PROGRESSIVE METAMORPHISM OF PELITIC SCHISTS FROM THE TRI-STATE, MA, CT and NY, AREA: A FIELD AND THEORETICAL ANALYSIS OF GARNET + CHLORITE + CHLORITOID + BIOTITE ASSEMBLAGES

by

Ping Wang

A Dissertation

Submitted to the State University of New York at Albany

in Partial Fulfillment of

the Requirements for the Degree of

Doctor of Philosophy

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ABSTRACT

The prograde evolution of mineral assemblages in metapelites of a Barrovian sequence from the tri-state area (Massachusetts, Connecticut and New York) of the southern Taconic Range shows the displacement of the assemblages Ga+Ch+Ct+Bi, Ga+Ch+Ct+St, and Ga+Ch+Bi+St, displaying the reaction sequence [St] -> [Bi] -> [Ct].

Detailed petrologic observations on Ga+Ch+Ct+Bi assemblages show: (1) garnet high in Mn and Fe but low in Mg can be stable with chlorite at low grades before the stability of the Ct+Bi join; (2) such garnet reacts partially to form Ct+Bi at intermediate grades; and (3) at higher grades after the Ct+Bi join has been broken garnet resumes growth with a higher Mg/Mn ratio and coexists with chlorite. Garnet zoning and systematic mineral compositions suggest that (1) in the KFMASH system Ga+Ch is stable at higher T than Ct+Bi via the discontinuous Fe-Mg reaction Ct+Bi => Ga+Ch (2) Ct+Bi is stable at higher T than Ga+Ch via the same reaction in the MnKFASH system, and the Fe-Mn discontinuous reaction is Ga+Ch => Ct+Bi; and (3) in the MnKFMASH system, Ga+Ch may be stable at higher or at lower T than Ct+Bi depending on the effective bulk Mn-content of the rock.

A petrogenetic grid and associated T-X diagrams for the above mineral assemblages are modeled thermodynamically in the MnKFMASH system using the Gibbs method. The [As, Cd] invariant point is calculated to be at about P = 6.5±1.0 kbar and T = 540±50 ^{o}C. The topology of the univariant curves around the invariant point [As, Cd] in the KFMASH system is different from published ones. The stable part of the univariant curve [St] is shown to radiate upwards in the same direction as those of [Bi] and [Ct]. In the KFMASH system, the predicted [St] reaction is Ct+Bi => Ga+Ch, with Ga+Ch stable at high T. In the MnKFASH system, however, the predicted reaction is Ga+Ch => Ct+Bi. These results are contrary to previous work, but consistent with the petrologic observations of this study.

This thesis emphasizes the following important effects of the "extra" component, Mn, in the KFMASH system: (1) Mn allows the reaction sequence [Bi] -> [Ct] to occur in lower P/T terranes; (2) Mn allows the mineral assemblages Ga+Ch+Ct+Bi and Ga+Ch+Ct+St assemblages to be stable at lower T; (3) Mn allows the assemblage Ga+Ch+Bi+St to be stable at higher T; and (4) most importantly, Mn causes the [St] reaction directions to be reversed.

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abbr.	mineral
Ab	albite
Alm	almandine
An	anorthite
Ad	andalusite
Ann	annite
As	aluminum silicates
Bi	biotite
Cc	calcite
Cd	cordierite
Cela	Celadonite
Ch	chlorite
Ct	chloritoid
Ep	epidote
Ga	garnet
Grs	grossular
Hem	hematite
Ilm	ilmenite
Ksp	potassium feldspar
Ky	Kyanite
Mu	muscovite
Mt	magnetite
Pg	paragonite
Phl	phlogopite
Pl	plagioclase
Prl	pyrophyllite
Pyp	pyrope
Qz	quartz
St	staurolite
Sil	sillimanite
Sps	spessartine
Tur	tourmaline
W	water
Zrn	zircon