INTRODUCTION

Although not commonly reported in the Appalachians of the southeastern U.S.A., margarite [CaAl₂(Al₂Si₂)O₁₀(OH)₂] is widespread in greenschist-facies metamorphic rocks worldwide. However, few if any occurrences appear to be as rich in margarite as the margarite-corundum phyllites from the Charlotte belt (Central Piedmont) of South Carolina (Ranson and Stuart 1992). This margarite-rich assemblage is also noteworthy because it contains unusually large porphyroblasts of corundum that are reacting to margarite at their margins. This calcic and aluminous bimineralic assemblage represents the result of a complex geologic history involving hydrothermal alteration, metamorphism, and metasomatism. The assemblage provides an unique opportunity to study a nearly pure system relatively free from the usual solid solutions that characterize most silicate minerals. The aim of this work is to understand the conditions of pressure, temperature, and fluid composition under which these rocks were metamorphosed. The study focuses on three questions: (1) the nature and origin of the protolith; (2) the conditions of metamorphism resulting in the production of the margarite-corundum assemblage; and (3) the nature of the metamorphic reactions by which corundum broke down to form margarite.

The occurrence of the assemblage margarite-corundum appears to be unique in the piedmont of South Carolina. Although Sloan (1908) cites twelve deposits of corundum in the crystalline rocks of the state in addition to the present locality, there is no mention of associated margarite. This lack of reported margarite may be in part because of the difficulty in distinguishing margarite from muscovite in hand specimen. Certainly aluminous assemblages are common in the metamorphic belts of the southern Appalachians. Notably, in the Kings Mountain belt of South Carolina just to the west, there are deposits of andalusite, sillimanite, and kyanite, many of which have been mined (Espenshade and Potter 1960). To the east in the Carolina slate belt, there are high-alumina deposits of primarily kaolinite, pyrophyllite, and Al hydroxides (Schmidt 1985).

REGIONAL GEOLOGY

Margarite-corundum phyllites occur at the site of an old corundum mine, the Rickard Mine, in the Charlotte belt of northern York County, South Carolina (Fig. 1). The Charlotte belt is part of the Central Piedmont (Butler and Secor 1991), which was developed as part of an exotic terrane, the Carolina terrane (Secor et al. 1983). King (1955) defined the Charlotte belt as “dominantly plutonic” with intrusive rocks ranging in composition from gabbro to granite. The margarite-corundum assemblage, previously recognized as corundum-muscovite schist (Brazell 1984), occurs only in float as dense cobbles and boulders ranging in size from less than 1 cm up to 50 cm in long

ABSTRACT

Phyllites from the Charlotte belt (Central Piedmont) of South Carolina contain porphyroblasts of black corundum in a matrix of margarite and minor muscovite. The margarite-corundum phyllites formed during Ordovician (?) amphibolite facies metamorphism of an aluminous protolith with a probable mineralogy of pyrophyllite, diaspore, and calcite through reactions such as 6Dia + Prl + 2Cal = 2Mrg + 2CO₂ + 2H₂O and 2Dia = Crn + H₂O. The protolith is believed to have consisted of about 7 mol% calcite, 23 mol% pyrophyllite, and 70 mol% diaspore. A T-X_CO₂ plot of pertinent reactions in the system CaO-Al₂O₃-SiO₂-H₂O-CO₂ shows that in the presence of an H₂O-rich fluid (X_CO₂~0.08) margarite began forming by the reaction 6Dia + Prl + 2Cal = 2Mrg + 2CO₂ + 2H₂O at about 350 °C at 5 kbar. This reaction continued along a univariant path until pyrophyllite and calcite were consumed. The remaining diaspore was converted to corundum by the reaction 2Dia = Crn + H₂O at about 430 °C for this H₂O-rich fluid at 5 kbar. The upper temperature limit of this assemblage is constrained by the reaction Mrg = Crn + An + H₂O, which should occur at about 575 °C under this pressure. The absence of plagioclase in these rocks suggests that the conditions of this reaction were never achieved. Fluids associated with subsequent Alleghanian greenschist facies metamorphism reacted with corundum to form fine-grained margarite at corundum margins.

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