Oxygen isotope constraints on the quilibration of radiogenic isotope systems in minerals: Implications for metamorphic geochronology

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Mineral Sm-Nd and Rb-Sr isochrons have been frequently utilized to determine the age of metamorphic events. However, difficulties have been encountered in dating high to ultrahigh pressure metamorphic rocks. A potential problem concerning validity of the mineral isochrons is whether the radiogenic isotope systems have achieved thermodynamic equilibrium at a given metamorphic event and preserved the equilibrium since it. An open question is how to identify the equilibrium or disequilibrium of radiogenic isotope systems in minerals when the mineral isochron ages are applied to interprete the tectonic evolution of metamorphic terranes. An assessment of oxygen isotope fractionations between isochron minerals can provide a powerful means to make a distinction between them.

Oxygen and Sm-Nd isotopic ratios have been measured on the same mineral separates of omphacite and garnet from a number of eclogites in the Dabie-Sulu orogen, East China. The results illustrate the two clear categories: (1) reasonable ages of the mineral Sm-Nd isochron are obtained in the samples which show oxygen isotope equilibrium between omphacite and garnet; (2) unreasonable ages of the mineral Sm-Nd isochron are yielded in the samples which show significant oxygen isotope disequilibrium between the isochron minerals.

In order to understand the diffusivity of oxygen and neodymium in the metamorphic minerals, the same specimen of the eclogites was cut into two parts for the isotopic analyses. The results show that the rates of oxygen isotope exchange by diffusion between the minerals are comparable with those of neodymium diffusion in the same minerals at high to ultrahigh pressures. The lack of fluid and short time during prograde metamorphism are the basic reasons to result in the O and Nd isotopic disequilibrium between the isochron minerals.