

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

College of Science and Mathematics  
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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  $Ct+Bi \Rightarrow Ga+Ch$  (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  $Ga+Ch \Rightarrow Ct+Bi$ ; 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  $P = 6.5 \pm 1.0$  kbar and  $T = 540 \pm 50$  °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  $Ct+Bi \Rightarrow Ga+Ch$ , with Ga+Ch stable at high T. In the MnKFASH system, however, the predicted reaction is  $Ga+Ch \Rightarrow Ct+Bi$ . 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]  $\rightarrow$  [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.

## ACKNOWLEDGEMENTS

The author has had the great pleasure and privilege to conduct his doctoral studies under the guidance of Dr. Frank Spear, and the aegis of Dr. Mark Harrison. They acted not only as teachers, but as friends as well. Their recognition of the importance of this work and their direction of the avenue to the completion of this dissertation were essential to the present presentation. Great benefits have been obtained through their colorful lectures, patient advice and friendly discussion. Their profound thinking has greatly influenced the author and will benefit his career. Their valuable time, helpful advice and thoughtful consideration are greatly appreciated. Their kind financial support in probe work and for the presentations at professional meetings are also deeply acknowledged. This dissertation would have been impossible to completed this without any of their kind and friendly hands. Their friendship will always be remembered.

The writer appreciates the other dissertation committee members, Drs. Bill Kidd and George Putman, for their kind advice, help and critical suggestions.

The writer would like to thank the Department Chairman, Dr. Steve Delong, and Dr. Winthrop Means of the graduate

committee for the benefit of their lectures, kindly discussions and the financial aid during the four-year Ph.D studies at the State University of New York at Albany. Funding through a SUNY Benevolent Fellowship is also gratefully acknowledged. Great appreciation is also due to the department secretary, Diana Paton, who always was of great help to the author.

The friendly help given in various ways from all the other faculty members, staff and fellow students at SUNY/Albany and Rensselaer Polytechnic Institute is also gratefully acknowledged. It is virtually impossible to adequately thank and acknowledge all of the people who have contributed to the completion of this dissertation, but I thank them all very much.

## CONTENTS

	Page
ABSTRACT.....	iii
ACKNOWLEDGEMENTS.....	v
LIST OF FIGURES.....	ix
LIST OF TABLES.....	xii
LIST OF PLATES.....	xiii
1. INTRODUCTION.....	2
2. METHODS OF STUDY.....	5
3. GEOLOGICAL SETTING.....	6
4. ISOGRADS, METAMORPHIC ZONES AND MINERAL ASSEMBLAGE.....	13
5. MINERALOGY.....	19
6. P-T CALCULATIONS.....	32
7. IMPLICATIONS OF MICROSCOPY AND MICROPROBE ANALYSIS ON METAMORPHIC REACTIONS.....	35
7.1 Reactions in grades lower than Ga-Ch-Ct-Bi isograd.....	35
7.1.1 Reactions in the chloritoid zone.....	35
7.1.2 Reactions in the garnet zone.....	37
7.1.3 Reactions in the lower biotite zone.....	41
7.1.4 Comparision of the systematic change of Fe, Mg and Mn for the assemblages below the Ga-Ch-Ct-Bi zone.....	43
7.2 Reactions in the assemblage Ga+Ch+Ct+Bi.....	46
7.2.1 Sample 282-2.....	46
7.2.1.1 Evidence of three-stage-growth of garnet. ....	46
7.2.1.2 Further discussions.....	65
7.2.2 Sample 106-3.....	67
7.2.3 Mn-Fe-Mg projections.....	78
7.2.4 Mass balance.....	83
7.2.5 Summary of petrologic observations.....	85
7.3 Reactions in the assemblage Ga+Ch+Ct+St.....	86

7.4	Reactions in the assemblage Ga+Ch+Bi+St.....	105
8.	THERMODYNAMIC MODELINGS: GIBBS METHOD CALCULATION.....	123
8.1	General comment.....	123
8.2	P-T grid for assemblage Ga-Ch-Ct-Bi-St in the KFMASH system.....	133
8.2.1	The topology of petrogenetic grid in the KFMASH system.....	133
8.2.2	The effect of $P(\text{H}_2\text{O}) < P(\text{total})$ on the topology of grid.....	138
8.3	P-T space for 4-AFM-mineral assemblages in the MnKFMASH system.....	139
8.4	P-T grid and T-X diagrams in KFASH, KMASH and MnKASH sub-systems.....	145
8.5	Modeling on the effect of Mn on the stability field of mineral assemblages.....	163
8.5.1	The effect of Mn on three-AFM-phase assemblages.....	163
8.5.2	The effect of Mn on invariant and univariant AFM assemblages.....	171
8.5.3	The effect of Mn on reaction sequence.....	177
9.	DISCUSSIONS: COMPARISON OF FIELD STUDY AND THERMODYNAMIC MODELS.....	181
9.1	Further discussion on the Ga+Ch+Ct+Bi parageneses.....	181
9.1.1	Implication of T-X relationships.....	181
9.1.2	Implication of Mn-Fe-Mg projections.....	182
9.1.3	Implication of petrogenetic grids.....	182
9.1.4	The effect of $P(\text{H}_2\text{O})$ .....	193
9.1.5	The effect of oxygen fugacity.....	193
9.1.6	Summary.....	194
9.2	The implication of thermodynamic models to the evolution of mineral assemblages.....	195
10.	CONCLUSIONS.....	200
	REFERENCES.....	203
APPENDIX I	MODEL FORMULA OF MINERALS.....	209
APPENDIX II	MICROPROBE DATA OF MINERALS FROM THE STUDY AREA.....	210



## LIST OF FIGURES

		Page
Figure 1	Geologic map of the study area.....	7
Figure 2	Schematic representation of the evolution of mineral assemblages in the study area.....	14
Figure 3	P-T conditions and P-T paths of representative samples in the study area.....	33
Figure 4	Composition profile of garnet by microprobe analysis (sample 293-1).....	39
Figure 5	Mn-Fe-Mg diagram and AFM diagram for the assemblages below the Ga-Ch-Ct-Bi isograd.....	44
Figure 6	Compositional map of garnet from probe data (sample 282-2).....	51
Figure 7	Composition profile of garnet by microprobe analysis (sample 282-2).....	55
Figure 8	Composition profile of garnet by microprobe analysis (for a small grain in sample 282-2)....	59
Figure 9	Schematic showing two scenarios for the growth history of garnet.....	62
Figure 10	Composition profile of garnet by microprobe analysis (sample 106-3).....	71
Figure 11	Composition profile of chloritoid in the matrix by microprobe analysis (sample 106-3).....	74
Figure 12	Composition profile of garnet (adjacent to chloritoid inclusions) by microprobe analysis (sample 106-3).....	76
Figure 13	Composition profile of chloritoid inclusions in garnet by microprobe analysis (sample 106-3).....	79
Figure 14	Mn-Fe-Mg projection for the assemblage Ga-Ch-Ct-Bi-Mu-Qz in the study area.....	81
Figure 15	Composition profile of garnet by microprobe analysis (sample 111-1).....	90

	Page
Figure 16	Composition profile of garnet by microprobe analysis (sample 103-4).....96
Figure 17	Stereoscopic AFMMn projection of the Ga+Ch+Ct+St assemblage.....98
Figure 18	Composition profile of staurolite by microprobe analysis (sample 111-1).....100
Figure 19	Mn-Fe-Mg and AFM diagrams for the assemblage Ga+Ch+Ct+St+Mu+Qz in the study area.....102
Figure 20	Composition profile of garnet by microprobe analysis (sample 444-14).....109
Figure 21	Composition profile of garnet by microprobe analysis (sample 124-1).....115
Figure 22	Mn-Fe-Mg and AFM diagrams for the assemblage Ga+Ch+Bi+St+Mu+Qz in the study area.....118
Figure 23	Stereoscopic AFMMn projection of the Ga+Ch+Bi+St assemblage.....120
Figure 24	Petrogenetic grid for the assemblages Ga+Ch+Ct+Bi+St+Mu+Qz+H <sub>2</sub> O in the KFMASH system at P(H <sub>2</sub> O) = P(Total).....136
Figure 25	P-T field of the assemblage Ga+Ch+Ct+Bi+Mu+Qz+H <sub>2</sub> O in the MnKFMASH system.....141
Figure 26	Calculated Mn-Fe-Mg diagram for the assemblage Ga+Ch+Ct+Bi+Mu+Qz+H <sub>2</sub> O in the MnKFMASH system.....143
Figure 27	P-T field of the assemblage Ga+Ch+Ct+St+Mu+Qz+H <sub>2</sub> O in the MnKFMASH system.....146
Figure 28	Calculated Mn-Fe-Mg diagram for the assemblage Ga+Ch+Ct+St+Mu+Qz+H <sub>2</sub> O in the MnKFMASH system.....148
Figure 29	P-T field of the assemblage Ga+Ch+Bi+St+Mu+Qz+H <sub>2</sub> O in the MnKFMASH system.....150
Figure 30	Calculated Mn-Fe-Mg diagram for the assemblage Ga+Ch+Bi+St+Mu+Qz+H <sub>2</sub> O in the MnKFMASH system.....152

		Page
Figure 31	P-T grid for the assemblages Ga+Ch+Ct+Bi+Mu+Qz+H <sub>2</sub> O in the MnKFMASH system and the sub-systems KFASH, KMASH and MnKASH at P(H <sub>2</sub> O)/P(Total).....	155
Figure 32	T-X diagrams for the assemblage Ga+Ch+Ct+Bi+Mu+Qz+H <sub>2</sub> O at P=5 Kb.....	158
Figure 33	Schematic T-X(Fe-Mg-Mn) diagram for the assemblage Ga+Ch+Ct+Bi+Mu+Qz+H <sub>2</sub> O at P=5 Kb....	161
Figure 34	T-X(Fe-Mg) diagram for the assemblage Ga+Ch+Ct+St+Mu+Qz+H <sub>2</sub> O at P=7 Kb.....	164
Figure 35	T-X(Fe-Mg) diagram for the assemblage Ga+Ch+Bi+St+Mu+Qz+H <sub>2</sub> O at P=7 Kb.....	166
Figure 36	Univariant curves for some assemblages with three AFM(Mn)-phases Ga, Ch, Ct, Bi and St (+ Mu, Qz and H <sub>2</sub> O).....	169
Figure 37	Petrogenetic grid for the assemblages with Ga, Ch, Ct, Bi, Mu, Qz and H <sub>2</sub> O in the MnKFMASH system at X(sps) = 0 and 0.1.....	172
Figure 38	Schematic P-T space showing the effect of Mn on the [As, Ad] invariant point in the KFMASH system.....	174
Figure 39	a) Schematic P-T-Mn space for the assemblage Ga+Ch+Ct+Bi+St+Mu+Qz+H <sub>2</sub> O in the MnKFMASH system; b) Mn-T space reflected from (a) at P=P <sub>0</sub> .....	178
Figure 40	Two models of petrogenetic grid for the assemblages Ga+Ch+Ct+Bi+St+Qz+Mu+H <sub>2</sub> O in the KFMASH system at P(H <sub>2</sub> O)=P(total).....	184

## LIST OF PLATES

	Page
Plate 1 Photomicrograph of a postkinematic growth of garnet.....	23
Plate 2 Photomicrograph of a subhedral garnet and the associated minerals (sample 282-2).....	47
Plate 3 Backscattered electron image of garnet (sample 282-2).....	49
Plate 4 Photomicrograph of a euhedral garnet and its inclusions (sample 106-3).....	68
Plate 5 Photomicrograph of garnet in the assemblage Ga+Ch+Ct+St from the lower Ga-Ch-Ct-St zone (sample 111-1).....	88
Plate 6 Photomicrograph of garnet in the assemblage Ga+Ch+Ct+St from the higher Ga-Ch-Ct-St zone (sample 103-4).....	94
Plate 7 Texture of the assemblage Ga+Ch+Bi+St in the lower Ga+Ch+Bi+St zone (sample 444-14).....	107
Plate 8 Texture of the assemblage Ga+Ch+Bi+St in the higher Ga+Ch+Bi+St zone (sample 124-1).....	113

Table 1. Abbreviation of mineral symbols

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