

ELECTRONIC ARTICLE

An evaluation of spatial correlation functions in textural analysis of metamorphic rocks

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ABSTRACT

Spatial correlation functions, which quantify spatial relationships among porphyroblasts over a range of length scales, can be used in combination with other techniques of quantitative textural analysis to constrain crystallization mechanisms in metamorphic rocks. The utility, reliability, and robustness of these functions, however, depend critically upon correct methods of calculation and application to geological samples.

Application of the L' -function, Pair Correlation Function, and Mark Correlation Function (Stoyan and Stoyan, 1994) to artificial arrangements of crystals yields results consistent with their predetermined ordering and clustering qualities. These results serve as a foundation for the interpretation of more complex simulated and natural crystal arrays. Analysis of artificial and simulated crystal arrays in which ordering signals are obscured in various ways (displacing crystals in an ordered array by increasing amounts, reducing the number of crystals, and increasing the sample's aspect ratio) demonstrates that these scale-dependent functions are robust indicators of effects diagnostic of certain crystallization mechanisms, even in complex circumstances. The effects of clustering of nucleation sites, however, can strongly obscure any underlying signal that might reveal crystallization mechanisms.

The L' -function and the Pair Correlation Function are sensitive to short-range ordering of crystals, which may reflect suppression of nucleation in the vicinity of growing porphyroblasts. The Mark Correlation Function is sensitive to size-isolation correlations, which may reflect retardation of growth among crystals competing for nutrients. Interpretation of these functions, however, requires careful attention to proper calculation of Monte Carlo simulations, which are used to identify values of the functions that constitute a null-hypothesis region for comparison to samples with unknown ordering and clustering characteristics. To yield functional values commensurate with those calculated for a particular natural rock specimen, each simulation must match as closely as possible several critical features of the natural rock, including the set of crystal radii, limitations on the observability of crystals, and the shape and size of the bounding surface of the sample.

Crystallization mechanisms in seven previously studied garnetiferous rocks from three localities (Carlson et al. 1995; Denison and Carlson 1997) have been reassessed using both scale-dependent correlation functions and single-valued spatial statistics, both evaluated by comparison to rigorously computed null-hypothesis regions. The results confirm previous inferences that the nucleation and growth rates of the garnet porphyroblasts in these specimens were governed by rates of diffusion through the intergranular medium.

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