DLA-modeling of metamorphic mineral growth

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Information on the degree of supersaturation is essential to evaluate *P-T* estimations and predict the pattern formation in metamorphic rocks. Instability of a growing interface at a high degree of supersaturation leads to irregular patterns (Mullins and Sekerka, 1963). The origin of irregular patterns of metamorphic cordierites can be modeled by DLA (Diffusion-limited aggregation) (Miyazaki, 2001), which is the simple statistical model for the universal fractal pattern. For DLA-like growth, the following processes are essentials; (1) diffusion-controlled growth, (2) selective growth (enhancement and prevention of growth by surrounding matrix minerals), (3) random spatial distribution of matrix minerals. The processes (2) and (3) correspond to generation of random noise due to the sticking of a finite size random-walking particle in the original DLA model. Formation of DLA-like pattern is expected when diffusion-controlled growth is at a high degree of supersaturation. However, such a pattern is not common in natural metamorphic rocks. The effect of interfacial energy becomes important at a low degree of supersaturation. To simulate pattern transition with increasing effect of interfacial energy, I modeled mineral growth by DLA with a sticking probability depending on interface curvature and random-walk of particles on the grain-boundary. The results show that the pattern changes from a DLA cluster (c) to a compact pattern (a) with decreasing degree of supersaturation (Fig.1). The pattern at a cross-over (b) shares some features of an irregular pattern of garnet in a natural sample (d) (Fig.1). The results suggest that the diffusion-controlled growth pattern is a potential indicator for degree of supersaturation.

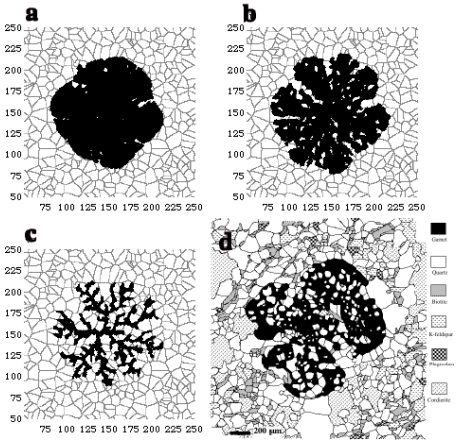

Fig. 1

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Short-Term Temporal Variation of PM_1 Chemical Composition Measured in Tokyo

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Near real-time measurements of fine particle (PM1) chemical composition were made with a 15-min time resolution at a ground-based site in urban city Tokyo in April-May 2003. The measurements were based on a Particle-Into-Liquid-Sampler (PILS), which collects particles into a flow of purified water for on-line analysis with a dual channel ion chromatograph. The measurements successfully revealed the transient events of the particle concentrations over a period of few hours. The maximum total ion mass concentration observed during the period was 30 $\mu g/m^3$. On average, nitrate, sulfate, and ammonium were the major components of a suite of inorganic aerosol ions. The most unique events were a sudden increase of nitrate concentartions up to 10-20 $\mu g/m^3$ especially in the morning or at midnight. During these events, nitrate concentartions were higher than sulfate concentrations by a factor of 2-5. Chloride concentrations also showed enhencement, which were strongly correlated with nitrate concentrations. The variable chemical properties of these events and insights into sources are presented and discussed.