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Margarite-corundum phyllites from the Appalachian orogen of South Carolina: Mineralogy and metamorphic history

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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 + $2CO_2$ + $2H_2O$ and 2Dia = Crn + H_2O. The protolith was probably a hydrothermally altered felsic tuff of Late Proterozoic to Cambrian age. Based on a whole-rock chemical analysis of margarite-corundum phyllite, the protolith is believed to have consisted of about 7 mol% calcite, 23 mol% pyrophyllite, and 70 mol% diaspore. A T-X_{CO_2} plot of pertinent reactions in the system CaO-Al_2O_3-SiO_2-H_2O-CO_2 shows that in the presence of an H_2O-rich fluid (X_{CO_2}~0.08) margarite began forming by the reaction 6Dia + Prl + 2Cal = 2Mrg + $2CO_2$ + $2H_2O$ 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 + H_2O at about 430 °C for this H_2O-rich fluid at 5 kbar. The upper temperature limit of this assemblage is constrained by the reaction Mrg = Crn + An + H_2O, 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.