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Fractal analysis and thermal-elastic modeling of a subvolcanic magmatic breccia

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We examine the development of a subvolcanic magmatic breccia located along the contact of a granitic intrusion using fractal analysis and thermal-mechanical modeling. Over a thickness of approximately 1 km, the breccia grades from clast-supported, angular clasts adjacent to unfractured host rock to isolated, rounded clasts supported by the granitic matrix adjacent to the intrusion. Field observations point to an explosive breccia mechanism, and clast size distribution analysis yields fractal dimensions (Ds > 3) that surpass the minimum value known to result from explosion (Ds > 2.5). Field observations, clast size distribution data, clast circularity data, and clast boundary shape data suggest that the clast sizes and shapes reflect post-brecciation modification by partial melting and thermal fracture. Numerical modeling is employed to explore the possible thermal-mechanical effects on the size distribution of clasts. Instantaneous immersion is assumed for metasedimentary clasts of a fractal size distribution in a superheated granitic matrix for different matrix volume percentages. Thermal analysis is restricted to conductive heat transfer corrected for latent heat. Metasedimentary clast melt was an effective secondary modification process which markedly altered the clast size distribution for clast populations adjacent to the intrusion. Diabase clasts experienced late-stage fracture due to the instantaneous thermal pulse in which angular clasts with high surface area to volume ratios were preferentially fractured but had no observable influence on clast size distribution.