Coexisting retrograde jadeite and omphacite in a jadeite-bearing lawsonite eclogite from the Motagua Fault Zone, Guatemala

TATSUKI TSUJIMORI,* JUHN G. LIOU, AND ROBERT G. COLEMAN

Department of Geological and Environmental Sciences, Stanford University, Stanford, California 94305, U.S.A.

ABSTRACT

Coexisting jadeite and omphacite were found as retrograde minerals in a jadeite-bearing lawsonite-eclogite from the Motagua Fault Zone, Guatemala. The lawsonite-eclogite is characterized by the occurrence of garnet porphyroblasts up to 2.5 cm in size, and the eclogite-facies parageneses, almandine-rich garnet + impure jadeite + lawsonite + rutile + quartz; garnet contains inclusions of impure jadeite, phengite, ferroglaucophane, chlorite, lawsonite, rutile, ilmenite, and quartz. Textural relations and parageneses and compositions of minerals indicate that the lawsonite-eclogite experienced two stages of metamorphism: prograde eclogite-facies stage (M1) and retrograde stage (M2). The impure jadeite (Jd-I) of the M1 eclogite-facies occurs in both the matrix and as inclusions in garnet, and contains considerable amounts of augite and aegirine components (Jd61-75Aug16-24Ae0-18). It is partly recrystallized into retrograde M2 jadeite (Jd74Aug916Ae011) and omphacite (Jd42Aug36Ae716); some of these two sodic pyroxenes may have crystallized from fluids. Both M1 jadeite and omphacite show textural equilibrium and are believed to have grown concurrently. Based on the observed compositions and the phase relations of sodic pyroxenes from Carpenter (1980), the M1 impure jadeite (Jd-I) may have had a disordered C2/c symmetry at T = ca. 450 °C and P = ca. 1.8–2.4 GPa, and was subsequently crystallized into jadeite (Jd-II) plus ordered P2/n omphacite during retrogression with infiltration of fluids at T < ca. 300 °C and P = ca. 0.7 GPa (M2). The extreme low-T conditions during retrogression may have prevented reaction between eclogitic jadeite and adjacent minerals. Instead, eclogitic impure jadeite (plus fluid) has recrystallized into the retrograde jadeite + omphacite pair with a wide compositional gap.

INTRODUCTION

Jadeitic pyroxene is ubiquitous in a variety of high-pressure (HP) and ultrahigh-pressure (UHP) metamorphic rocks; its parageneses and compositions often have been used to characterize HP-UHP rocks. Blueschist- and eclogite-facies clinopyroxenes are composed mainly of jadeitic and augitic components with minor amounts of an aegirine component (e.g., Maruyama and Liou 1987). Miscibility regions between jadeitic pyroxene (C2/c)-omphacite (P2/n) and augitic pyroxene (C2/c)-omphacite (P2/n) have been recognized along the augite [Ca(Mg,Fe)Si2O6]-jadeite (NaAlSi2O6) join (Carpenter 1980). Coexisting pairs of augitic pyroxene + omphacite have been reported from some blueschist-facies rocks (e.g., Enami and Tokonami 1984; Tsujimori 1997; Tsujimori and Liou 2004). On the other hand, coexisting jadeitic pyroxene and omphacite pairs in natural parageneses are rare except in jaditeites (e.g., Harlow 1994); hence the nature and extent of the jadeitic pyroxene–omphacite miscibility gap remains uncertain. Because there are no experimental studies to constrain the miscibility gap at low-T (<400 °C), the occurrence of pyroxene pairs in nature is the only way to deduce the shape of the miscibility gap and to evaluate the theoretically proposed phase diagram.

As this paper newly reports, coexisting pairs of jadeitic pyroxene and omphacite occur as inferred retrograde products of impure jadeite in a sample of jadeite-bearing, lawsonite-eclogite from the Motagua Fault Zone in Guatemala. The eclogite from this locality contains impure jadeite instead of omphacite, in addition to garnet, rutile, lawsonite, and quartz as inferred peak-stage minerals. During retrogression (accompanied by deformation), the impure jadeite partly recrystallized to a jadeite + (minor) omphacite pair corresponding to the possible miscibility gap. In this paper, we describe the parageneses and compositions of sodic pyroxenes formed during prograde and retrograde recrystallization. Mineral abbreviations are after Kretz (1983) excepting aegirine (Ae), ferroglaucophane (Fgl), and phengite (Phe) throughout this paper.

GEOLOGIC SETTING

The Motagua Fault Zone (MFZ) is part of the suture zone juxtaposing the Maya and Chortís continental blocks in Guatemala. The left-lateral, strike-slip faults of the MFZ separate the present-day North American plate from the Caribbean plate. An eastern extension of the MFZ crosses the Caribbean Sea and lies along the Swan Islands fracture zone. Along the MFZ of central Guatemala, serpentinite bodies are exposed on either side of the Río Motagua (e.g., Beccaluva et al. 1995; Harlow et al. 2003). The jadeite- and other HP rocks to the north of the MFZ yield phengite...