Relict edenite in a garnet lherzolite from the Chinese Su-Lu UHP metamorphic terrane: Implications for metamorphic history

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ABSTRACT

Study of mineral inclusions in garnet in orogenic peridotites provides important information on their metamorphic history. Similar study of mineral inclusions in pyroxene is also encouraging. Edenite is found as relict inclusions in phlogopite-clinopyroxene intergrowths forming the cores of clinopyroxene porphyroblasts in a garnet lherzolite at Zhimafang in the Chinese Su-Lu ultrahigh-pressure metamorphic terrane. Texture shows that the phlogopite and clinopyroxene were products of the breakdown of edenite. The composition of the edenite is represented by K-Ed$_{6.0}$Ed$_{0.7}$Fe-Ed$_{6.6}$Ts$_{0.4}$Fe-Ts$_{0.4}$Tr$_{0.2}$Cm$_{0.4}$. Those of the clinopyroxene and phlogopite are, Ur$_{4.5}$Jd$_{3.7}$Ae$_{6.5}$CaTs$_{2.2}$Di$_{8.1}$En$_{8.9}$ and Phl$_{86.0}$Na-Phl$_{13.3}$Na-An$_{0.7}$, respectively. The edenite breakdown is accompanied by gains of Ca, Si, and Cr, and losses of H, Mg, Al, Fe, Na, and K. The hypothetical composition of clinopyroxene resulting from isothermal breakdown of edenite is higher in Jd, CaTs, and En but lower in Di components than the cores of clinopyroxene porphyroblasts. The calculated mode of phlogopite is much higher than measured. The gain of Si and loss of H can be explained by involvement of SiO$_2$-enriched fluids during formation of the Cpx+Phl intergrowth, whereas the other gains and losses suggest the existence of an older generation clinopyroxene slightly more enriched in Ca and Cr and depleted in Na, Mg, and Al, which homogenized with the clinopyroxene produced by the breakdown of edenite. Interaction with fluids also increased the Ca/Mg ratio of the system. It is suggested that, after having been exhumed to a shallow level for the first time, the peridotite was infiltrated by crust-derived fluids resulting in the replacement of clinopyroxene by edenite. During subduction, the edenite was replaced by clinopyroxene + phlogopite. Relics of edenite in clinopyroxene were able to survive ultrahigh-pressure metamorphism.

INTRODUCTION

It is widely recognized that the study of mantle-derived garnet peridotites in ultrahigh-pressure (UHP) metamorphic terranes is important for our understanding of the evolution of orogenic belts. However, little is known about the early history of these rocks, such as how they were incorporated into orogenic belts from the mantle. Detailed petrological study and reliable metamorphic $P$-$T$ paths are needed for elucidating the problem. Much can be learned from careful petrographic study on mineral inclusions in UHP metamorphic minerals. Examples of such studies include those of Carswell et al. (1983), Jamtveit (1984), and Yang and Jahn (2000), who observed low-pressure mineral assemblages in garnet and deduced segments of prograde $P$-$T$ paths for mantle-derived garnet peridotites. Based on the observation of hydrous silicate and spinel inclusions in garnet, Yang and Jahn (2000) showed that the garnet peridotites at Zhimafang in the Chinese Su-Lu UHP metamorphic terrane were first emplaced from the upper mantle at a shallow level [lower crust or the “magic corner” in mantle wedge (Davies and Stevenson 1992)], and then later subducted to great depths during the Triassic collision between the Sino-Korean and the Yangtze cratons. A similar study of pyroxene also exists (e.g., Yamaguchi et al. 1978), although more examples are awaited. In this report, the occurrence of relict edenite in an unusual phlogopite + clinopyroxene intergrowth forming the cores of clinopyroxene porphyroblasts is documented. The texture, along with the field relationship with country-rock gneiss, strengthens the suggestion that the Zhimafang garnet peridotites were once emplaced to a shallow level from the upper mantle and experienced a subduction history, rather than being in the hanging wall (mantle wedge) at the time of UHP metamorphism. Fluid-rock interactions took place within the subducted slab.

SAMPLE DESCRIPTION

The peridotite bodies at Zhimafang in the Su-Lu terrane are enclosed in quartzofeldspathic gneiss and have been serpentinitized while on the surface. The edenite-bearing garnet lherzolite samples were collected from fragments of old drill cores. The UHP mineral assemblage of the lherzolite consists mainly of olivine, garnet, orthopyroxene, clinopyroxene, and phlogopite, with minor magnesite and titanian clinohumite. Garnet porphyroblasts contain trails of minute mineral inclu-