MEASURING LOW-TEMPERATURE EQUILIBRATION THROUGH FOURIER ANALYSIS

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As clastic sediments are subjected to increasing diagenesis and low-temperature metamorphism, mineral compositions, crystal structures, defect content, boundary orientations, and grain sizes progress toward equilibrium. Although past studies have documented low-temperature compositional evolution, few investigations have proposed quantitative models for chemical equilibration of fluids and solids under these conditions. We have simulated the chemical homogenization of chlorite crystals during low-grade metamorphism in order to investigate the possibility of using Fourier analysis for quantifying the extent and style of diffusion-dominated homogenization. The models are based on linear arrays of crystals embedded in a continuous intergranular fluid medium and consider the effects of variable solid and fluid diffusivities. Fourier spectra of simulation results are indeed sensitive to progressive homogenization and can be used to distinguish between conditions where the solid and fluid diffusivities are either similar or differ greatly. The simulations show that the decrease in standard deviation of mineral analyses can be related to an effective diffusion-time parameter. Samples from the Liassic black shales from central Switzerland were analyzed by Fourier analysis. Spectra generated from linear traverses of chlorite analyses demonstrated that compositional variation decreases with increasing metamorphic grade, and they suggest that the diffusivities of the solid and fluid differ by several orders of magnitude. Mineral zonation patterns and the extent of homogenization within populations of chlorite crystals suggest that the coupled diffusion coefficient for FeÜMg is much lower than current estimates.