Superplastic flow of reaction products in mylonites

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I show three examples of mylonites formed associated with chemical reactions and superplastic flow of reaction products in mylonites.

A replacement reaction of K-feldspar by myrmekite occurred at temperatures of 340-400 degrees centigrade in the granite and aplite mylonites along the Hatagawa Shear Zone in the Abukuma Mountains (Tsurumi et al., 2003). With increasing mylonitization, the modal content of fine-grained (smaller than 50 microns) polymineralic aggregate composed of plagioclase, K-feldspar, quartz and biotite increases up to 60-80% in the granite and aplite ultramylonites. Quartz aggregate is deformed by dislocation creep, because its quartz grains exhibit both shape and crystallographic preferred orientations. In contrast, fine-grained polymineralic aggregate is deformed by grain boundary sliding, because its main constituent minerals, plagioclase and K-feldspar both of which are the reaction products, exhibit neither shape nor crystallographic preferred orientations. Fine-grained polymineralic aggregate likely controls the rheology of the granite and aplite ultramylonites in which its modal content reaches to 60-80%.

A decomposition reaction of pyroxenes occurred at pressures of ca. 5 kb and temperatures of 600-700 degrees centigrade in the Pankenushi gabbro mylonite in the Hidaka metamorphic belt. Strain localization into fine-grained (smaller than 50 microns) polymineralic aggregate composed of orthopyroxene, clinopyroxene, hornblende, quartz, biotite and ilmenite mainly derived from the reaction products is observed. Plagioclase aggregate making up more than 50% of the mylonite is deformed by dislocation creep, because its plagioclase grains exhibit both shape and crystallographic preferred orientations. In contrast, fine-grained polymineralic aggregate composing ca. 30% of the mylonite is deformed by grain boundary sliding, because its main constituent minerals, orthopyroxene and clinopyroxene, exhibit neither shape nor crystallographic preferred orientations. However, since fine-grained polymineralic aggregate is lenticular and isolated in plagioclase aggregate, the rheology of the Pankenushi gabbro mylonite is likely controlled by plagioclase deforming by dislocation creep.

A phase transformation reaction from spinel lherzolite to plagioclase lherzolite occurred at pressures of 700-1000 MPa and temperatures of 760-960 degrees centigrade in the Uenzaru lherzolite mylonite in the Hidaka metamorphic belt, and strain localization into fine-grained (smaller than 50 microns) polymineralic aggregate composed of olivine, plagioclase and spinel derived from the reaction products is observed (Furusho and Kanagawa, 1999). Olivine aggregate making up ca. 20% of the mylonite is deformed by dislocation creep, because its olivine grains exhibit a distinct crystallographic preferred orientation. In contrast, fine-grained polymineralic aggregate composing ca. 50% of the mylonite is deformed by grain boundary sliding, because olivine and plagioclase grains are equant and exhibit random crystallographic preferred orientations. Fine- grained polymineralic aggregate forms layers in the mylonite, and likely controls its rheology.

Thus reaction products flow superplastically by grain boundary sliding where mylonites are developed associated with chemical reactions as shown above, and may control the rheology of the mylonites if they make up a significant volume.