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Viscous flow and thermal evolution of metamorphic belt

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Evolution of internal structure of metamorphic belt under viscous flow and thermal diffusion was evaluated using a virtual metamorphic belt. The virtual metamorphic belt consists of two phases viscous fluids. Thickness of the virtual metamorphic belt is set at 3 km and periodic boundary condition (9 km long) is adopted. Two phases viscous fluids is sandwiched by top and bottom solid plates. Viscosity of two phases fluids is set at 10^23 and 10^21 Pa s, respectively. Simple shear deformation is induced by the top and bottom moving-plates. Shear velocities of these plates are 1 cm/y and -1 cm/y, respectively. Thermal boundary conditions are given by constant temperatures at both plates (600 and 800 ?C). Heat conductivity of the both viscous fluids is set at 2.5 W/m/K.

Thermal structure within the virtual metamorphic belt shows a simple vertical thermal gradient during deformation. Thermal structure will be steady-state under the given thermal boundary conditions during 0.1 M yr.

When residential time is shorter than sufficient progress of diffusional relaxation and hydration reaction at lower temperatures, metamorphic rocks record peak metamorphic temperature. Therefore, thermal structures of metamorphic belt may represent spatial distribution of peak temperature. Spatial distribution of peak temperature of each element of the virtual metamorphic belt is mapped. The result shows that thin layers of which peak temperature is higher or lower than surrounding area were formed. Very large apparent thermal gradient is observed in the virtual metamorphic belt. These thermal structures are not formed without viscosity contrast between two phases. Therefore, the thin layers are formed by selective elongation of low viscosity phase under shear deformation.

Large thermal gradient perpendicular to schistosity is observed in many metamorphic belts. The above-mentioned selective-elongation of low viscosity phase is one of explanation for the large thermal gradient observed in the metamorphic belt.

Keywords: Metamorphic belt, viscous flow, thermal structure