Cas et al. 2008, Table 10).

• **Pyroclastic** (primary and syn-eruptive resedimented)	
< 0.0625 mm	fine ash/tuff
0.0625 – 2 mm	coarse ash/tuff
2 – 4 mm	extremely fine lapilli/lapillistone
4 – 8 mm	very fine lapilli/lapillistone
8 – 16 mm	fine lapilli/lapillistone
16 – 32 mm	medium lapilli/lapillistone
32 – 64 mm	coarse lapilli/lapillistone
> 64 mm	bomb/block breccia/agglomerate
• **Autobreccia**	
• **Hyaloclastite/Peperite** breccia (> 2mm) /sandstone (< 2mm)	
• **Hydraulic fracture** breccia	
• **Post-eruptive epiclastic** (surface sedimentary processes)	
< 0.0625 mm	clay/silt/claystone, siltstone/mudstone
0.0625 – 0.125 mm	very fine sand/sandstone
0.125 – 0.25 mm	fine sand/sandstone
0.25 –0.5 mm	medium sand/sandstone
0.5 – 1 mm	coarse sand/sandstone
1 – 2 mm	very coarse sand/sandstone
2 – 4 mm	grit/gritstone
4 – 8 mm	very fine pebble gravel/breccia/conglomerate
8 – 16 mm	fine pebble gravel/breccia/conglomerate
16 – 32 mm	medium pebble gravel/breccia/conglomerate
32 – 64 mm	coarse pebble gravel/breccia/conglomerate
64 – 256 mm	cobble gravel/breccia/conglomerate
> 256 mm	boulder gravel/breccia/conglomerate
• **Intrusive setting into unconsolidated sediments**	
	- for autobreccias, hyaloclastites and peperites, add "syn-depositional intrusive" before the textural-compositional genetic names as above
• **Intrusive into consolidated country rock**	
	- for autobreccia, add "intrusive"
• **Subterranean blind intrusion**	
	- These could experience hydraulic fracturing, autobrecciation, and at shallow depths hydrothermal, phreatomagmatic and magmatic explosive fragmentation. The appropriate terminology, should be applied as above.

Table 7. Emplacement setting and origin for a. coherent and b. fragmental kimberlite (from Cas et al. 2008, Table 11).

a

i. subaerial, subaqueous, subvolcanic

ii. *intra-vent volcanic*	*extra-vent volcanic*	*subvolcanic*
- lava	- lava	- sill
- clastogenic lava pond	- lava dome	- dyke
- lava dome		- laccolith
		- cryptodome

b

i. subaerial, subaqueous, subvolcanic

ii. *within the vent/intra-vent*	*outside the vent/ extra-vent*
- pyroclastic fallout	- pyroclastic fallout
- pyroclastic flow	- pyroclastic flow
- pyroclastic surge	- pyroclastic surge
- in-vent eruption column collapse	
- rock-fall	
- rock-fall megaclast	
- debris flow	- debris flow
- turbidity current	- turbidity current
- sedimentary tractional reworking	- sedimentary tractional reworking
- hemi-pelagic settling	- hemi-pelagic settling

References

Cas, R.A.F., Porritt, L., Pittari, A., Hayman, P. 2008. A new approach to kimberlite facies terminology using a revised general approach to nomenclature for all volcanic rocks: descriptive to genetic. Journal of Volcanology and Geothermal Research, 174, 226-240.

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