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An improved equation for crystal size distribution in second-phase influenced aggregates

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ABSTRACT

A model is presented to calculate crystal size distributions (CSDs) for coarsened mineral aggregates. The equations consider the second-phase particles inside coarsening aggregates. This approach is different from other published kinetic growth equations. The proposed model includes grain size limits due to the presence of second-phase particles. These limits control the behavior of growing grains. The physical basis for this model is taken from a neighborhood-coarsening model. The model is able to compute coarsening of a given set of crystal sizes, to simulate the evolution of the CSD, and to describe the influence of the amount and size of the second-phase particles. The model is limited to rocks that can be described as matrix with second phases. For very low second-phase concentrations (volume fraction <0.01), the model gives results similar to Lifshitz-Slyozov-Wagner models (LSW). In the case where the second-phase content is extremely high (volume fraction >0.5), the model would not allow coarsening or the system can be no longer described as matrix and second-phase particles. Depending on the size and amount of second phases, the CSD develops similar to LSW at high growth rates, but intermediate growth rates produce CSDs that are unknown in other closed-system coarsening models.

To test the model, natural data from a contact-metamorphic calcite marble with different mica contents have been compared with simulated CSDs. The measured and simulated CSDs can be well described by the proposed model for variable amounts of second-phase particles. The two-phase model is applicable to impure carbonates, mica-bearing quartzites, or impure dunites. The proposed model has interesting applications to experimental data, where porosity may influence grain coarsening.