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Constraints on mingling of crystal populations from off-center zoning profiles: A statistical approach

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ABSTRACT

Major- and trace-element and isotopic analyses of single crystals can reveal temporal changes in the thermodynamic and mechanical behavior of magmatic systems. Additionally, zoning can be used to define crystal populations that have shared a common environment based on the correlation of zoning profiles among groups of crystals. However, as is evident in petrographic thin sections, comparison of zoning patterns is complicated by the geometric distortions resulting from crystal sections that are off-center. Because of these distortions, identification of crystal populations becomes increasingly difficult with increasing degrees of geometric non-ideality. In addition, because of the inherent complexity of zoning profiles, often there is ambiguity in determining what level of correlation is significant, even for ideal cases. Consequently, significance levels must be determined for each correlation technique and set of natural profiles. We evaluate the effectiveness of standard correlation, wavelet-based correlation (WBC), and profile-normalization techniques designed to counter the effects of non-ideality using Monte Carlo experiments correlating synthetic profiles. Results from the experiments show that adaptive profile normalization provides more significant correlations from fewer profiles than other techniques indicating that it is at least partially effective in counteracting the effects of non-ideality.