Temperatur-dependence of pressure solution in shales of the Shimanto accretionary complex

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We have studied the temperature dependence of pressure solution development in shales of the Shimanto belt in southeastern Shikoku through meso and microscopic observations (Kawabata et al., 2007). Pressure solution seams (PSS) developed in shales associated with two distinct types of deformation, that is shear-dominated type (type II melange) and compaction-dominated type (coherent type). The PSS density was used as a quantitative index of pressure solution deformation intensity, and positive correlation between PSS density and paleotemperature for both deformation types, showing that generation of PSS is fundamentally controlled by temperature.

We examined the data from Kawabata et al., (2007) to estimate activation energy of deformation using Arrhenius diagrams (reaction rate vs 1/T). Estimated activation energy for type II melange (H_{II}) is about 18 kJ/mol and that for coherent type (H_C) is 45 kJ/mol. The activation energy is a sum of activation energies of solubility (Hs) and diffusion coefficient (H_D) (e.g. Rutter, 1983). The values obtained here are lower than previously reported H_S (60-80 kJ/mol) and H_D (15-30 kJ/mol) (e.g. Rimstidt and Barnes, 1980; Nakashima, 1995). One of the reasons for such low activation energies for pressure solution may be resulted from chemical effect of clay minerals in the deformed shales. The precise mechanisms by which clay minerals affect pressure solution efficiency is not yet clear, but some studies showed that clay mineral such as illite or mica can act as catalyst and greatly enhance quartz dissolution (e.g. Oelkers et al., 2000). In samples of both types we observed illite and mica by XRD analysis. Activation energies also show large differences between the shales of two types. Major difference between samples of both types is mode of deformation type that is shear- or compaction dominated. We infer that the shear deformation somehow enhances pressure solution deformation and lowers activation energy. As a summary, we propose a hypothesis that pressure solution deformations are enhanced both by chemical and mechanical effects. Generally matured fault zones contain large amount of clay minerals in gouge zone. Pressure solution deformation may be more enhanced in more matured fault zone by both effects.

References

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