First record of K-cymrite in North Qaidam UHP eclogite, Western China

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ABSTRACT

Inclusions of polycrystalline K-feldspar aggregates after K-cymrite (KAlSi8O20·nH2O) were discovered in garnet from a Dulan eclogite in the Qaidam ultrahigh-pressure (UHP) terrane, western China. The eclogite consists of garnet (Alm80Gr56Prp5Sp80), omphacite (Jd86Aeg35Aug16), and minor rutile and apatite. The 20 to 200 μm inclusions vary in shape from prismatic, hexagonal to rounded, and exhibit palisade and mosaic textures. Host garnets show radial fractures, similar to those surrounding quartz pseudomorphs after coesite. Some inclusions consist of almost end-member K-feldspar (Or80Ab20) polycrystalline aggregates, whereas others are composed of >90 vol% K-feldspar (Or60Ab40) with minor secondary albite occurring along the margins of the inclusions. Raman spectra of K-feldspar crystalline aggregates vary slightly reflecting various degrees of Si-Al ordering, and show a Raman peak at ~390–395 cm⁻¹, typical for cymrite structure. These characteristics of the K-feldspar polycrystalline inclusions imply the presence of former K-cymrite in the Dulan eclogite formed at >3 GPa at ~720 °C. The occurrence of K-cymrite in UHP eclogite is significant because of its potential as an important carrier of crustal K and H2O to the upper mantle.

Keywords: K-cymrite, K-feldspar, inclusion, eclogite, Raman spectrum, North Qaidam UHP terrane

INTRODUCTION

Since the discovery of coesite in Dora Maira and the Western Gneiss Region of Norway (Chopin 1984; Smith 1984), more than 20 ultrahigh-pressure (UHP) metamorphic terranes have been identified (Liou et al. 2007). Extensive studies of high-pressure (HP) and UHP rocks provide invaluable information about mountain-building processes. An UHP terrane in northern Qaidam, northwest China, was recently identified by the discoveries of coesite inclusions in zircon from the country rock gneiss of Dulan eclogite (Yang et al. 2002; Song et al. 2003) and diamond inclusions in zircon from the Luliangshan garnet lherzolite (Song et al. 2005) (Fig. 1).

High-pressure experiments indicate that some hydrous potassic silicates are stable at high pressure. For example, phengite is stable from 5.5 to 11 GPa at 900 °C (Domanik and Holloway 1996), and K richterite is stable at 6–7 GPa (Konzett and Ulmer 1999). A recent experimental study reversed the upper pressure stability limit of potassium amphibole at 13–15 GPa at ≤1400 °C (Konzett and Fei 2000). K-cymrite (KAlSi8O20·nH2O) and K-hollandite (K4Al8Si8O24) are two additional potassic phases stable at deep mantle conditions (Harlow and Davies 2004). K-cymrite (Kcym) was first synthesized by Seki and Kennedy (1964) at high P, according to the reaction Kcym = K-feldspar + H2O between 300–800 °C; subsequent experiments defined its stability from 2.5 GPa at 400 °C (Massonne 1991; Fasshauer et al. 1997; Thompson et al. 1998) to 9 GPa at 1200 °C (Massonne 1991; Harlow and Davies 2004). K-hollandite is stable over a wide P-T range from ~9 GPa at 1000 °C to >95 GPa at 2300 °C (Harlow and Davies 2004).

Kokchetavite, a new potassium-feldspar polymorph (anhydrous K-cymrite) with a hexagonal structure, was first discovered in natural rocks as composite inclusions (kokchetavite ± siliceous glass ± cristobalite/quartz) in garnet and clinopyroxene from a garnet-pyroxene rock, and in clinopyroxene from a dolomitic marble from the Kokchetav Massif, Kazakhstan (Hwang et al. 2004). Polycrystalline inclusions of “K-feldspar + quartz” in eclogitic garnet or omphacite have been reported from several UHP terranes, such as Sulu, eastern China, (Yang et al. 1998; Enami et al. 1993; Okay 1993), Erzgebirge, Germany (Schmädicke 1991; Massonne 1993; Massonne et al. 2004), and Northern Qaidam, China (Song et al. 2003). The origin of “Kfs + Qtz” inclusions in eclogitic garnet or omphacite has been attributed to exsolution of KAI8Si8O24 component from former K-bearing omphacite.

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FIGURE 1. Simplified geologic map of the Northern Qaidam UHP terrane showing study area (Dulan).