American Mineralogist, Volume 109, pages 439–448, 2024

A revisit to the phase transition behavior of K-feldspar at high-pressure and high-temperature: Implications on metastable K-feldspar in cold subduction

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Abstract

Felsic gneiss is a major type of ultrahigh-pressure metamorphic rock in continental subduction zones. As an important mineral of felsic gneiss, the phase behavior of K-feldspar is of great significance for studying subducting seismic activities, crust-mantle interactions, and plate tectonics in the Earth's interior. In this study, we investigated the phase relations in K-feldspar using Raman spectroscopy combined with externally heating diamond-anvil cell (DAC) under high-pressure (28 GPa), high-temperature (400 °C), and simultaneous high pressure-temperature (*P-T*) (14 GPa, 430 °C) conditions. The phase diagram of K-feldspar at relatively low temperatures has been constructed, and together with previous results, a more comprehensive *P-T* phase diagram of K-feldspar is established. K-feldspar undergoes a reversible phase transition from $C\bar{1}$ to $P\bar{1}$ (metastable K-feldspar) symmetry at 10.3 GPa. Metastable K-feldspar is an intermediate phase from K-feldspar to K-holl-I ($KAlSi_3O_8$ with a hollandite-I structure) in extremely cold subduction slabs (<2 °C/km) or the center of some old, cold, and rapidly subducting slabs. Metastable K-feldspar is stable even at 11.4 GPa and 400 °C in enriched hydroxyl group (OH) environments, which shows greater high-*P-T* stability than K-feldspar. Thus metastable K-feldspar could withstand subduction-zone fluids, low-temperature metamorphism, and survive to deeper than previously expected. These results enhance our understanding of the formation paths and conditions of K-holl-I, the subducted depth of K-feldspar, the effect of subduction-zone fluids on continental subduction, and provide a possible reason for the origin of intermediate- and deep-focused seismicity.

Keywords: Metastable K-feldspar, Raman spectroscopy, high-pressure-temperature conditions, continental subduction, subduction-zone fluids; Physics and Chemistry of Earth's Deep Mantle and Core