INTRODUCTION

Coesite is a key index mineral used to define ultrahigh-pressure (UHP) metamorphic conditions (Liou et al. 1998) and the areal extent of UHP metamorphism in orogenic belts (Tabata et al. 1998; Parkinson and Katayama 1999; Ye et al. 2000). Coesite and its pseudomorph are easy to identify by optical means in UHP rocks. However, because of the extensive retrogression, no index UHP phases can be identified by optical methods in the Dabieshan-Sulu regional country gneisses (Carswell et al. 2000). Recent investigations have shown that zircon is a promising rigid vessel for the preservation of primary UHP phases. Laser Raman microspectroscopy has frequently been used to identify minute coesite and quartz inclusions in zircon of gneissic rocks from several UHP terranes (Soblev et al. 1992; Tabata et al. 1998; Parkinson and Katayama 1999; Ye et al. 2000).

Coesite and α-quartz are distinguishable by their diagnostic Raman spectra. Coesite is characterized by a strong band at 521 cm⁻¹, together with other weaker bands at 116, 151, 176, 269, 326, 355, and 427 cm⁻¹ at room temperature and atmospheric pressure (Hemley 1987; Sharma et al. 1981; Boyer et al. 1985). The main band of α-quartz is located at 464 cm⁻¹ with subsidiary bands at 128, 206, and 355 cm⁻¹. However, the Raman spectra of coesite included in unfractured zircons often show a shift to higher frequency (Tabata et al. 1998; Parkinson and Katayama 1999; Ye et al. 2000).

Parkinson and Katayama (1999) reported that the 521 cm⁻¹ spectra of “pure monocrystalline” coesite inclusions in unfractured zircon and garnet of UHP metamorphic rocks show consistent shifting to 525–526 cm⁻¹. Raman spectra of coesite and quartz demonstrated a systematic pressure-dependent shift in a series of experiments by Hemley (1987). Based on the pressure calibration of Hemley (1987), Parkinson and Katayama (1999) deduced present-day ultrahigh overpressures (19–23 kbar) in coesite inclusions in unfractured zircon and garnet. Applying an elastic model, which was developed to explain the preservation of coesite inclusions in rigid-host containers (Gillet et al. 1984; van der Molen and van Roermund 1986), they concluded that the host mineral exerts an overpressure on the coesite inclusion, constraining it on, or close to, the coesite-quartz equilibria boundary, and the overpressures inhibited the coesite-quartz transformation during the exhumation of the host rocks.

Recently, we systematically analyzed Raman spectra of more than 120 coesite inclusions in zircons of various gneissic rocks from the Dabieshan and Sulu UHP terranes in eastern China. Various (0–24 kbar) present-day overpressures are deduced in coesite and its pseudomorph inclusions in zircons. Our new data indicate that the overpressures are induced by various degrees of the coesite-quartz transition, and the need for the elastic model is underscored. Effects of fluids on the coesite-quartz transition inside zircon and the P-T paths of the coesite inclusions during exhumations are discussed.

ABSTRACT

More than 120 coesite and few polycrystalline quartz (coesite pseudomorph) inclusions were identified by Raman microspectroscopy in zircons of various kinds from gneissic rocks located in the Dabieshan and Sulu ultrahigh-pressure (UHP) metamorphic terranes in eastern China. The coesite inclusions have undergone, to various degrees, the coesite-quartz transition. Raman spectra of coesite and subsidiary quartz inclusions show various shifts, which are closely correlated to the extent of the transition. The coesite-pseudomorph inclusions in zircon show the highest Raman shift. Calibrations based on the experimental work of Hemley (1987) yielded inconsistent present-day overpressures (0–24 kbar) in coesite inclusions inside zircons. The availability of fluids, which resulted in the pervasive regional retrogression of the UHP gneisses during later exhumation stages, is regarded as the main factor controlling the extent of the coesite-quartz transition. This study underscores the need for the elastic model applied by previous researchers to explain the preservation of the coesite inclusions in rigid host minerals.