

Olivine crystal size distributions in kimberlite

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ABSTRACT

Olivine is the dominant component in coherent kimberlite rocks and related pyroclastic rocks. Quantitative characterization of olivine crystals in kimberlite rocks may be used to better understand kimberlite emplacement and eruption. Here, we construct the first complete olivine crystal size distribution (CSD) for magmatic or coherent kimberlite using two-dimensional image analysis techniques with a new method for scale-integration. Crystal size and frequency data are collected from polished slabs and thin sections, normalized to the largest scale of observation, and stereologically corrected to create a complete CSD covering the full range of observed olivine crystal sizes.

Resulting CSDs show the following properties for olivine in crystal-rich interiors of intrusive coherent kimberlite in the A154N kimberlite pipe, Diavik, Northwest Territories: (1) 0.03–10.0 mm in diameter size range; (2) 46.7–51.2% modal crystal content; (3) modal% dominance by crystals >1 mm; (4) frequency dominance by crystals <1 mm; and (5) equant-axial crystal shapes that cannot be easily described by a single external morphology for any size fraction.

Measured size ranges and modal crystal content are consistent with previous reported data. Relative frequency and area ratios between crystals of different sizes and shape properties differ from previous assessments. Olivine CSDs are consistent with a power-law distribution over at least two orders of magnitude, and statistical parameters (power-law exponents, Inman parameters) suggest that apparent characteristic ranges are independent of crystal frequencies, modal abundance (area%), or sampling locale. These properties suggest olivine crystals may be a single population with a shared paragenesis, and not the end-product of a combination of two populations of olivine. On this basis, olivine CSDs and population parameters have the following uses: (1) to compare and discriminate among kimberlite facies and deposit types, and (2) to test models for olivine paragenesis.

Keywords: Olivine, kimberlite, crystal size distribution, image analysis, emplacement, diamond