Crystal tracht of groundmass pyroxene crystals recorded magma ascent paths during the 2011 Shinmoedake eruption

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Online Resource 2: Corrections for tracht-specific CSDs

In this study, we expressed CSDs as a function of short-axis length (*S*) to show differences according to eruptive styles. This method is explained in detail by Okumura et al. (2022a), and we here briefly describe the procedure. Using *CSDCorrections* (Higgins 2000), the number of crystals per unit volume in the *i*th size interval, n_{Vi}, is converted stereologically from the number of crystal cross sections per unit area, n_{Ai}, as (modified from Equations 5 and 8 of Higgins 2000):

$$n_{\mathrm{V}i} = n_{\mathrm{A}i} \cdot \frac{1-CF_i}{P_{ii}} \cdot \frac{\ln(y_i/x_i)}{A(y_i(S)-x_i(S))} \tag{A1}$$

where A is the aspect ratio L/S, P_{ii} is the probability that a crystal with a true (i.e., determined in 3D) size in the *i*th interval will have a cross-sectional size in the same interval, and CF_i is a correction factor representing the proportion of crystals with true sizes larger than the *i*th interval among the cross sections within that interval. The lower and upper limits of the *i*th interval are expressed as $x_i(S)$ and $y_i(S)$, which are functions of S because we assume that the measured widths of crystal cross sections are close to S (Higgins 1994). *CSDCorrections* then yields the population density in the *i*th interval, N_i, as a function of long-axis length (L) as:

$$N_i(L) = \frac{n_{\mathrm{V}i}}{y_i(L)-x_i(L)} = \frac{1}{A^2} \cdot \frac{1-CF_i}{P_{ii}} \cdot \frac{n_{\mathrm{A}i}\ln(y_i/x_i)}{\left(y_i(S)-x_i(S)\right)^2}, \tag{A2}$$

where the interval length is converted as:

$$y_i(L) - x_i(L) = A \cdot \left(y_i(S) - x_i(S)\right). \tag{A3}$$

After the calculation by *CSDCorrections*, we obtained the population densities as a function of S, $N_i(S)$, as:

$$N_i(S) = \frac{n_{\mathrm{V}i}}{y_i(S)-x_i(S)} = \frac{y_i(L)-x_i(L)}{y_i(S)-x_i(S)} \cdot N_i(L) = A \cdot N_i(L). \tag{A4}$$

In addition to the above procedure reported by Okumura et al. (2022a), we applied an additional correction to the obtained population densities for tracht-specific CSDs. *CSDCorrections* addresses the sectioning effect, i.e., the fact that a crystal can yield a cross section far thinner than its actual short-axis length (S) when the polished surface intersects the edge of the crystal (Higgins 2000). The correction term for this effect appears in Equations A1 and A2 as $(1 - CF_i)$. In contrast, because the crystal cross sections classified into specific trachts (i.e., octagon, heptagon, or hexagon) were limited to those including at least one pair of parallel faces, the widths of those cross sections should not be shorter than their actual widths in 3D (i.e., S); therefore, the correction for the sectioning effect $(1 - CF_i)$ is unnecessary for the tracht-specific CSDs. For this reason, we divided the population density $N_i(S)$ by $(1 - CF_i)$ in the case of tracht-specific CSDs.

References cited

Higgins, M.D. (1994) Numerical modeling of crystal shapes in thin sections: estimation of crystal habit and true size. American Mineralogist, 79, 113–119.

——— (2000) Measurement of crystal size distributions. American Mineralogist, 85, 1105–1116. https://doi.org/10.2138/am-2000-8-901

Okumura, S.H., Mujin, M., Tsuchiyama, A., and Miyake, A. (2022a) 3D crystal size distributions of pyroxene nanolites from nano X-ray computed tomography: Improved correction of crystal size distributions from CSDCorrections for magma ascent dynamics in conduits. American Mineralogist, 107. https://doi.org/10.2138/am-2022-8039