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Structural evolution of partially melted metamorphic rocks and role of deformation and reaction

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Migmatites occur pervasively at lower structural levels of high-T metamorphic belts. Migmatites are composite rocks that have metamorphic and igneous textures. Migmatites at the high-T metamorphism may consist of solid rocks and melts. Widespread occurrences of migmatites are corresponding to nearly homogeneous high-T area, which is high enough to partially melting. Migration of melt has an important role of heat transport at lower structural levels of the high-T metamorphic belt. However, migration rate of felsic melt through grain boundaries is very slow owing to very high viscosity. Effective transport of felsic melt requires felsic melt segregation to layers or lenses that connected to each other.
Theoretical treatment of structural evolution of partially melted rocks is very difficult. Here, partially melted metamorphic rocks are treated as immiscible viscous fluids. Simple shear is adopted by moving solid plate, and reaction is assumed that high viscosity fluid changes to low viscosity fluid. In numerical simulation, the following 3-casees were performed. 1) Volume fraction of 2-types of fluids is constant throughout simulation, 2) probability of reaction is high at the place where energy dissipation due to deformation is high, 3) probability of reaction is high at the place where energy dissipation due to deformation is high, however the probability is lower than that in the case-1. In both cases, localization of low viscosity fluids occurs with progress of deformation. Decreasing of dissipation of energy due to deformation in the cases-2) and -3) decreases is smoother than that in the cases-1). Dissipation of energy normalized by volume fraction of high viscosity fluid in cases-2) and 3) is lower than that in the case-1). Structural evolutions and spatial distribution of strain rate in cases-2) and -3) show localization of deformation and reaction occur. Higher probability of reaction at higher energy dissipation site is assumed in the simulations. Energy dissipation due to deformation is proportional to products of square of shear strain rate and viscosity. High strain rate part in high viscosity fluid is likely to occur reaction. If probability of melting reaction at a place where partially melted rocks having high shear strain is higher than the other place, localization of deformation and reaction will take place, and felsic melt segregation to layers and lenses will accelerate.

Keywords: partially melted rock, Structural evolution, deformation, reaction, metamorphic rock