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Mass transfer and reaction paths in alteration zones around carbonate veins in the Nishisonogi Metamorphic Rocks, southwest Japan

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ABSTRACT

This paper describes local mass transfer and fluid-rock interaction in epidote-blueschist subfacies basic schist around retrograde dolomite + calcite veins in the Nishisonogi Metamorphic Rocks, southwest Japan. The veins have alteration zones on both sides. The mineralogical and chemical changes during alteration were documented along two sample traverses normal to the veins. Approaching the veins, the peak metamorphic assemblage (winchite + epidote + chlorite + calcite + albite + quartz) has been modified by progressive breakdown of amphibole, epidote, and calcite to illite and dolomite. Mass-balance calculations using the isocon method reveal that CO_2 and K were added to the basic schists, and Ca was removed during alteration. The mass balance does not hold for these components between the vein + alteration zone and protolith as a whole. These findings suggest that the vein formation and metasomatism represent a process driven by fluid flow and long-distance element transport. Possible reaction paths between the vein-fluids and basic schists were estimated from the progressive change of mineral assemblages in the alteration zones. The phase relations on ionic activity diagrams indicate an increase in $\log f_{CO_2}$ and decreases in $\log(a_{Ca^{2+}}/\sigma_{Ca^{2+}}a_{H^+}^2)$ and $\log(a_{Mg^{2+}}/\sigma_{Mg^{2+}}a_{H^+}^2)$ with progress of the alteration. Although a change in $\log(a_{K^+}/\sigma_{K^+}a_{H^+}^2)$ is poorly constrained on the activity diagrams, the mass balance suggests a concentration gradient of K across the alteration zones. Hence, the reaction paths and mass balance calculations suggest that a combination of the concentration gradients of CO_2, Ca, Mg, and K produced by the vein-fluids drove the alteration process.