APPENDICES

Appendix 1 Results of Microscopic Observation of Thin sections (1)

First Phase

Igneous Rocks

Area	Sample No.	Rock name	Texture	Minerals																									
				Primary														Secondary and Alteration( )											
				Qz	Kf	Pl	Bt	Am	Hr	Aa	Op	Cp	Ol	Sn	Ap	Zi	M	Qz	Bt	Ac	Se	Ta	Sp	Ep	Ch	Ti	Ca	M	others
Van Yen	VFT-17	Metadolerite	oph			◎			◎								△				○			○	○	○			
	VFT-22	Metadolerite	oph			◎			◎			○					○		△	○	△			△	○	△			
	VFT-39	Altered alkari gabbro	suboph		◎					○		○					○		◎										
	VFT-47	Metadolerite	oph			◎			◎			○					○	△		○				○	○	△			
	VMT- 1	Peridotite	gra			○	○					◎	◎	△									○		△				
	VMT- 7	Peridotite	gra			○						◎	◎				○						○		○				
	VMT- 8	Dolerite	oph			◎						◎					○				○				○		○		
	VMT-10	Dolerite	oph			◎						◎					○			○				○	○	△			
	VMT-13	Metagatbro	euh gra			◎						◎					○			△				△	○	△			
	VGT- 5	Dolerite	oph			◎						◎					○			△				△	◎	△	△		
	VGT- 7	Alkari gabbro	gra	○	◎	○	○										○										△		
	VGT- 8	Metagabbro				◎		◎									○		○	○				○	○	△	△		
	VGT-13	Metagabbro	suboph			◎						◎					○				○			○	○	△			Am(○)
	VGT-26	Pegmatite		○	◎												○				△								
Western Thanh Hoa	TFT- 5	Gabbro	euh gra			◎		○			○	○	◎								△	△	○				△		
	TFT-18	Clinopyroxenite	gra			○						◎																△	Ae(△)
	TFT-22	Metagatbro	euh gra			◎			◎			○					○		△	○	○				○				
	TFT-29	Altered microdiorite	suboph	◎		○									△		△			○	△				○		○		
	TMT- 7	Granite	gra	◎	◎	◎	○										△				△				△				
	TMT-10	Granite	sub-gra	◎	◎	◎	○														△				△				
	TMT-11	Granite	gra	◎	◎	◎	○								△						△				△				
	TMR- 3	Granite	gra	◎	◎	◎	○								△	△					△								
	TGT- 6	Quartz porphyry	por	◎	○	◎	△										△				○				△	△			
	TGT-11	Metagatbro	euh gra			◎			◎								△			○					○				Cz(△)
	TNT- 7	Granite	gra	◎	◎	◎	△										△				△								Go(△)
	TNT-22	Gabbro	euh gra			◎						◎								○					○		△	△	
	TST- 8	Granite	gra	◎	◎	◎	○										△				△								

Texture: euh gra;euhedral granular,gra;granular,sub-gra;subgranular,oph;ophitic,suboph;subophitic,por;porphyritic
Abundance of mineral: ◎;abundant,○;common,△;scarce
Abbreviation: Qz;quartz,Kf;K-feldspar,Pl;plagioclase,Bt;biotite,Am;amphibole,Hr;hornblende,Aa;alkali amphibole,Op;orthopyroxene
Cp;clinopyroxene,Ol;olivine,Sn;spinel,Ap;apatite,Zi;zircon,M;opaque minerals,Ac;actinolite,Se;sericite,Ta;talc
Sp;serpentine,Ep;epidote,Ch;chlorite,Ti;titanite,Ca;carbonate minerals,Ae;aegirine,Cz;clinozoisite,Go;goethite

First Phase

Volcanic Rocks

Area	Sample No.	Rock name	Texture	Minerals																												
				Phenocryst										Groundmass								Secondary and Alteration( )										
				Qz	Kf	Pl	Bt	Am	Hr	Op	Cp	Ol	M	Qz	Kf	Pl	Bt	Cp	Ap	M	Gl	Bt	Ac	Se	Ta	Sp	Ep	Ch	Ti	Ca	Go	CM
Van Yen	VFT-15	Trachyte	tra		◎	○																		△				△				
	VFT-16	Trachyte	tra		△									△	◎	○				△				△				○				
	VFT-21	Quartz trachyte	tra											○	◎	○				○				○								
	VFT-38	Trachyte	tra											△	◎	○				△				△						△		
	VFT-44	Sheared syenite	por	○	◎									○	◎	○				△	◎			◎					△			
	VFT-48	Syenite	por		◎	○									◎	◎			△	○												
	VMT- 3	Syenite	por		○										◎	○					◎							◎	△	○		
	VMT- 4	Basalt	por							○	◎	○				◎		○		○								○				
	VMT- 9	Trachyte	tra												◎	○				○	◎			○				○	△			
	VMT-11	Syenite porphyry	por		◎	○								○	◎	○				△				△				△		△	△	
	VGT-10	Andesite	por						○					○	○	◎			△	○			△	△			○	○	△	△		
	VGT- 6	Syenite porphyry	por		◎									○	◎	○				○				△							△	△
	VGT- 1	Trachyte	por-tra		◎	○								○	◎	○												○		○		
	VGT-15	Trachyte	tra												◎	◎				○	◎						○	○				
	VGT-25	Trachyte	tra		○										◎	◎			△	○	○							○		△		
	VNT-10	Trachyte	tra												◎	○					◎						○	○	△			
Western Thanh Hoa	TFT-13	Rhyolite	por	◎		◎	○						△	○	○	◎			△	△				○								◎
	TFT-17	Syenite	por		◎						○			△	◎	◎	○		△	△				○				△		△		
	TNT- 3	Quartz porphry	por	◎		◎		○						○	○	◎				△				○			△	○				
	TNT- 6	Quartz porphry	por	◎		◎								○		○						○						△				
	TNT- 8	Rhyolite	por	◎	○	◎		○						○	○	○					◎			△								◎
	TST- 4	Quartz porphry	por	◎		◎								○	○	◎					◎			○						○		

Texture: por;porphyritic,tra;trachytic
Abundance of mineral: ◎;abundant,○;common,△;scarce
Abbreviation: Qz;quartz,Kf;K-feldspar,Pl;plagioclase,Bt;biotite,Am;amphibole,Hr;hornblende,Op;orthopyroxene,Cp;clinopyroxene
Ol;olivine,M;opaque minerals,Ap;apatite,Gl;glass,Ac;actinolite,Se;sericite,Ta;talc,Sp;serpentine,Ep;epidote
Ch;chlorite,Ti;titanite,Ca;carbonate minerals,Go;goethite,CM;clay minerals
;alteration minerals

Appendix 1 Results of Microscopic Observation of Thin sections (2)

Sedimentary Rocks

First Phase

Area	Sample No.	Rock name	Texture	Minerals																			
				Fragment							Matrix								Alteration				
				Qs	Kf	Pl	Zi	Tr	Gl	M	Qs	Kf	Pl	Se	Ap	Zi	CM	M	Se	Ca	Ox	Ti	CM
Van Yen	VNT- 2	Siltstone	clastic	○	○	○	△			△				◎			○						
	VNT- 6	Tuff breccia	clastic		○			◎	◎										△	△			
Western	TFT-19	Tuff breccia	clastic	◎	○	○					◎	◎	○		△	△		○			○	△	
Thanh Hoa	TGT- 1	Sandstone	clastic	◎	○	○				△									△				△

Abundance of mineral: ◎;abundant,○;common,△;scarce
Abbreviation: Qs;quartz,Kf;K-feldspar,Pl;plagioclase,Zi;zircon,Tr;trachyte,Gl;glass,M;opaque minerals
Se;sericite,Ap;apatite,CM;clay minerals,Ca;carbonate minerals,Ox;oxychlorite,Ti;titanite

Metamorphic Rocks

First Phase

Area	Sample No.	Rock Name	Texture	Minerals																					
				Primary																			Sec&Alt		
				Qs	Kf	Pl	Al	Bt	Am	Ac	Hr	Cp	Se	Mu	Ti	Ca	Zi	Ap	Pr	Ep	Ch	M	Se	Ch	Go
Van Yen	VFT- 6	Carbonatized tuff		○									◎			◎					○	○			
	VNT- 5	Metabasite					○			◎					△					◎	○	△			
Western	TFT-23	Metabasite				◎			◎			○	△		△							△			
Thanh Hoa	TFT-27	Sheared granulite	sheared	◎					○			◎			△	△						△			
	TFT-30	Quartz porphry	sub-gra	◎		△									△					○		△			
	TNT-12	Phyllite	shistose	◎		◎								◎	△			△				△			△
	TNT- 3	Meta-quartzite	granular	◎										○			△		△			△			
	TNT-21	Granulite	grenular			◎			◎			○										△			
	TNT-25	Hornfels	granular	◎	○	◎		◎			○						△					△	○	○	

Abundance of mineral: ◎;abundant,○;common,△;scarce,
Abbreviation: Qs;quartz,Kf;K-feldspar,Pl;plagioclase,Al;albite,Bt;biotite,Am;amphibole,Ac;actinolite
Hr;hornblend,Cp;clinopyroxene,Se;sericite,Mu;muscovite,Ti;titanite,Ca;carbonate minerals,Zi;zircon
Ap;apatite,Pr;prehnite,Ep;epidote,Ch;chlorite,M;opaque minerals,Go;goethite
;alteration minerals

Appendix 1 Results of Microscopic Observation of Thin sections (3)

Intrusive Rocks 1

Second Phase

Area	Sample No.	Rock Name	Texture	Minerals																									
				Primary														Secondary and Alteration ( )											
				Qz	Kf	Pl	Bt	Am	Hr	Aa	Op	Cp	Ol	Sn	Ap	Zi	M	Qz	Bt	Ag	Ac	Sa	Ta	Sp	Ep	Ch	Ca	M	others
Yan Yen	VMT 51	altered diorite	gra			◎	△		○																	△	△		
	VMT 54	dunite (serpentinization)	euh gra			△	△										△							◎					
	VMT 57	gabbro	oph	△		○	△		◎			△			△										△				
	VGT 51	dolerite	por			◎					○								△		△					○	△		
	VGT 52	peridotite	gra				△													○				◎					○
	VGT 58	dolerite	por			○	△				△	○	△								△			△		△			
	VGT 60	gabbro	gra			◎						△			△						◎				△	△	△		
	VGT 61	biotite tonalite	gra	○	△	◎	△												△										
	VGT 62	biotite granite	gra	○	○	○										△			△										
	VGT 66	two mica granite	gra	○	○		△									△						○							
	VGT 69	biotite tonalite	gra	○	△	◎	△								△	△													
	VGT 71	granite	gra	○	△	◎																				△			
	VGT 81	serpentinite (?)	euh gra				△					○												◎					
	VGT 93	peridotite	euh gra			△	△					○					△							◎					
	VAT 51	dunite	euh gra		△															○				◎		△			
	VAT 56	feldspar dunite	euh gra			○	△													○				◎					
	VAT 57	feldspar peridotite	euh gra		△	○	△													○				◎					
	VAT 61	dolerite	por	△															○								◎		
	VAT 63	gabbro/peridotite	euh gra			○	△													○				◎					
	VST 51	dolerite	oph			○	△		○											◎							△		
	VST 52	quartz syenite	por	○	◎		△									△						○							
	VBT 54	peridotite	oph			○	△						◎							○									
	VBT 55	dunite	euh gra				△													○				◎					

Intrusive Rocks 2

Second Phase

Area	Sample No.	Rock Name	Texture	Minerals																									
				Primary														Secondary and Alteration ( )											
				Qz	Kf	Pl	Bt	Am	Hr	Aa	Op	Cp	Ol	Sn	Ap	Zi	M	Qz	Bt	Ag	Ac	Se	Ta	Sp	Ep	Ch	Ca	M	others
Thanh Hoa	TNT 52	gabbro-diabase	sub-gra			◎						○	△								△								
	TNT 53	brecciated gabbro	gra			◎						○																	
	TNT 55	biotite granite	gra	○	△	○	○									△									△				
	TGT 51	biotite granite	gra	○	△	○	△								△	△									△	△			
	TGT 56	granite	gra	○	◎	△										△						△			△	△			
	TGT 60	two mica granite	gra	○	△	○	△																						
	TGT 64	gabbro (fine-medium grained)	oph			◎						○									△				△				
	TAT 51	gabbro	gra			○			◎			△													△				
	TAT 55	diabase	oph			△						◎													△				
	TST 52	biotite granite	gra	△	○	△	△								△	△						△				△			
	TBT 51	granite	gra	○	△	◎			△						△							△			△	△			
	TBT 52	granite	euh gra	△	◎	△	△		△							△													
	TBT 58	dacite porphyry	por	◎	○		△															△							
	TBT 60	biotite granite	euh gra	○	○	△	△									△													
	TBT 64	biotite granite	euh gra	△	△	◎									△										△				
	TBT 68	biotite granite	euh gra	○	○	△	△									△													

Texture : euh gra:euhedral granular, gra:granular, sub-gra:subgranular, oph:ophitic, suboph:subophitic, por:porphyritic
Aboundance of mineral : ◎:abundant, ○:common, △:scarce
Abbreviation : Qz:quartz, Kf:K-feldspar, Pl:plagioclase, Bt:biotite, Am:amphibole, Hr:hornblende, Aa:alkali amphibole, Op:ortopyroxene
Cp:clinopyroxene, Ol:olivine, Sn:spinel, Ap:apatite, Zi:zircon, M:opaque minerals, Ac:actinolite, Se:sericite, Ta:talc
Sp:serpentine, Ep:epidote, Ch:chlorite, Ti:titanite, Ca:carbonate minerals, Ag:aegirine, Cz:clinozoisite, Go:goethite
( ):alteration minerals

Appendix 1 Results of Microscopic Observation of Thin sections (4)

Volcanic Rocks

Second Phase

Area	Sample No.	Rock Name	Texture	Minerals: Phenocryst Qz	Kf	Pl	Bt	Am	Hr	Op	Cp	Ol	M	Groundmass Qz	Kf	Pl	Bt	Cp	Ap	M	Gl	Secondary and Alteration ( ) Bt	Ac	Se	Ta	Sp	Ep	Ch	Ti	Ca	Go	CM
Van Yen	VAT 62	olivine basalt	micro-por			△				△		△				◎		○														
Thanh Hoa	TGT 59	rhyorite	por	△	△	△	△							○	○		△										△	△				
	THT 54	dacite porphyry	por	△		△								◎	△	△	△		△					△			△	△		△		
	TAT 52	dacite porphyry	por	△	△	△	△							◎	△	△								△				△				
	TAT 56	dacite porphyry	por	△		△								○	○									△			△	△				
	TST 51	dacite porphyry	por	△		△								◎	○	△	△		△					△				△				
	TST 53	pyroxene basalt	micro poikilitic			○					◎																△					
	TST 54	dacite porphyry	por	△		○								◎	△	△	△		△													
	TBT 53	dacite porphyry	por	△										◎	△	△	△															
	TBT 55	dacite porphyry	por	△	△	△	△							◎		△	△							△								
	TBT 56	dacite porphyry	por	△		△								◎		△	△							△								
	TBT 57	dacite porphyry	por	△	△	△								◎		△	△															
	TBT 62	dacite porphyry	por	△	△	△								◎			△													△		

Texture : por:porphyyritic, tra:trachytic

Aboundance of mineral : ◎:abundant, ○:common, △:scarce

Abbreviation : Qz:quartz, Kf.K-feldspar, Pl:plagioclase, Bt:biotite, Am:amphibole, Hr:hornblende, Op:ortopyroxene, Cp:clinopyroxene Ol:olivine, M:opaque minerals, Ap:apatite, Gl:glass, Ac:actinolite, Se:sericite, Ta:talc, Sp:serpentine, Ep:epidote Ch:chlorite, Ti:titanite, Ca:carbonate minerals, Go:goethite, CM:clay minerals ( ):alteration minerals

Sedimentary Rocks

Second Phase

Area	Sample No.	Rock Name	Texture	Minerals: Fragment Qz	Kf	Pl	Zi	Tr	Gl	M	Matrix Qz	Kf	Pl	Se	Ap	Zi	CM	M	Alteration Se	Ca	Ox	Ti	CM
Van Yen	VMT 52	sandstone	clastic	◎		△				△	◎		△			△		△		△			
	VMT 53	calcareous mudstone	clastic	△						△									△	◎			△
	VMT 56	sandstone	clastic	○		○			△		△	○		△									△
	VGT 89	feldspar limestone	clastic			△														◎			
	VAT 64	sandstone	clastic	◎		△					◎		△	△		△		△	△				
	VAT 65	calcareous clay/siltstone	clastic	○		△													○	○	○		○
	VAT 66	sandstone	clastic	◎	△	△					◎	△	△	△		△		△	△				△
	VAT 67	quartz sandstone	clastic	◎		△	△	△											△		△		△
	VAT 68	siltstone	clastic	◎		△	△			△	△						△			○			
	VAT 70	quartz sandstone	clastic	◎		△		△			△			△					△				
Thanh Hoa	TMT 51	siltstone (pressed)	clastic	◎	△	△								△						△			
	TAT 53	sandstone (polymictic)	clastic	◎	△	△					△			△	△								
	TAT 54	coarse sandstone	clastic	◎		△	△				△			△									

Aboundance of mineral : ◎:abundant, ○:common, △:scarce

Abbreviation : Qz:quartz, Kf:K-feldspar, Pl:plagioclase, Zi:zircon, Tr:trachyte, Gl:glass, M:opaque minerals Se:sericite, Ap:apatite, CM:clay minerals, Ca:carbonate minerals, Ox:oxychlorite, Ti:titanite

Appendix 1 Results of Microscopic Observation of Thin sections (5)

Second Phase

Metamorphic Rocks

Area	Sample No.	Rock Name	Texture	Minerals: Primary: Qz	Kf	Pl	Al	Bt	Am	Ac	Hr	Cp	Se	Mu	Ti	Ca	Zi	Ap	Pr	Ep	Ch	M	Sec&Alt: Se	Ch	Go
Van Yen	VMT 55	biotite gneiss	cataclastic	○		◎		△						△		△		△		△					
	VMT 58	biotite gneiss	cataclastic	○		◎		○								△		△		△			△		
	VGT 54	quartz biotite schist	por-blastic	◎				△						△			△								
	VGT 55	biotite gneiss (gneiss of granite)	blastic	○	△	○		△									△	△							
	VGT 65	quartz biotite hornfels	grano-blastic	◎				○										△							
	VGT 68	quartz biotite feldspar schist	porphyro-blastic	△		◎		○								△		△							
	VGT 70	feldspar amphibole schist	grano- blastic	△		○		△		◎										△					
	VAT 69	biotite quartz hornfels	grano- blastic	◎		△		△										△				△	△	△	
Thanh Hoa	TMT 54	Actinolite feldspar schist	platy-blastic			◎				○										△				△	
	TGT 55	feldspar hornblend hornfels	grano-platy-blastic			◎					○	△													
	TGT 61	mylonite	mylonitic			◎				○										△					
	TAT 57	gneiss of granodiorite	oph+ cataclastic	○	△	◎											△	△					△		
	TBT 61	hornfels	por-blastic	△		◎		△		△															
	TBT 67	biotite gneiss (gneiss of granodiorite)	cataclastic	○	△	○		△															△		

Aboundance of mineral : ◎:abundant, ○:common, △:scarce

Abbreviation : Qz:quartz, Kf:K-feldspar, Pl:plagioclase, Al:albite, Bt:biotite, Am:amphibole, Ac:actinolite
Hr:hornblend, Cp:clinopyroxene, Se:sericite, Mu:muscovite, Ti:titanite, Ca:carbonate minerals, Zi:zircon
Ap:apatite, Pr:prehnite, Ep:epidote, Ch:chlorite, M:opaque minerals, Go:goethite, :alteration minerals

Third Phase

Sample Number	Sample Location	Rock Name	Texture	Minerals: Fragments: Qz	Fl	Bi	Cc	Si	To	Lm	Sh	Qt	Matrix: Cl	Cc	Qz	Op
TT101	150 m from E end of MJT-1	Quartz Wacke	Clastic	◎		·		·			△		◎			
TT102	202 m from E end of MJT-1	Micrite	Aphanitic											◎	·	
TT103	Surface of MJVS-1	Black mudstone	Clastic										◎		△	
TT201	124 m from E end of MJT-2	Limestone breccia		△						◎				◎	△	
TT301	93 m from E end of MJT-3	Fine limestone					◎									
TT302	60 m from E end of MJT-3	Fine limestone					◎									
TT303	400 m west of MJVS-4	Shale	Clastic										◎		·	
TT304	450 m west of MJVS-4	Fine sandstone	Clastic	◎								△	◎		△	
TT305	300 m southwest of MJVS-2	Mudstone	Clastic	◎									◎		○	○
TT306	1,250 m south of MJVS-2	Siltstone	Clastic	◎	·						·	·	◎			
TT307	400 m SSW of MJVS-2	Siltstone/mudstone	Clastic	◎		○							◎			
TT308	550 m south of MJVS-2	Silicified rock											·	·	◎	△
TT309	550 m south of MJVS-2	Medium sandstone	Clastic	◎						·		·	◎	△	·	·
TB101	MJVS-1 93.6 m	Siltstone	Clastic	◎	△	·						△		◎	△	
TB102	MJVS-1 93.5 m	Sandstone-Siltstone	Clastic	◎	△	△						△	△	◎	△	
BT201	MJVS-2 146.4 m	Limestone												◎	·	
BT301	MJVS-3 201.5 m	Calcite veinlet														
BT401	MJVS-4 74.0 m	Limestone												◎	·	
BT402	MJVS-4 75.5 m	Limy siltstone	Clastic	◎	·					○	·	·	△	◎	·	

Abbreviation

Qz:Quartz
Fl:Feldspar
Bi:Biotite
Cc:Carbonate
Si:Siliceon
To:Tourmaline
Lm:Limestone
Sh:Shale
Qt:Quartzite
Cl:Clay minerals
Op:Opaque minerals

◎:Abundant
○:Common
△:Few
·:Rare

Appendix 2 Results of Microscopic Observation of Polished Sections (1)

First Phase

Area	Sample No.	Mineralization zones	Py	Cp	Go	Il	Sc	Co	Ga	An	Ce	Sp	Ca	Wo	Mo	Ba	
Van Yen	VFP- 1	Suoi Tiat	◎	○					tr						tr		Au(tr)
	VFP- 2	Suoi Tiat		◎													
	VFP- 3	Suoi Tiat	○	◎											tr		Bi(tr)
	VFP- 4	Suoi Boc	tr						tr	tr	○	○					
	VFP- 5	Suoi Let		○				tr									Ma(◎)
	VFP- 6	Suoi Cu								△	○	△					Sm(◎)
	VFP- 7	Suoi Tiat	○	△					tr						tr	tr	
	VGP- 1	Quartz vein	tr	tr	tr	△											
	VGP- 4	Ban Na Vang			tr	tr											Hm(tr)
	VGP- 6	Suoi Yan(1)			tr											tr	
	VGP-10	Suoi Yan(1)			tr	tr											Zi(tr),Hm(tr)
	VGP-14	Quartz vein			tr	tr						tr			tr		
	VGP-15	Suoi Yan(2)			tr	tr									tr		
	VGP-16	Suoi Yan(2)			tr							tr					Pr(tr)
	VGP-17	Quartz vein			tr										tr		
	VGP-18	Ban Suoi Tion		tr	○			tr									
	VGP-19	Ban Suoi Tion			tr			tr	tr							tr	
	VGP-20	Ban Suoi Tion	tr		△					tr							
	VGP-21	Ban Mung			tr												Hm(◎)
	VGP-24	Ban Da Do							tr								Si(○),Xe(tr)
	VGP-27	Ban Suoi Ton							◎	tr						◎	
	VGP-28	Suoi Yan(2)			◎												Xe(tr)
	VGP-29	Quartz vein	◎	tr													
	VMP- 1	Limonite vein	◎		◎												
	VMP- 2	Ban Ngnon		tr	tr	○						tr					
	VMP- 6	Suoi Hanne		○	tr	△		tr									
Western Thanh Hoa	TFP- 1	Bu Me Prospect	△										△	tr			As(tr)
	TFP- 2	Bu Me Prospect					○										As(△)
	TFP- 4	Bu Me Prospect	tr	tr									○				As(tr)
	TFP- 5	Bu Me Prospect			tr									tr			Zi(tr),Xe(tr)
	TFP- 7	Bu Me Prospect	◎	tr	○				tr								Bi(tr)
	TFP- 8	Bu Me Prospect											tr	tr	tr		
	TFP- 9	Hon Mo			tr				tr						tr		
	TFP-10	Bu Me Prospect			○		tr										Bs(tr),Be(tr)
	TFP-11	Bu Me Prospect			○					tr			tr	○			Ur(tr)
	TFP-12	Bu Me Prospect															Pr(○)
	TGP- 1	Luong Son		tr	○												
	TGP- 2	Coc Thuong			◎												Pr(○)
	TGP- 3	Lang Hac			◎					tr					tr		
	TMP- 1	Hon Can	△		tr				tr								
	TNP- 5	Lang Ngai	○						tr								

Abbreviation: Py;pyrite Cp;chalcopyrite As;arsenopyrite Go;goethite Il;Ilmenite
Sc;scorodite Hm;hematite Si;siderite Co;covelline Ma;malachite
Ga;galena An;anglesite Ce;cerussite Sp;sphalerite Sm;smithsonite
Ca;cassiterite Wo;wolframite Au;gold Mo;monazite Zi;zircon Xe;xenomite
Bi;bismuthinite Bs;bismuthite Be;beudantite Ba:barite Pr;pyrolusite
Ur;uraninite

Abundance of minerals:◎;abundant ○;common △;small tr;trace

Second Phase

Area	Sample No.	Locality	Py	Cp	Go	Il	Sc	Co	Ga	An	Ce	Sp	Ca	Wo	Mo	Be	Po	Mt	Cc	Qz	CM
Van Yen	VAP 55	Ban Coi	△	△																◎	
	VGP 56	Kiet Son	△		tr													tr		◎	
	VGP 63	Suoi Leng			○															◎	
	VGP 85	Suoi Can							◎												
	VGP 90	Suoi Can							△											◎	
	VAP 56	Muong Do		tr														tr		◎	
	VAP 57	Muong Do			○															◎	
	VAP 58	Suoi Tioun	tr																		◎
	VAP 59	Suoi Tioun	tr	tr													tr				◎
	VAP 60	Suoi Tioun	tr														△				◎
	VAP 61	Suoi Tioun	tr														tr			◎	
	VAP 62	Suoi Nghi			tr															◎	
	VAP 63	Suoi Nghi																△			
	VAP 64	Suoi Nghi	△																	◎	
	VAP 65	Suoi Nghi																		◎	
	VAP 66	Song De	tr																	◎	
	VAP 67	Song Da	△																	◎	
	VAP 68	Suoi Lai	△																	◎	
Suoi Boc	VAP 51	Suoi Boc																			◎
	VAP 52	Suoi Boc																			◎
	VAP 53	Suoi Boc																			◎
	VAP 54	Suoi Boc																			◎
	VAP 55	Suoi Boc																			◎
W.Thanh Hoa	TGP 53	Lang Tu	△		△																
	TGP 54	Lang Tu	△	tr																	
	THP 53	Muong Ly		△															△	◎	
	TAP 51	Lang Trang	tr														△			◎	
	TAP 52	Ban Kem	△																		
	TAP 53	Ban Kem	tr																	◎	
	TAP 54	Ban Kem	tr																	◎	
	TAP 55	Ban Hua Na	△	tr														tr			
Luong Son	LMP 1	Luong Son																		◎	
	LMP 4	Luong Son	tr	tr																	
	LMP 5	Luong Son																		◎	
	TGP 63	Luong Son	△	tr					tr											◎	
	TGP 65	Luong Son	△																		
	TGP 70	Luong Son	△																	◎	

Abbreviation: Py:Pyrite Cp:Chalcopyrite Go:Goethite Il:Ilmenite Sc:Scorodite Co:Covelline Ga:Galena An:Anglesite Ce:Cerussite Sp:Sphalerite
Ca:Cassiterite Wo:Wolframite Mo:Monazite As:Arsenopyrite Po:Pyrrhotite Mt:Magnetite Cc:Chalcocite Qz:Quartz CM:Carbonate minerals
abundance of minerals : ◎:abundant ○:common △:few tr:trace

Appendix 2 Results of Microscopic Observation of Polished Sections (2)

Third Phase

Sample Number	Sample Location	Description	Ore Mineral							
			Py	As	Cp	Gn	Po	He	Li	Gr
TP101	94 m from E end of MJT-1	Silicified Vein	·		·			◎	◎	
TP102	163 m from E end of MJT-1	Massive Hematite	·						◎	
BP101	MJVS-1 79.0 m	Dissemination	△		△					·
BP102	MJVS-1 82.5 m	Dissemination	△	△	·	·	·			·
BP103	MJVS-1 93.5 m	Dissemination	○		△					·
BP401	MJVS-4 74.0 m	Dissemination	△		·	·				·
BP402	MJVS-4 75.5 m	Dissemination	△		·					·

Abbreviation

Py:Pyrite
As:Arsenopyrite
Cp:Chalcopyrite

Gn:Galena
Po:Pyrohtite
He:hematite

Li:Limonite
Gr:Graphite

◎:Abundant
○:Common
△:Few
·:Rare

Appendix 3 Results of X-Ray Diffraction Analysis (1)

First Phase

No.	Sample No.	Remarks	Rock unit	Clay Minerals								Sulphate m.				Carbonate m.			Silica m.				Feld m.		Miscellaneous m.				Remark
				Mt	Mu/Mt	Mu	Kl	Kl/Sm	Ch			Ja	Al			Ca	Do		Qz	Tr	Cr	Tz	Pl	Kf	Py	Po	Px	Sup	
Van Yen Area																													
1	VFX-1	Argillization	K	•	•	Δ													O				◎	O			Δ		Phai Lay M.Z
2	VFX-2	Argillization	T_1			Δ	Δ												◎				◎				•	•	
3	VFX-3	Argillization	T_2			•	•									◎	◎		Δ										Suoi Cu M.Z
4	VFX-4	Argillization	T_1			◎			◎							O	◎				•		Δ					•	Suoi Tiat Mine
5	VFX-5	Argillization	T_1			◎	O										O		◎				◎						
6	VFX-6	Argillization	K			Δ	Δ												◎				◎	O					
7	VFX-7	Argillization	K	O		O	O												◎				◎	O					
8	VGX-1	Quartz vein	T_1			O										•			◎				◎	O	•				Suoi Banne
Western Thanh Hoa Area																													
1	TFX-1	Greisen	γ_6																◎			O				•	•		Bu Me Prospect
2	TFX-2	Greisen	γ_6				Δ												◎										Bu Me Prospect
3	TFX-3	Argillization	P_2T_1a			O	•												◎			•							Bu Me Prospect
4	TFX-4	Argillization	ν_4			O													◎										
5	TFX-5	Argillization	P_2T_1a			◎													◎			Δ							
6	TFX-6	Argillization	P_3T_1a			O	Δ												◎			•		•		•			
7	TFX-7	Greisen	γ_6			◎	•												◎			O		•			•		
8	TFX-8	Greisen	γ_6			◎													◎			O		•					
9	TFX-9	Greisen	γ_6			◎													◎			O							
10	TFX-10	Greisen	γ_6			O	Δ	Δ											◎			Δ	Δ						
11	TFX-11	Argillization	γ_6			O	O												Δ										
12	TGX-1	Argillization	Ta_2			O	•												◎				Δ				Δ		Luong Son M.Z
13	TGX-2	Argillization	Ta_1			◎	•				Δ	Δ							◎								Δ		Luong Son M.Z
14	TGX-3	Argillization	P_2T_1a			O	•												◎			•					Δ		Coc Thuong M.Z
15	TMX-1	Granite(altered)	γ_6			O	Δ												◎				◎						Luong Son M.Z
16	TMX-2	Granite(altered)	γ_6				Δ													O			◎						Luong Son M.Z

Abbreviations

◎:abundant, O:common, Δ: few, • : rare

Mt:montmorillonite, Mu:muscovite, Mu/Mt:muscovite/montmorillonite mixed-layer mineral, Kl/Sm:kaolinite/smectite mixed-layer mineral, Kl:kaolinite, Sm:smectite, Ch:chlorite, Ja:jarosite, Al:alunite, Ca:calcite, Do:dolomite, Qz:quartz, Tr:toridymite, Cr:cristobalite, Tz: topaz, Pl:plagioclase, Kf:K-feldspar, Py:pyrite, Po:phyrrohtite, Px:pyroxene, Sup:serpentine, M.Z:mineralization zone

Second Phase

No.	Sample No.	Remarks	Rock unit	Clay Minerals				Sulp m.		Carb m.		Silica m.			Feld. m		Miscellaneous m.						Remark
				Se	Ch	Kl		Gy		Ca	Do	Qz			Pl	Kf	Ga	Ce	Py	Go	He	Ho	
Van Yen Area																							
1	VGX 56	Silicified sandstone	D_2			•		•				◎							•				
2	VGX 63	Silicifed rock	PR_1	•								O								O	•		
3	VGX 84	White argillized rock	D_2							◎		◎					◎	•					Suoi Can M.Z
4	VGX 86	White argillized rock	D_2							◎		◎					O	Δ					Suoi Can M.Z
5	VGX 89	Silicified limestore	D_2							◎	O	Δ			O								Suoi Can M.Z
6	VGX 91	Limestore	D_2							◎	◎												Suoi Can M.Z
Western Thanh Hoa Area																							
1	TGX 53	Biotite schist	O_5		O							◎			◎	O			Δ				
2	TGX 67	Alterd sandstone	T_2a	•		•						◎											Luong Son M.Z
3	TGX 70	Altered sandstone	T_2a	•								◎							Δ				Luong Son M.Z
4	TAX 51	Altered granite	ν_4		O						O	O			O	Δ						Δ	
5	TAX 52	Altered rock	J7	Δ		•						◎				O							
6	TPX 51	Altered rock	T_2a	Δ		•						◎			O	O							Luong Son M.Z
7	THX 52	Altered gabbro	ν_4	Δ	◎							◎											Luong Son M.Z
8	THX 53	Altered gabbro	ν_4	Δ	◎							◎			•	•?							Luong Son M.Z
9	THX 54	black mudstone	T_2a	•		•						◎											Luong Son M.Z
10	THX 55	black mudstone	T_2a			•						◎											Luong Son M.Z
11	TBX 53	Siliciteid mudstone	T_2a	•		Δ						◎				O							

Abbreviation

◎:abundant, O:common, Δ:few, • :rare

Se:sericite, Ch:chlorite, Kl:kaoline, Gy:gypsum, Ca:calcite, Do:dolomite, Qz:quartz, Pl:plagioclase, Kf:K-feldspar, Ga:galena
Ce:cerussite, Py:pyrite, Go:goethite, He:hematite, Ho:hornblende, Sulp m.:sulphate mineral, Carb m.:carbonate mineral,
Silica m:silicate mineral, Feld m.:feldsper mineral, M.Z:mineralizatione zone

Appendix 3 Results of X-Ray Diffraction Analysis (2)

Third Phase

Sample Number	Sample Location	Rock Name	Mineral							
			Qs	Fl	Mi	Ka	Ch	Cc	Do	Go
TX101	94 m from E end of MJT-1	Silicified sandstone	◎	○	△	△				
TX102	98 m from E end of MJT-1	Altered sandstone	◎	○	△	△				
TX201	39 m from E end of MJT-2	Oxidized Fe vein						◎	△	·
TX202	90 m from E end of MJT-2	Oxidized Fe vein						◎	△	·
TX203	196.5 m from E end of MJT-2	Oxidized Fe vein						◎	△	·
BX101	MJVS-1, 91.3 m	Clay with Py dissemi	◎		◎		○	△	○	
BX102	MJVS-1, 99.5 m	Clay with Py dissemi	○	○	◎		○	△	△	△
BX103	MJVS-1, 126.7 m	Shear zone	○	△	◎		△	·	·	△
BX104	MJVS-1, 141.5 m	Sheared calcite	◎	·	△		·		◎	·
BX105	MJVS-1, 146.9 m	Clay with Py-Qtz	○	△	○		○	○	△	
BX401	MJVS-4, 58.2 m	Clay	○	△	◎		△			
BX402	MJVS-4, 70.0 m	Phyllite			△		△	◎	△	

Abbreviations

Qs:Quartz
Fl:Feldspar
Mi:Mica
Ka:Kaoline

Ch:Chlorite
Cc:Calcite
Do:Dolomite
Go:Goethite

◎:Abundant
○:Common
△:Few
·:Rare

Appendix 4 Assay Result of Ore Samples (1)

(Van Yen Area) First Phase

No.	Sample No.	Au ppb	Ag ppm	Cu %	Pb %	Zn %	Cr %	Mn %	Ni %
1	VFM 1	3	<2	<0.001	<0.001	0.007	0.010	0.059	0.001
2	VFM 2	19	<2	0.001	0.003	0.012	0.022	0.107	0.011
3	VFM 3	29	<2	<0.001	<0.001	0.007	0.023	0.151	0.011
4	VFM 4	14	<2	<0.001	<0.001	0.008	0.034	0.074	0.007
5	VFM 5	3	<2	0.026	0.019	0.009	0.005	0.061	0.005
6	VFM 6	5810	6	6.618	0.016	0.058	0.014	0.161	0.003
7	VFM 7	184	<2	0.922	<0.001	0.011	0.012	0.130	0.003
8	VFM 8	203	<2	1.601	<0.001	0.008	0.008	0.309	0.002
9	VFM 9	1740	3	3.439	0.004	0.012	0.010	0.197	0.003
10	VFM10	1160	<2	0.179	0.001	0.009	0.004	0.301	0.002
11	VFM11	4	<2	0.007	0.001	0.002	0.017	0.073	0.002
12	VFM12	1	<2	0.018	0.005	0.043	0.011	0.013	<0.001
13	VFM13	3	<2	0.003	0.005	0.026	0.018	0.060	0.002
14	VFM14	<1	<2	0.004	0.002	0.008	0.022	0.090	0.008
15	VFM15	5	<2	0.003	0.003	0.009	0.021	0.098	0.008
16	VFM16	1	<2	0.003	0.001	0.007	0.018	0.108	0.006
17	VFM17	<1	<2	0.003	0.005	0.008	0.027	0.061	0.009
18	VFM18	36	32	0.969	<0.001	<0.001	0.061	0.003	0.004
19	VFM19-1	2	<2	0.643	0.001	0.002	0.049	0.011	0.002
20	VFM19-2	24	<2	0.446	<0.001	0.003	0.050	0.025	0.002
21	VFM19-3	<1	<2	0.143	<0.001	0.014	0.026	0.100	0.006
22	VFM19-4	6	<2	0.058	<0.001	0.005	0.053	0.027	0.002
23	VFM20	8	<2	0.803	<0.001	0.001	0.048	0.003	0.001
24	VFM21-1	41	5	0.877	0.012	0.059	0.073	0.018	0.012
25	VFM21-2	12	3	0.410	0.006	0.012	0.049	0.027	0.002
26	VFM21-3	1	<2	0.043	<0.001	0.011	0.056	0.042	0.002
27	VFM22	1	431	0.025	11.874	39.414	0.009	0.053	0.002
28	VFM23	<1	<2	0.003	0.201	0.410	0.050	0.019	0.002
29	VFM24-1	25	<2	0.152	0.026	0.055	0.008	0.059	0.002
30	VFM24-2	1	<2	0.040	0.014	0.038	0.004	0.122	0.002
31	VFM25	27	<2	2.187	0.020	0.042	0.141	0.097	0.108
32	VFM26-1	1	<2	0.082	0.014	0.038	0.031	0.116	0.008
33	VFM26-2	<1	197	0.033	0.012	0.021	0.039	0.018	0.003
34	VFM27	1	75	0.128	25.819	28.892	0.004	0.208	0.002
35	VFM28	19	<2	0.611	0.964	37.775	0.004	0.265	0.001
36	VFM29	5	3	0.003	0.051	0.147	0.005	0.044	0.002
37	VFM30	5180	2	1.541	0.014	0.029	0.006	0.207	0.003
38	VFM31	471	100	1.832	0.020	0.030	0.025	0.249	0.006
39	VFM32	5	<2	0.016	34.542	0.025	0.027	0.008	0.002
40	VNM 1	16	<2	0.038	0.281	0.104	0.017	0.018	0.003
41	VNM 2	2	<2	0.011	0.019	0.016	0.039	0.104	0.010
42	VNM 3	8	8	<0.001	0.023	0.011	0.036	0.020	0.001
43	VNM 4	33	<2	0.983	0.022	0.022	0.023	0.055	<0.001
44	VNM 5	19	<2	0.027	0.006	0.007	0.025	0.022	0.004
45	VNM 6	1	<2	0.104	0.009	0.009	0.035	0.069	0.004
46	VGM 1	15	<2	<0.001	0.007	0.005	0.066	0.006	0.001
47	VGM 2	1	<2	0.005	0.007	0.007	0.045	0.015	0.001
48	VGM 3	7	<2	<0.001	0.004	0.006	0.034	0.032	0.002
49	VGM 4	<1	<2	<0.001	0.003	0.005	0.026	0.050	<0.001
50	VGM 5	3	<2	<0.001	0.003	0.004	0.035	0.243	0.001
51	VGM 6	8	<2	0.035	0.007	0.012	0.016	0.072	0.002
52	VGM 9	8	<2	0.001	0.006	0.006	0.023	0.010	<0.001
53	VGM10	12	<2	0.102	0.004	0.004	0.021	0.308	<0.001
54	VGM11	<1	<2	0.012	0.004	0.015	0.015	0.145	0.006
55	VGM12	12	<2	0.006	0.004	0.057	0.007	0.262	0.003
56	VGM13	7	<2	<0.001	0.003	0.005	0.014	0.068	<0.001
57	VGM14	9	<2	<0.001	0.004	0.007	0.009	0.088	<0.001
58	VGM15	10	<2	<0.001	0.002	0.003	0.013	0.320	0.005
59	VGM16	<1	<2	0.006	0.049	0.017	0.137	0.701	0.075
60	VGM17	6	<2	0.030	0.043	0.008	0.099	0.099	0.020
61	VGM18	8	<2	0.191	0.003	0.003	0.023	0.014	<0.001
62	VGM19	2	<2	0.053	<0.001	0.001	0.035	0.004	0.003
63	VGM20	<1	<2	0.013	0.002	0.004	0.045	0.188	0.004
64	VGM21	<1	<2	<0.001	<0.001	0.006	0.031	0.110	0.003
65	VGM22	3	<2	<0.001	<0.001	<0.001	0.026	0.018	0.003
66	VGM23	2	<2	<0.001	<0.001	0.001	0.028	0.013	0.002
67	VGM24	8	<2	0.250	0.002	0.007	0.036	0.110	0.005
68	VGM25	3	<2	0.001	0.001	0.002	0.041	0.024	0.003
69	VGM26	<1	69	<0.001	<0.001	<0.001	0.038	0.005	0.003
70	VGM27	26	<2	0.009	17.244	0.004	0.005	<0.001	0.001
71	VGM28	<1	<2	<0.001	0.052	0.003	0.012	0.182	0.005
72	VGM29	5	<2	0.099	0.006	0.009	0.017	0.194	0.006
73	VSM 1	1	<2	<0.001	0.003	0.003	0.013	0.012	0.009
74	VSM 2	6	<2	<0.001	0.002	<0.001	0.012	0.003	<0.001
75	VSM 3	<1	<2	<0.001	0.003	0.002	0.030	0.042	<0.001
76	VSM 4	6	37	0.003	0.021	0.004	0.139	0.029	0.023
77	VSM 1	50	<2	1.651	0.005	0.112	0.064	0.060	0.002
78	VSM 2	3	<2	0.007	<0.001	0.005	0.025	0.054	0.011

Appendix 4 Assay Result of Ore Samples (2)

(Western Thanh Hoa Area) First Phase

No.	Sample No.	Au ppb	Ag ppm	Cu %	Pb %	Zn %	Cr %	Mn %	Ni %	Sn %	W %
1	TFM 1	2	<2	0.004	0.001	0.001	0.030	0.0[illegible]	0.001	0.003	0.001
2	TFM 2	6	<2	0.009	<0.001	0.006	0.006	0.072	0.003	<0.001	<0.001
3	TFM 3	<1	<2	0.002	0.004	0.009	0.008	0.036	0.002	<0.001	<0.001
4	TFM 4	1	<2	<0.001	0.001	0.001	0.008	0.003	<0.001	<0.001	<0.001
5	TFM 5	<1	<2	<0.001	0.005	0.025	0.008	0.093	0.001	0.008	0.001
6	TFM 6	1	<2	<0.001	0.005	0.013	0.013	0.176	<0.001	0.019	0.017
7	TFM 7	<1	<2	0.005	0.009	0.005	0.006	0.070	<0.001	0.119	0.004
8	TFM 8	2	<2	0.004	0.007	0.004	0.006	0.046	<0.001	0.018	0.002
9	TFM 9	2	<2	0.004	0.007	0.007	0.009	0.095	0.001	0.018	0.002
10	TFM10	3	2	0.003	0.010	<0.001	0.021	0.002	<0.001	0.027	0.001
11	TFM11	1	<2	0.011	0.029	0.011	0.014	0.252	<0.001	0.053	0.007
12	TFM12	<1	<2	0.001	0.006	0.008	0.022	0.364	<0.001	0.020	3.783
13	TFM13	7	<2	0.005	0.011	0.030	0.014	0.153	<0.001	0.010	0.034
14	TFM14	4	5	0.005	0.068	0.011	0.018	0.182	<0.001	0.050	0.093
15	TFM14-1	<1	<2	0.004	0.035	0.002	0.023	0.026	<0.001	0.483	0.015
16	TFM15	4	<2	0.003	0.007	0.001	0.024	0.076	<0.001	0.066	4.687
17	TFM16	1	<2	<0.001	0.002	0.002	0.033	0.307	<0.001	0.015	2.247
18	TFM17	2	2	0.002	0.009	0.002	0.017	0.008	<0.001	0.023	0.044
19	TFM18	293	12	0.701	0.002	0.011	0.011	0.012	0.013	<0.001	0.011
20	TFM19	155	44	2.321	0.016	0.037	0.030	0.022	0.004	0.002	0.004
21	TFM20	101	<2	0.017	0.010	0.012	0.025	0.006	0.001	<0.001	0.001
22	TFM21	243	<2	0.006	0.050	0.030	0.007	0.222	0.002	<0.001	<0.001
23	TFM22	21	<2	0.009	0.024	0.065	0.023	0.685	0.009	<0.001	0.002
24	TMM 1	2	<2	0.002	<0.001	0.003	0.043	0.032	<0.001	0.001	0.064
25	TMM 2	2	<2	<0.001	0.001	0.001	0.016	0.004	<0.001	<0.001	<0.001
26	TMM 3	1	<2	0.001	<0.001	0.003	0.023	0.005	<0.001	<0.001	0.003
27	TMM 4	2	<2	<0.001	0.002	0.002	0.010	0.002	<0.001	<0.001	0.001
28	TMM 5	3	<2	<0.001	<0.001	<0.001	0.013	0.004	<0.001	<0.001	0.002
29	TCM 1-1	<1	<2	0.004	0.019	0.044	0.031	0.015	0.002	<0.001	0.003
30	TCM 1-2	<1	<2	0.002	0.007	0.005	0.017	0.003	<0.001	<0.001	<0.001
31	TCM 1-3	<1	<2	0.003	0.015	0.023	0.020	0.005	0.002	<0.001	0.001
32	TCM 2	2	<2	<0.001	<0.001	<0.001	0.012	0.004	<0.001	<0.001	0.003
33	TCM 3	5	<2	0.004	0.009	0.003	0.009	0.002	<0.001	<0.001	0.001
34	TCM 4	1	<2	<0.001	0.003	0.001	0.036	0.007	<0.001	<0.001	0.002
35	TCM 5	110	<2	0.019	0.006	0.009	0.008	0.059	0.005	<0.001	<0.001
36	TCM 6	22	<2	0.004	0.002	0.002	0.036	0.029	0.001	<0.001	0.001
37	TCM 7	4	<2	0.005	0.002	0.010	0.009	0.371	0.003	<0.001	<0.001
38	TCM 8	2	16	0.015	0.002	0.050	0.013	2.424	0.006	<0.001	<0.001
39	TCM 9	3	2	0.013	0.002	0.021	0.007	1.934	0.026	<0.001	<0.001
40	TCM10	<1	<2	0.009	0.001	0.007	0.021	0.048	0.003	<0.001	<0.001
41	TNM 1	2	<2	<0.001	<0.001	0.001	0.062	0.018	<0.001	<0.001	0.003
42	TNM 2	1	<2	<0.001	0.006	0.044	0.021	0.016	0.002	<0.001	<0.001
43	TNM 3	1	<2	<0.001	0.001	0.003	0.049	0.031	0.001	<0.001	0.002
44	TNM 4	2	<2	<0.001	<0.001	<0.001	0.047	0.006	<0.001	<0.001	0.003
45	TNM 5	18	<2	0.001	0.019	0.029	0.021	0.007	<0.001	<0.001	<0.001
46	TNM 6	1	<2	0.001	0.003	<0.001	0.024	0.005	<0.001	<0.001	0.004

Appendix 4 Assay Result of Ore Samples (3)

Second Phase

No.	Sample No Unit		Au ppb	Ag ppm	Cu %	Pb %	Zn %	Ni %	Cr %	Mn %	Pt ppb
1	VWM	51	< 2	< 2	< 0.001	< 0.001	0.004	0.001	<0.001	0.010	< 5
2	VWM	52	< 2	< 2	< 0.001	0.002	0.005	0.001	0.030	0.003	< 5
3	VWM	53	< 2	< 2	< 0.001	0.004	0.019	0.003	0.030	0.009	< 5
4	VWM	54	< 2	< 2	0.004	0.002	0.024	0.130	0.152	0.116	15
5	VWM	55	< 2	< 2	0.456	0.017	< 0.001	0.003	0.038	0.053	< 5
6	VWM	60	< 2	< 2	< 0.001	0.002	0.018	0.003	0.004	0.056	< 5
7	VWM	61	< 2	< 2	0.001	< 0.001	0.034	0.006	0.044	0.109	< 5
8	VGM	52	< 2	< 2	0.010	< 0.001	0.024	0.081	0.102	0.118	10
9	VGM	56	< 2	< 2	0.002	0.002	< 0.001	0.002	0.032	0.008	< 5
10	VGM	57	< 2	< 2	< 0.001	< 0.001	0.001	0.002	0.057	0.010	< 5
11	VGM	59	< 2	< 2	0.012	< 0.001	< 0.001	0.001	0.025	0.006	< 5
12	VGM	60	< 2	< 2	0.007	0.002	0.047	0.010	0.012	0.161	< 5
13	VGM	63	< 2	< 2	< 0.001	0.008	0.048	0.014	0.015	0.409	< 5
14	VGM	64	< 2	< 2	0.002	< 0.001	< 0.001	0.002	0.031	0.023	< 5
15	VGM	81	< 2	< 2	0.011	< 0.001	0.026	0.133	0.167	0.108	< 5
16	VGM	82	< 2	< 2	< 0.001	0.713	0.002	0.133	0.002	0.007	< 5
17	VGM	83	< 2	< 2	< 0.001	0.019	0.010	0.133	< 0.001	0.012	< 5
18	VGM	87	< 2	< 2	0.007	8.861	0.012	< 0.001	0.016	0.007	< 5
19	VGM	93	< 2	< 2	0.005	0.197	0.026	0.114	0.169	0.103	15
20	VAM	51	< 2	< 2	< 0.001	< 0.001	0.004	< 0.001	< 0.001	0.010	< 5
21	VAM	52	< 2	< 2	< 0.001	< 0.001	0.003	0.111	0.108	0.136	< 5
22	VAM	53	< 2	< 2	< 0.001	< 0.001	< 0.001	0.111	0.108	0.136	< 5
23	VAM	54	< 2	< 2	< 0.001	< 0.001	< 0.001	0.111	0.108	0.136	< 5
24	VAM	55	< 2	< 2	< 0.001	< 0.001	0.001	0.111	0.108	0.136	< 5
25	VAM	56	< 2	< 2	0.005	< 0.001	0.052	0.111	0.108	0.136	15
26	VAM	57	< 2	< 2	< 0.001	0.026	0.201	0.019	0.039	0.178	< 5
27	VAM	58	< 2	< 2	0.012	< 0.001	< 0.001	< 0.001	< 0.001	0.030	< 5
28	VAM	59	< 2	< 2	0.007	< 0.001	< 0.001	< 0.001	< 0.001	0.026	< 5
29	VAM	60	< 2	< 2	< 0.001	0.002	0.018	0.003	0.004	0.056	< 5
30	VAM	61	< 2	< 2	0.001	< 0.001	0.034	0.006	0.044	0.109	< 5
31	VAM	62	< 2	< 2	< 0.001	< 0.001	< 0.001	0.002	0.017	0.007	< 5
32	VAM	64	< 2	< 2	< 0.001	< 0.001	<0.001	0.002	0.021	0.003	< 5
33	VAM	65	< 2	< 2	< 0.001	< 0.001	< 0.001	0.002	0.017	0.010	< 5
34	VAM	66	< 2	< 2	< 0.001	0.002	0.001	0.002	0.015	0.029	< 5
35	VAM	67	< 2	< 2	0.002	0.003	0.014	0.002	0.006	0.025	< 5
36	VAM	68	< 2	< 2	< 0.001	< 0.001	0.004	< 0.001	0.017	0.153	< 5
37	VSM	51	< 2	< 2	0.005	< 0.001	0.018	0.034	0.112	0.143	5
38	VBM	51	< 2	< 2	0.004	0.018	0.003	0.001	0.015	0.067	< 5
39	VBM	52	< 2	< 2	< 0.001	< 0.001	0.001	0.003	0.028	0.017	< 5
40	VBM	53	< 2	< 2	< 0.001	< 0.001	<0.001	0.001	0.026	0.005	< 5
41	VBM	54	< 2	< 2	0.008	< 0.001	0.036	0.118	0.159	0.122	10
42	VBM	55	< 2	< 2	0.005	< 0.001	0.031	0.111	0.133	0.115	10
43	H1	-1	< 2	< 2	0.009	0.003	0.019	0.096	0.183	0.135	15
44	H2	-2	< 2	< 2	0.017	0.002	0.005	0.052	0.245	0.058	40
45	H3	-1	< 2	< 2	0.011	0.008	0.005	0.033	0.245	0.072	35
46	H4		< 2	< 2	0.055	0.002	0.005	0.044	0.231	0.072	35
47	H5		< 2	< 2	0.015	0.002	0.006	0.036	0.258	0.075	20

Appendix 4 Assay Result of Ore Samples (4)

Western Thanh Hoa Area

Second Phase

No.	Sample No Unit	Au ppb	Ag ppm	Cu %	Pb %	Zn %	Ni %	Cr %	Mn %	Sn %	W %
1	TCM 53	5	<2	0.005	0.016	0.017	0.006	0.016	0.065	0.001	<0.001
2	TCM 54	1	<2	0.002	0.014	0.036	0.004	0.020	0.041	<0.001	<0.001
3	TCM 58	<1	<2	<0.001	0.003	0.002	<0.001	0.063	0.005	<0.001	0.002
4	TCM 62	<1	<2	0.001	0.009	0.022	0.003	0.057	0.140	<0.001	0.002
5	TCM 63	8	5	0.073	0.080	0.007	<0.001	0.031	0.005	<0.001	0.002
6	TCM 65	<1	7	0.008	0.025	0.004	0.002	0.058	0.005	<0.001	<0.001
7	TCM 66	<1	<2	<0.001	0.001	<0.001	<0.001	0.024	0.006	<0.001	0.002
8	TCM 67	<1	<2	0.002	0.050	0.006	0.002	0.017	0.009	<0.001	<0.001
9	TCM 68	6	<2	0.001	0.006	0.004	<0.001	0.034	0.021	<0.001	0.001
10	TCM 69	<1	<2	0.003	0.009	0.014	0.002	0.037	0.102	<0.001	<0.001
11	TCM 70	22	2	<0.001	0.062	0.021	0.002	0.025	0.013	<0.001	0.001
12	THM 51	<1	<2	0.146	0.001	0.002	<0.001	0.023	0.008	<0.001	0.001
13	THM 52	4	<2	0.290	0.003	0.005	0.001	0.029	0.010	<0.001	<0.001
14	THM 53	<1	3	0.691	0.002	0.019	<0.001	0.017	0.007	<0.001	<0.001
15	THM 54	<1	<2	0.004	<0.001	<0.001	<0.001	0.026	0.004	<0.001	0.002
16	THM 55	<1	<2	0.001	<0.001	<0.001	<0.001	0.023	0.004	<0.001	<0.001
17	THM 56	<1	<2	0.001	<0.001	<0.001	0.002	0.036	0.014	<0.001	<0.001
18	THM 57	<1	<2	<0.001	<0.001	<0.001	<0.001	0.018	0.005	<0.001	<0.001
19	THM 58	<1	<2	0.001	<0.001	0.001	0.002	0.027	0.052	<0.001	<0.001
20	THM 59	<1	<2	0.006	0.002	0.056	0.013	0.067	0.066	<0.001	0.003
21	THM 60	11	<2	0.005	0.016	0.005	0.003	0.030	0.102	<0.001	0.002
22	THM 61	<1	<2	0.001	0.002	0.062	0.008	0.036	0.091	<0.001	0.003
23	THM 62	1	<2	0.001	0.004	0.085	0.003	0.003	0.073	<0.001	<0.001
24	THM 63	<1	<2	0.017	0.002	<0.001	<0.001	0.039	0.005	<0.001	0.003
25	THM 64	<1	<2	0.002	0.012	0.004	<0.001	0.022	0.003	<0.001	<0.001
26	THM 65	<1	<2	0.007	0.141	0.034	0.004	0.017	0.026	0.001	<0.001
27	THM 66	<1	<2	0.003	0.055	0.022	0.003	0.014	0.020	0.002	<0.001
28	TAM 51	<1	<2	0.009	0.003	0.088	0.009	0.031	0.034	<0.001	0.003
29	TAM 52	<1	<2	<0.001	0.003	0.034	0.003	0.012	0.032	<0.001	0.001
30	TAM 53	<1	<2	0.019	0.002	0.009	0.007	0.049	0.022	<0.001	0.001
31	TAM 54	<1	<2	<0.001	0.009	0.027	0.001	0.011	0.006	<0.001	<0.001
32	TAM 55	1	<2	<0.001	0.007	0.041	0.001	0.014	0.012	<0.001	<0.001
33	TSM 51	53	<2	<0.001	0.002	<0.001	<0.001	0.018	0.003	<0.001	0.001
34	TSM 52	4	<2	<0.001	0.002	0.009	0.002	0.025	0.003	<0.001	0.001
35	TSM 53	14	<2	<0.001	0.012	0.001	<0.001	0.024	0.008	<0.001	0.001
36	TSM 54	1	15	0.014	0.145	0.062	0.024	0.013	12.169	<0.001	<0.001
37	TSM 56	<1	<2	<0.001	0.006	0.005	0.001	0.021	0.069	<0.001	<0.001
38	TSM 57	<1	3	0.039	0.007	0.054	0.006	0.018	1.339	<0.001	<0.001
39	TSM 58	1	<2	0.001	0.018	0.024	0.007	0.031	0.434	<0.001	<0.001
40	TSM 60	<1	<2	<0.001	0.004	0.011	0.001	0.038	0.019	<0.001	0.002
41	LVM 1	<1	<2	0.001	0.031	0.045	0.003	0.033	0.010	<0.001	<0.001
42	LVM 2	<1	<2	0.002	0.008	0.025	0.003	0.038	0.140	<0.001	<0.001
43	LVM 3	<1	<2	0.002	0.013	0.020	0.002	0.016	0.010	<0.001	<0.001
44	LVM 4	49	<2	0.002	0.009	0.007	0.001	0.036	0.008	<0.001	0.003
45	LVM 5	<1	<2	<0.001	0.004	0.019	<0.001	0.021	0.008	<0.001	<0.001
46	LVM 6	<1	<2	<0.001	<0.001	<0.001	<0.001	0.018	0.003	0.002	0.002

Appendix 4 Assay Result of Ore Samples (5)

Third Phase

試料番号	採取位置	試料名	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
TA101	MJT-1,94-95.2m from E end	Sili. zone with Qtz vein	0.4	<1	<0.01	<0.01	<0.01
TA102	MJT-1,94.5m from E end	Sili. sandstone	<0.4	<1	<0.01	<0.01	<0.01
TA103	MJT-1 98m from E end	Dissemi. part	0.8	<1	<0.01	<0.01	<0.01
TA104	MJT-1 118m from E end	Hematite veinlet	0.4	1	<0.01	0.01	0.06
TA105	MJT-1 109m from E end	Hematite vein	<0.4	2	<0.01	0.05	0.08
TA106	MJT-1 106m from E end	Hematite network	0.4	11	0.02	0.29	0.26
TA107	MJT-1 102m from E end	Hematite network	0.4	3	<0.01	0.07	0.05
TA108	MJT-1 150.5m from E end	Sili. zone	<0.4	<1	<0.01	<0.01	<0.01
TA109	MJT-1 151.5m from E end	Massive hematite	<0.4	<1	<0.01	<0.01	<0.01
TA110	MJT-1 154m from E end	Dissemi. part	0.4	<1	0.02	0.03	0.01
TA111	MJT-1 155m from E end	Dissemi. part	<0.4	<1	0.03	0.03	0.01
TA112	MJT-1 15m from E end	Hematite network	0.4	<1	<0.01	0.01	0.01
TA201	MJT-2 39m from E end	Limonite network	<0.4	1	<0.01	0.04	<0.01
TA202	MJT-2 50m from E end	Limonite network	0.4	<1	<0.01	0.04	0.05
TA203	MJT-2 149.5m from E end	Limonite network	0.4	<1	<0.01	0.02	0.03
TA204	MJT-2 170m from E end	Limonite network	<0.4	<1	<0.01	0.01	0.03
TA205	MJT-2 187m from E end	Hema.-Goe. network	0.4	<1	<0.01	0.01	0.02
TA206	MJT-2 188.5m from E end	Hematite vein	0.4	<1	<0.01	<0.01	0.01
TA207	MJT-2 194m from E end	Limonite vein	0.4	<1	<0.01	<0.01	0.04
TA301	MJT-3 185m from E end	Hematite network	<0.4	<1	<0.01	<0.01	0.01
TA302	MJT-3 179.5m from E end	Calcite vein	0.4	<1	<0.01	<0.01	<0.01
TA303	MJT-3 170-171m from E end	Hematite network	0.4	<1	<0.01	<0.01	<0.01
TA304	MJT-3 169-170m from E end	Hematite network	<0.4	<1	<0.01	<0.01	<0.01
TA305	MJT-3 168-169m from E end	Hematote network	<0.4	<1	<0.01	<0.01	<0.01
TA306	MJT-3 160.7m from E end	Hematote network	<0.4	<1	<0.01	0.01	0.02
TA307	MJT-3 160m from E end	Hematote network	0.4	<1	<0.01	<0.01	<0.01
TA308	MJT-3 159.5m from E end	Hematote network	<0.4	<1	<0.01	0.01	<0.01
TA309	MJT-3 158.5m from E end	Hematote network	0.4	<1	<0.01	<0.01	0.01
TA310	MJT-3 136m from E end	Goethite vein	0.4	<1	<0.01	0.03	0.05
TA311	MJT-3 123.5m from E end	Hematite network	0.4	<1	<0.01	<0.01	0.03

Third Phase

試料番号	採取位置	試料記載	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
BA201	MJVS-2, 208.0 m	Hematite-geothite veinlet	<0.4	1	<0.01	0.05	0.16
BA301	MJVS-3, 17.3 - 17.7 m	Hematite-goethite vein	0.4	<1	<0.01	0.04	0.09
BA302	MJVS-3, 26.0 - 26.5 m	Hematite-goethite vein	0.4	1	<0.01	0.04	0.02
BA303	MJVS-3, 70.0 - 70.1 m	Goethite-hematite vein	0.4	<1	<0.01	0.01	0.01
BA304	MJVS-3, 87.3 - 88.2 m	Limonite vein	0.4	1	<0.01	0.06	0.10
BA305	MJVS-3, 65.9 m	Hematite veinlet	0.4	<1	<0.01	0.04	0.02

Appendix 5 Results of Whole Rock Chemical Analysis (1)

First Phase

Yan Yen Area

Sample No.	1 YFR 1	2 YFR 2	3 YFR 3	4 YFR 4	5 YFR 5	6 YFR 6	7 YMR 1	8 YMR 4	9 YMR 7	10 YMR 8	11 YMR10
SiO_2	72.07	46.40	44.89	61.26	47.61	61.25	43.47	49.22	43.64	47.54	44.58
TiO_2	0.13	3.42	3.08	0.51	2.10	0.60	0.85	2.05	0.65	1.32	3.35
Al_2O_3	15.03	14.07	14.34	14.54	14.59	16.98	7.25	11.64	5.91	15.12	13.48
Fe_2O_3	0.90	4.50	3.93	6.82	3.36	6.86	3.40	2.82	3.26	1.77	6.39
FeO	1.49	8.32	9.83	2.74	9.20	0.50	8.70	8.45	8.58	7.58	9.51
MnO	0.04	0.24	0.23	0.16	0.20	0.04	0.19	0.17	0.18	0.13	0.25
MgO	0.78	5.17	7.13	0.06	6.76	0.02	21.39	9.33	22.96	8.96	6.65
CaO	0.28	8.69	9.85	1.58	10.63	0.27	8.04	9.63	7.03	10.75	9.36
Na_2O	6.45	3.80	2.33	4.74	2.32	5.36	0.74	3.30	0.51	2.43	3.25
K_2O	1.17	1.06	0.74	5.05	0.75	7.10	0.16	1.34	0.21	0.92	0.63
P_2O_5	<0.01	1.30	0.87	0.06	0.24	0.13	0.06	0.32	0.05	0.13	0.41
LOI	1.11	2.46	2.45	1.98	1.84	0.51	2.92	1.43	4.27	2.99	1.72
Total	99.45	99.43	99.67	99.50	99.60	99.62	97.17	99.70	97.25	99.64	99.58

Sample No.	12 YMR11	13 YGR 5	14 YGR 6	15 YGR 7	16 YGR 8	17 YGR10	18 YGR11	19 YGR13	20 YGR15	21 YGR25	22 YGR26
SiO_2	57.40	44.43	63.04	65.23	49.10	51.30	62.47	47.79	46.18	64.22	64.10
TiO_2	0.97	1.58	0.45	0.37	0.96	1.66	0.73	2.32	4.55	0.46	0.20
Al_2O_3	16.19	14.34	14.93	16.77	9.35	16.55	14.71	14.61	13.94	15.51	15.45
Fe_2O_3	2.19	2.72	6.88	1.90	3.39	5.08	3.56	3.45	5.22	4.69	6.71
FeO	4.41	8.52	0.55	1.18	6.34	4.22	3.11	8.32	8.45	2.11	0.31
MnO	0.14	0.19	0.19	0.05	0.17	0.20	0.21	0.20	0.33	0.29	0.05
MgO	1.20	11.49	0.33	0.30	12.02	4.34	0.35	6.71	5.58	0.22	<0.01
CaO	3.07	8.49	0.97	0.83	11.99	5.50	2.17	10.52	6.91	0.98	0.05
Na_2O	5.54	2.24	4.89	5.67	1.45	4.55	6.37	2.50	4.05	5.52	3.16
K_2O	3.91	0.67	5.93	6.02	1.47	3.92	3.69	1.11	1.05	5.49	8.95
P_2O_5	0.26	0.32	0.04	0.06	0.39	0.77	0.09	0.32	0.59	0.04	0.02
LOI	4.14	4.88	1.58	1.20	3.11	1.57	2.06	1.88	2.59	0.28	0.39
Total	99.42	99.86	99.78	99.58	99.74	99.66	99.52	99.73	99.44	99.81	99.39

First Phase

Western Thanh Hoa Area

Sample No.	1 TFR 1	2 TFR 2	3 TFR 3	4 TFR 4	5 TMR 1	6 TMR 2	7 TMR 3	8 TMR 4	9 TMR 5	10 TMR 6	11 TGR21	12 TNR 8	13 TNR23	14 TNR22	15 TSR 4	16 TSR 8
SiO_2	46.90	71.26	49.39	77.00	70.25	70.90	78.00	76.02	77.40	75.90	46.43	68.48	50.99	48.99	73.48	75.55
TiO_2	0.09	0.36	1.92	0.08	0.61	0.60	0.13	0.10	0.11	0.10	0.17	0.77	0.19	0.19	0.30	0.11
Al_2O_3	25.45	13.52	13.86	16.95	12.87	13.31	10.87	12.25	12.00	12.32	22.26	12.55	16.57	19.12	12.93	12.80
Fe_2O_3	0.86	1.22	2.87	3.02	0.90	1.12	0.26	0.40	0.94	0.19	0.71	1.10	0.77	0.46	0.60	0.63
FeO	1.99	1.67	7.89	0.13	3.42	2.68	1.25	1.12	0.87	1.25	3.29	3.91	5.16	2.79	1.74	0.93
MnO	0.05	0.05	0.19	<0.01	0.05	0.03	0.03	0.02	0.01	0.02	0.08	0.06	0.12	0.08	0.03	0.02
MgO	5.42	0.32	8.18	<0.01	1.36	1.41	<0.01	<0.01	0.11	<0.01	7.37	2.09	8.97	8.61	0.28	<0.01
CaO	14.85	0.84	10.44	0.07	0.98	0.75	0.30	1.21	0.21	1.11	13.93	1.74	12.78	14.63	1.70	0.84
Na_2O	1.71	3.36	3.12	0.03	1.99	2.68	3.12	3.74	5.51	3.79	2.60	2.57	2.52	2.24	0.87	3.79
K_2O	0.19	5.59	0.57	0.04	4.94	5.56	5.22	4.38	1.54	4.42	0.29	4.11	0.22	0.43	4.57	4.21
P_2O_5	0.42	0.13	0.20	0.01	0.17	0.15	0.02	0.01	0.02	0.02	<0.01	0.16	<0.01	<0.01	0.12	0.02
LOI	1.78	1.17	0.90	2.00	1.80	0.84	0.39	0.35	0.94	0.43	2.49	1.93	1.44	1.99	2.78	0.75
Total	99.71	99.55	99.53	99.33	99.34	99.33	99.59	99.60	99.66	99.55	99.62	99.47	99.64	99.53	99.40	99.65

Second Phase

Yan Yen Area

Sample No.	1 YMR51	2 YMR54	3 YMR57	4 YGR51	5 YGR52	6 YGR50	7 YGR61	8 YGR62	9 YGR68	10 YGR69	11 YGR71	12 YGR81
SiO_2	42.98	33.49	49.24	49.31	44.08	45.85	72.34	71.39	77.23	72.34	76.55	43.25
TiO_2	2.20	0.59	1.99	2.54	0.97	1.09	0.16	0.31	0.09	0.21	0.02	0.81
Al_2O_3	10.42	4.53	12.27	12.38	8.31	13.98	14.23	14.01	11.50	13.61	12.59	7.12
Fe_2O_3	3.02	5.78	4.56	3.26	3.36	4.16	1.54	1.13	1.03	1.09	0.39	3.73
FeO	8.32	5.87	12.97	9.17	7.46	11.01	0.49	1.22	0.42	1.11	0.37	8.62
MnO	0.19	0.17	0.26	0.19	0.18	0.25	0.02	0.01	0.01	0.01	0.03	0.16
MgO	7.98	27.80	4.86	7.45	20.23	7.76	0.42	0.64	0.23	0.77	0.13	21.50
CaO	11.36	3.93	7.52	8.96	9.39	7.76	0.41	0.23	0.11	0.62	0.26	9.57
Na_2O	2.73	0.06	1.84	4.25	0.73	2.46	3.38	2.31	2.31	4.05	4.69	0.06
K_2O	0.09	0.11	2.02	0.75	0.45	1.74	5.64	7.01	5.20	4.43	3.87	0.09
P_2O_5	0.44	0.06	0.76	0.45	0.10	0.13	0.05	0.08	0.01	0.05	0.01	0.09
LOI	9.90	9.52	1.21	2.79	4.47	3.25	1.17	1.25	1.33	1.25	0.72	5.57
Total	99.62	97.90	99.50	99.53	99.73	99.44	99.84	99.59	99.47	99.59	99.63	98.57

Sample No.	13 YGR93	14 YBR51	15 YAR56	16 YAR57	17 YSR51	18 YSR52	19 YSR54	20 YBR55	21 YBR56	22 YBR57	23 YBR58
SiO_2	41.72	45.58	40.51	49.60	45.86	73.06	41.88	41.02	47.64	1.30	4.61
TiO_2	0.92	2.01	0.72	0.55	2.11	0.25	0.71	0.74	2.33	0.03	0.04
Al_2O_3	6.61	9.55	6.20	6.23	7.90	13.43	6.29	6.20	14.43	0.23	1.13
Fe_2O_3	2.00	1.70	2.40	4.83	1.64	0.69	4.13	2.27	1.37	0.16	0.16
FeO	6.99	10.82	9.17	5.62	8.75	0.73	6.84	7.71	8.68	0.24	1.11
MnO	0.15	0.21	0.29	0.16	0.18	<0.01	0.17	0.16	0.13	0.03	0.21
MgO	23.86	15.21	25.20	25.36	14.04	0.67	24.89	24.16	8.19	20.51	0.83
CaO	6.79	9.39	4.67	6.49	12.59	0.31	6.73	6.65	7.88	30.29	49.79
Na_2O	0.04	1.42	0.06	0.14	1.48	2.13	0.35	0.10	1.76	0.26	0.10
K_2O	0.06	0.37	0.06	0.09	1.23	7.44	0.15	0.15	0.65	0.04	0.15
P_2O_5	0.11	0.30	0.06	0.05	0.25	0.07	0.08	0.08	0.31	0.01	0.03
LOI	6.67	2.95	8.26	7.53	3.40	0.90	5.49	7.17	7.54	45.39	41.24
Total	98.22	99.51	97.51	103.75	99.43	99.75	97.70	97.41	97.83	99.49	99.43

Second Phase

Western Thanh Hoa Area

Sample No.	1 TMR52	2 TMR53	3 TMR54	4 TMR55	5 TGR51	6 TGR60	7 TGR57	8 TSR51	9 TSR52	10 TSR54	11 TBR51	12 TBR52	13 TBR55	14 TBR57	15 TBR58	16 TBR50	17 TBR54	18 TBR67	19 TBR68
SiO_2	49.72	49.37	49.79	75.31	74.46	76.94	72.05	70.18	70.99	70.59	71.13	75.35	68.67	72.62	79.71	74.23	71.29	71.41	76.49
TiO_2	0.22	1.16	1.06	0.13	0.15	0.07	0.57	0.63	0.56	0.54	0.18	0.09	0.51	0.50	0.21	0.37	0.59	0.62	0.11
Al_2O_3	19.01	15.49	16.32	12.99	12.95	11.81	13.78	13.30	13.42	13.91	13.54	12.86	13.69	14.64	9.68	13.45	13.53	13.64	12.29
Fe_2O_3	1.24	2.06	1.63	0.36	0.53	0.30	0.40	0.56	0.46	0.56	0.29	0.20	1.42	0.80	2.02	0.33	0.70	1.49	1.27
FeO	5.02	7.09	7.89	1.40	1.35	1.11	3.18	3.85	3.11	3.24	1.95	1.29	3.66	0.18	0.31	0.24	2.82	2.14	0.31
MnO	0.11	0.19	0.16	0.03	0.03	0.05	0.03	0.06	0.07	0.04	0.03	0.03	0.05	<0.01	<0.01	<0.01	0.04	0.04	0.02
MgO	9.23	9.13	8.21	0.19	0.32	0.06	1.13	1.20	0.89	1.20	0.19	0.09	1.59	0.25	0.24	0.14	0.93	0.87	0.08
CaO	12.25	8.76	12.27	1.25	1.32	0.55	1.21	1.07	0.71	0.51	1.81	0.91	0.27	0.06	0.05	0.06	1.77	1.24	0.61
Na_2O	1.87	3.13	2.00	3.31	3.34	3.60	3.17	2.96	2.40	2.12	3.33	3.45	1.69	1.68	0.09	0.88	1.96	1.73	2.96
K_2O	0.07	0.23	0.14	4.14	4.49	4.51	2.88	4.13	5.36	5.25	4.31	4.94	5.27	7.06	5.82	8.80	4.84	4.74	5.31
P_2O_5	0.01	0.13	0.09	0.02	0.02	<0.01	0.14	0.16	0.16	0.16	0.03	0.03	0.16	0.09	0.04	0.04	0.14	0.15	0.01
LOI	1.80	2.66	1.22	0.56	0.75	0.49	1.04	1.44	1.37	1.51	0.62	0.41	2.22	1.63	1.55	1.21	0.99	1.44	0.42
Total	99.55	99.42	99.79	99.68	99.70	99.49	99.58	99.49	99.50	99.69	99.42	99.63	99.59	99.72	99.73	99.76	99.50	99.51	99.83

EXPLANATORY NOTE
ON
THE GEOLOGY AND ORE DEPOSITS
OF
THE VAN YEN AND WESTERN THANH HOA AREAS
THE SOCIALIST REPUBLIC OF VIETNAM

FEBRUARY 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

PREFACE

In response to the request of the Government of the Socialist Republic of Vietnam, the Japanese Government decided to conduct a Mineral Exploration Project in the Van Yen and Western Thanh Hoa Areas and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The Government of the Socialist Republic of Vietnam appointed the Geological Survey of Vietnam to execute the survey as a counterpart to the Japanese team.

The cooperative mineral exploration in the Van Yen and Western Thanh Hoa areas has continued for three years. It consisted of geological, geochemical and geophysical survey, and drilling exploration.

We hope that this report will serve for the development of this project and contribute to the promotion of friendly relations between our two countries.

We wish to express our deep appreciation to the officials concerned of the Government of the Socialist Republic of Vietnam for the close cooperation extended to the team.

February 1996

Kimio FUJITA
President,
Japan International Cooperation Agency

Shozaburo KIYOTAKI
President,
Metal Mining Agency of Japan

CONTENTS

Chapter 1. Introduction

1-1. Areas and objective of survey

Pursuant to the request made by the Government of Socialist Republic of Vietnam, and through the meeting with the Geological Survey of Vietnam in June, 1993, the Government of Japan decided to conduct the technical cooperation for mineral exploration on areas of Van Yen and Western Thanh Hoa.

The objective of the survey is to explore and to assess the mineral potential of the areas trough clarification of their geology and mineral occurrence. The areas comprise two districts enclosed by the following points.

(1) Van Yen Area, 2,000 km²

1.	21°20'N	104°33'E	2.	20°56'N	104°33'E
3.	20°56'N	105°00'E	4.	21°20'N	105°00'E

(2) Western Thanh Hoa Area, 1,300 km²

1.	20°10'N	105°00'E	2.	19°50'N	105°00'E
3.	19°50'N	105°22'30"E	4.	20°00'N	105°22'30"E
5.	20°10'N	105°15'E			

1-2. Outline of the study

In 1993, the study of existing data, and geological and geochemical surveys were conducted in the west of Van Yen and in the east of Thanh Hoa Areas. In addition, geochemical investigation of soil was implemented at the mineralized zone at Bu Me in Western Thanh Hoa.

In 1994, the study of existing data, and geological and geochemical surveys were carried out in the east of Van Yen Area. A detailed geological survey of Suoi Boc - Suoi Cu zone and geochemical and geophysical surveys of Suoi Boc zone of the Area were also conducted. In Western Thanh Hoa, the study of existing data, and geological and geochemical surveys were implemented in the west of the Area. A detailed geological survey and geochemical survey of soil were carried out at Luong Son zone.

In 1995, a trench survey and drilling program were conducted at promising zone of Suoi Boc in Van Yen Area.

The outline of the survey methods and amounts is tabled in the next page.

Phase	Survey	Area	Amount of Work
First	Study of Available Relevant Data	Van Yen Area Western Thanh Hoa Area	
	Regional Geological Survey and Geochemical Exploration	Van Yen Area	Area : 1,000 km² Stream Sediments 899 pcs Pan Concentrates 193 pcs
		Western Thanh Hoa Area	Area : 650 km² Stream Sediments 532 pcs Pan Concentrates 147 pcs
	Semi-detailed Geochemical Exploration	Bu Me Zone, Western Thanh Hoa Area	Area : 5 km² Soils 241 pcs
	Laboratory Works		Thin Sections 62 pcs Polished Sections of Ore 41 pcs X-ray Diffraction Analysis 24 pcs Chemical Analysis Whole Rocks 39 pcs Ore 124 pcs Stream Sediments 1,431 pcs Soils 241 pcs
Second	Study of Available Relevant Data	Van Yen Area Western Thanh Hoa Area	
	Regional Geological Survey and Geochemical Exploration	Van Yen Area	Area : 1,000 km² Stream Sediments 915 pcs Pan Concentrates 240 pcs
		Western Thanh Hoa Area	Area : 650 km² Stream Sediments 469 pcs Pan Concentrates 120 pcs
	Detailed Geological Survey and Geochemical Exploration	Suoi Boc - Suoi Cu Zone, Van Yen Area	Area : 10 km² Soils 100 pcs
		Luong Son Zone, Western Thanh Hoa Area	Area : 4 km² Soils 207 pcs Pan Concentrates 15 pcs
	Geophysical Survey	Suoi Boc Zone, Van Yen Area	Area : 3 km² IP 15.8 km
	Laboratory Works		Thin Sections 79 pcs Polished Sections of Ore 37 pcs X-ray Diffraction Analysis 17 pcs Chemical Analysis Whole Rocks 42 pcs Ore 93 pcs Stream Sediments 1,384 pcs Soils 307 pcs
Third	Drilling Exploration Trench Survey	Suoi Boc Zone, Van Yen Area	Area : 4.5 km² Drilling (4 holes) 742.70 m Trench (4 lines) 600.00 m
	Laboratory Works		Thin Sections 19 pcs Polished Sections of Ore 7 pcs X-ray Diffraction Analysis 12 pcs Chemical Analysis Rock 141 pcs Ore 36 pcs

Chapter 2. General geology and ore deposits

2-1. General geology

The areas are widely underlain by rocks of Proterozoic to Cambrian, Cambrian to Early Ordovician, Early to Middle Devonian, and Late Permian to Late Triassic in age. A distribution of Cenozoic rocks other than Quaternary is restricted and sporadic.

The succession of Proterozoic to Cambrian and Cambrian to Lower Ordovician Systems lies mainly in the right banks of Da River and Ma River and comprises limestones and metamorphic rocks, such as schists, quartzite and marble.

Lower to Middle Devonian rocks consist of terrestrial clastic reddish sediments and marine sediments mainly of shale and sandstone, and are distributed around the periphery of the Proterozoic to Cambrian and Cambrian to Lower Ordovician rocks.

The succession of Upper Permian to Upper Triassic has the most wide distribution in the vicinity of the area and consists of sediments, such as sandstone, shale and carbonate rocks, with subordinate volcanic rocks of andesite, basalt or rhyolite and their pyroclastic rocks.

Intrusive activities of four stages are known in northern Vietnam, being of Proterozoic, Early to Middle Paleozoic, Late Paleozoic to Early Mesozoic, and Late Mesozoic to Early Cenozoic.

Concordant intrusion of Proterozoic intrusive rocks into the metamorphic rocks is known on the right bank of Hong River.

Felsic rocks of Early to Middle Paleozoic, comprising diorite, diorite granite and granite, and similar felsic rocks of Late Paleozoic to Early Mesozoic are distributed comparatively in lumps on the right bank of Ma River.

Ultramafic and mafic rocks of Early to Middle Paleozoic and Late Paleozoic to Early Mesozoic comprise dunite and gabbro and occur as lenses of small scale in general.

A narrow distribution of intrusive rocks of Late Mesozoic to Early Cenozoic is only known in the south of Western Thanh Hoa Area.

2-2. Geological structure

The geological structure of northern Vietnam is complicated due to the tectonic movements during the long geological period. Tectonic provinces of West Bacbo and Truongson are arranged essentially in a NW-SE direction. The boundaries of the tectonic provinces are in accordance with main tectonic lines of a NW-SE direction along Hong River or Ma River. In the tectonic provinces, many faults run in parallel with the direction of main tectonic lines, controlling a distribution of geological strata. The distribution of intrusive rocks is concordant with the NW-SE direction of the structure.

The regions of West Bacbo and Truongson are situated in an area where plates of South China and Indosinian come across. The two plates are believed to have repeated to split and join during the period from Paleozoic to Cenozoic, though the details of tectonics are not fully proved. In concurrence with the plate activity, rift zones, obduction, and subduction are formed and these are followed by deposition of sediments, alignment of strata in a NW-SE direction and formation of tectonic lines.

The structure control of a NW-SE direction is obvious in the area. The Upper Permian to Upper Triassic Systems, which are distributed in the vicinity of the area, extend in a NW-SE direction with a width of 20 to 40 km. Strata of Proterozoic to Cambrian and of Early Paleozoic are also elongated in a NW-SE direction to form a distribution of horseshoe-shape. These strata often come into contact in faults of NW-SE direction. Intrusive rocks on the right bank of Ma River are concordant with structures of NW-SE trend. Lenses of ultramafic to mafic intrusive rocks of a small scale are also sporadically distributed on the tectonic line of NW-SE direction.

2-3. Ore deposits

Due to diversified tectonic movements over a long period, mineralization is full of variety. Five metallogenetic epochs are discriminated, being of Precambrian, Early to Middle Paleozoic, Indosinian of Late Carboniferous to Late Triassic, Late Mesozoic to Early Cenozoic with preponderance of Cretaceous to Paleogene, and Neogene to Quaternary periods.

Gold deposits in the area are Kim Boi in central Ha Son Binh Province, Lang Neo, Lang Mo, Cam Tam in Thanh Hoa Province, etc., of vein-type in limestone of Cambrian, mafic volcanic rocks of Late Permian to Early Triassic, and sedimentary rocks of Triassic. Suoi Tiat in the northwest of Van Yen Area is being mined as a gold-bearing copper deposit. Alluvial gold deposits are found in basins of all mountainous regions, but these are of a small scale and no details are known.

Ban Phuc of Ta Khoa zone in central Son La Province is a typical and of the largest nickel and copper deposits in Vietnam. The deposits are of vein-type and disseminated-type in ultramafic rocks of Permian to Triassic period, and located in the Da River mobile belt at the right bank of the Da River.

Quy Hop deposits in Nghe An Province are known to be of tin and tungsten, and of chiefly alluvial. Veins of cassiterite and sulfide minerals have been known in schists of Precambrian to Paleozoic in the area. A zone of pneumatolytic to hydrothermal mineralization of tin and tungsten at Bu Me in the southeast of Western Thanh Hoa Area is being investigated by Geological Survey.

Nui Nua zone in the east of Thanh Hoa Province is known with alluvial deposits of chrome. The deposits of the area are situated around the periphery of ultramafic rocks in Early to Middle Cambrian, and have been mined for a long time at a large scale.

Famous lead zinc deposits in northern Vietnam are known at Cho Dien in Bac Thai Province. A distribution of lead-zinc deposits is sporadic but details of their location and scale are not known.

Chapter 3. Results of the survey

3-1. Regional survey of Van Yen Area

3-1-1. Geological survey

(1) Stratigraphy

【Proterozoic】

Proterozoic consists chiefly of coarse-grained biotite gneiss. The gneiss is of an obvious gneissose structure and a cataclastic texture is noticed under the microscope. The main constituents are abundant plagioclase and fewer amounts of quartz and biotite. The thickness of the group is estimated at 2,000 m.

【Upper Cambrian to Lower Ordovician】

The Upper Cambrian to Lower Ordovician System is distributed in one place of northeast and two places in the southeast of the area. This System is situated in the vicinities of Proterozoic Group and unconformably overlies the latter in large part.

The System of the northeast is of phyllitic mudstone. The northern occurrence of two places in the southeast is made up mainly of coarse-grained sandstone, and the southern occurrence is of interdeds of pelitic schist, fine-grained gray siliceous sandstone and gray psammitic schist.

The System in the area is estimated to be of 1,200 m thick.

【Upper Ordovician to Silurian】

The main part of Upper Ordovician to Silurian system is formed chiefly of hard and compact sandstone. This System is estimated to be of 2,500 m in the area and unconformably overlies the Upper Cambrian to Lower Ordovician system.

【Lower Devonian】

The Lower Devonian System is found to lie in the northeast, eastern central and southeast parts of the area. In the northeast and eastern central, the system is chiefly made up of fine-grained to medium-grained sandstone. At the southeast of the area, limestone is dominant, in which the bedding planes of around 1 m interval are developed. This system unconformably overlies lower systems and amounts to 2,500 m thick in the area.

【Middle Devonian】

The Middle Devonian is overspread in the northeast, eastern central and in the mountainous area at the right bank of Da River in the southeast, overlying unconformably the strata lower than Middle Devonian. This System forms very steep mountains of folded rocks with those of Lower Devonian or Carboniferous to Permian.

The Middle Devonian consists mainly of phyllitic mudstone in the northeast and central parts of the area and of limestone and sandstone in the southeast. The thickness of the System in the area is estimated to be of 1,500 m.

[Middle to Upper Devonian]

The Middle to Upper Devonian is chiefly made up of massive limestone and is assumed to exceed 1,500 m thick.

[Carboniferous to Permian]

The Carboniferous to Permian system is situated in the northern central, central and south of the area, and overlies unconformably the Middle Devonian. The System is generally composed of fine-grained massive limestone. The thickness is estimated at 1,800 m thick.

[Lower Permian]

The Lower Permian is distributed narrowly at the west of the Carboniferous to Permian system in the northern central and central parts, overlying conformably the latter.

At the northern central part, massive limestone dominates in one place and mudstone dominates in other places. These are supposed to be of interfinger relationship. At the central part, the System comprises bedded limestone, fine-grained sandstone and phyllitic mudstone. The thickness is estimated to be of 700 m.

[Lower Triassic]

The Lower Triassic is distributed in the north, west to south and southeast of the area.

At the north, the system is overlain by the Middle Triassic, conformably in large part, and abuts against the Cretaceous System with faults of a north-south trend. The System is estimated to have a thickness of 1,500 m.

At the west to south, the Lower Triassic abuts against surrounding geological units with faults. Lithology of the System is formed of fine-grained tuff which is trachybasaltic to trachyandestic in composition. Due to intensive lateral pressure, most of fine-grained tuff is fissile and metamorphosed into green schist. The System is supposed to be of some 1,500 m thick.

At the southwest, the System abuts against the Middle Triassic with faults of a NW-SE direction and comprises interbeds of limestone and marl. Intensive deformation is indicated by kink fold and microfold in the limestone. The System exceeds 1,000 m thick.

【Middle Triassic】

The Middle Triassic overspreads in the western central and southwest.

The System at the western central part is made up of massive limestone with a thickness of 800 m, and unconformably overlies the lower Triassic.

The Middle Triassic in the southwest has different rock facies on the both sides of Cretaceous System of the center. At the northeast side, mudstone is overlain by trachybasaltic to trachyandesitic fine-grained tuff in the northwest. Interbeds of mudstone and fine-grained sandstone is eminent at the bottom and massive limestone is dominated on the top in the southwest. At the southeast side, the System is made up of bedded limestone. The thickness of the System is estimated to be about 1,000 m on the both sides of the Cretaceous.

【Upper Triassic】

The Upper Triassic comprises sandstone, mudstone, and limestone. The System comes into contact with Carboniferous to Permian and Lower Triassic by unconformity and faults. The System is estimated to be of 1,500 m thick.

【Cretaceous】

The Cretaceous is widespread in the northwest and southeast of the area.

At the northwest, the System is of fault contact with the Lower Triassic and of unconformity or fault contact with the Middle Triassic. The Cretaceous is chiefly made up of fine-grained bedded tuff which is trachybasaltic to trachyandesitic in composition. The System is supposed to exceed 1,000 m thick.

At the southwest, the Cretaceous System consists of conglomerate, fine-grained sandstone and mudstone and abuts with faults against the Middle Triassic in the southwest and unconformably overlies the Middle Triassic in the northeast.

【Quaternary】

The Quaternary System in the area is Holocene sediments of alluvial fan and running rivers. The sediments are composed of pebble, sand, silt, and clay.

(2) Intrusive rocks

【Proterozoic granite】

Dikes of Proterozoic granite intrude gneisses and schists of Proterozoic in the northeast and southeast ends, with a strike of northwest-southeast trend. The granite is of medium-grained biotite granite with a tint of pale pinkish to gritty pale pinkish. Under the microscope, the granite is of holocrystalline granular texture, being composed of alkali feldspar, plagioclase, and quartz with a small amount of biotite.

【Permian ultramafic rocks】

The ultramafic rocks of Permian in age intrude sediments of the Devonian to Permian in the central area, with forms of dike and sheet trending mainly E-W to WNW-ESE direction.

The ultramafic rocks are chiefly of compact peridotite which is, under the microscope, composed of olivine, clinopyroxene and plagioclase in a granular texture. Most olivine has been serpentinized.

【Early Triassic gabbro and dolerite】

Dikes of gabbro and dolerite, with the preponderance of gabbro, of early Triassic in age are widespread throughout the area, except an area in the south where Paleozoic and Mesozoic Systems underlie. Dikes extend generally in NW-SE and WNW-ESE, in accordance with a structural trend of intruded rocks.

Under the microscope, both gabbro and dolerite are ophitic in texture and consist chiefly of clinopyroxene and plagioclase.

【Early Triassic dikes of trachyte】

The dikes of trachyte occur only in the Lower Triassic at the west of Toc River Fault Zone. All dikes extend in NW-SE direction according to a strike of tuff of Lower Triassic in age.

The dikes are of trachyte and quartz-bearing leucocratic trachyte. The texture of both rocks is trachytic, with the groundmass of abundant potassium feldspar. Phenocrysts are also of potassium feldspar if exist.

【Cretaceous granite】

An outcrop of Cretaceous granite is located in the northern central area. The rock is medium- to coarse-grained biotite granite of the holocrystalline granular texture.

【Cretaceous syenite】

The syenite intrudes the Cretaceous and Lower Triassic in the northwest, Lower Triassic in the west, and Upper Ordovician to Silurian and Lower Devonian in the south. The rock is holocrystalline porphyritic in texture and both of phenocrysts and the groundmass are made up of abundant potassium feldspar.

【Cretaceous gabbro】

Altered alkali gabbro intrudes trachybasalt lava and pelitic rocks of Cretaceous in age. The gabbro consists of potassium feldspar, clinopyroxene, alkali amphibole and concomitant secondary biotite.

(3) Geological structure

【Folding】

The area suffered from tectonic movements, such as formation of rift at the Indosinian period and collisions of plates afterwards. In most areas, strata dip steeply and an entire image of folding is not seized in detail.

【Faults】

Faults are of four systems, being of NW-SE, WNW-ESE, N-S and NE-SW direction. These are complicated and a sequence of generation is not clarified. Trends of many faults are in accordance with those of extension of rocks which constitute the geological units.

(4) Mineralization and alteration

There are mineralized zones of gold, copper, lead and zinc and these are grouped as follows.

【Mineralized zones in Cretaceous System at the northwest】

Three localities of mineralized zones are known.

Mineral showing at Ban Cho is situated at the east of brook in the upper reaches of Kan Stream in the northwest. Galena-bearing floats have been found in the area of pelitic to fine-grained tuff of the Cretaceous. The floats are of vein-type, with galena, sphalerite and quarts. A massive sample yielded 34.5 % Pb.

Mineral showing at Lan Tio is located at the right bank of middle reaches of Kan Stream in the northwest. A quartz vein of 1.5 m wide crops out, with a small amount of chalcopyrite and specularite, in sandstone of the Cretaceous. A sample returned 1.65 % Cu.

Mineral showing at Phai Lay is situated at the right bank of middle reaches of Lang River in the northwest. There developed are several lenses comprising pyrite, chalcopyrite and quartz. The mineralized zone ranges from 0.1 to 0.3 m in width, extending 1 to 3 m in length. Samples assayed 0.04 to 0.88 % Cu.

【Mineralized zones in the Middle Triassic at the northwest】

Four localities of ore deposits and mineralized zones are known.

Ore deposit of Suoi Tiat is situated in the upper reaches of Tiat Stream, a tributary of Bua River. The deposits are being mined by local people on a small scale. A yield of gold stands at around 100 g a month. The ore deposits consist of several bodies, being concordant with the schistosity of tuff, which is trachybasaltic in composition. Unit bodies are of parallel banding of ores of 1 to 5 cm wide, intercalated with chloritized host rocks. Mineralized zone ranges from 0.05 to 0.5 m in width, extending around 10 m in length. Ore minerals are chiefly of pyrite and chalcopyrite. Gold grains of about 25 μ in size occur in openings of idiomorphic pyrite crystals. Gangue minerals consist of transparent to translucent massive quartz and chlorite, with a little amount of concomitant barite. Assays of ore returned results of 0.2 to 6 g/t Au and 1 to 6 % Cu.

The mineralized zone of Suoi Bao is situated at some 2.5 km west of Suoi Tiat deposits. The zone is of wide veins of quartz with sporadic chalcopyrite, pyrite and specularite. Malachite occurs along cracks of the veins. Quartz is massive and translucent. The veins grade at low values.

The mineralized zone of Suoi Let is located at some 5.5 km southwest of Suoi Tiat deposits. Mineralization is of bedded ores parallel to schistosity planes in trachybasaltic tuff of Triassic in age. The mineralized zone is 0.27 m in width. Main ore minerals are chalcopyrite and pyrite.

The mineral showing at Suoi Hanne is situated at the upper reaches of Hanne Stream, a tributary of Da River. Mineralization is noticed along schistosity planes in fine-grained trachybasaltic tuff, consisting mainly of quartz with a small amount of pyrite and chalcopyrite. Vein width ranges from 0.3 m to 2 m at the maximum.

【Mineralized zones in the area of Lower Triassic in the west】

The zones refer to mineralized zone at Suoi Boc and mineral showing at Suoi Cu. Details of these are given afterwards.

[Mineralized zones in the area of Middle Triassic in the southwest]

The mineral showing at Ban Suoi Ton is situated at the middle reaches Han Stream in the southwest. Floats of quartz veins are found at two localities. Each vein carries a little amount of galena and anglesite.

The mineral showing at Ban Suoi Tion is at the upper reaches of To Lai Stream in the southwest of the area. Mineralization is chiefly of galena spotted, marbled and disseminated in limestone of middle Triassic. Small amounts of anglesite and barite are accompanied. A sample returned 17.2 % Pb.

[Mineralized zone in the area of dolerite at the central area]

The disseminated chalcopyrite and sphalerite in dolerite dike is located at about 3.3 km west of Ban Ngnon village in the central area. A subordinate amount of ilmenite and a little amount of limonite are accompanied. A width of mineralized zone is 2.2 m. Intruded are limestones of late Carboniferous to Permian in age.

[Mineralized zone in the area of Middle Devonian at the east]

Trenches were dug at the upper most reaches of Can Stream, a tributary of Khac Stream in the east of the area. Vertical fissures in gritty massive limestone of Middle Devonian are filled with an aggregate of brecciated ore and limestone crushed into white powder. The ore mineral is only galena. Gangue minerals include calcite, dolomite and quartz. A sample assayed 8.9 % Pb.

3-1-2. Geochemical survey

(1) Geochemical survey of stream sediments

Based on a geochemical feature of the area, the geochemical survey was conducted at all over of Van Yen Area, to sort promising zones for ore.

Among geochemical anomalous zones obtained, the origins of anomaly are inferred as follows.

Anomalies of gold and copper in the vicinity of Suoi Tiat are situated in the area of Lower Triassic. Within the anomalous zone, the bedded cupriferous pyrite deposits of Suoi Tiat are located and the anomalies of gold and copper are assumed to be related with the ore deposits.

The anomalies of lead and zinc are detected in a zone of 10 by 4 km, centered at 4 km northwest of Phu Yen. The anomalous zone is situated in the area where many intrusive bodies of syenite are known in broadly prevailing Cretaceous rocks. Within this zone, mineral showing of

Ban Cho exists, being of float of quartz with concomitant galena and sphalerite.

(2) Geochemical survey of heavy minerals

Existing data show that mineralizations of gold, copper, lead, and zinc, and of platinum, copper and nickel have been known. The survey is implemented to delineate specific features in their occurrences of heavy minerals and to find out new mineral showings.

Heavy minerals directly related to the zones of mineralization mentioned above are native gold and copper minerals. These minerals are detected in concentration and the their origins are inferred at the following places.

【Anomalous zones of native gold】

The anomalous zone, some 3 km west of Gia Phu in the west is underlain by lower Triassic system. The zone is situated at the northwest of operating mine of Suoi Tiat. A number of gold grains detected in the anomalous zone was less than that of gold grains obtained at the down stream of the mine.

The anomalous zone at Let Stream in the west overlies the lower Triassic system. Mineralized zone of Suoi Let is situated in this anomalous zone, and similar to that of Suoi Tiat mine.

【Anomalous zone of copper minerals】

The anomalous zone at Tiat Stream in the west is situated around Suoi Tiat mine. Anomalies are considered to be originated in debris of the mine which contains copper minerals.

3-2. Suoi Boc - Suoi Cu zone in Van Yen Area

3-2-1. Detailed geological survey

(1) Stratigraphy

Rocks in the zone are, from the bottom to upwards, a series of volcanic rocks, pyroclastic rocks, and limestone of Early Triassic, a sequence of sedimentary rocks of Middle Triassic and unconsolidated sediments of Quaternary. Intrusive rocks are of dacite porphyry and aplite of Cretaceous in age.

The Lower Triassic System is distributed in the east of the zone, and composed of trachybasalt, its tuff and limestone.

The zone is occupied largely by the Middle Triassic System of two facies, one is clastic sediments chiefly of mudstone, accompanied by fine- to coarse-grained sandstone, siltstone and conglomerate, and another is of limestone.

The Quaternary extends north-southerly in a belt of low land in the west.

Dacite porphyry and aplite occur as small intrusive bodies in clastic sedimentary rocks at the vicinity of boundary between limestone and clastic sediments in the west.

(2) Geological structure

Beddings are partly developed in mudstone, siltstone and most of limestone in the zone. They strike N-S to NNE-SSW and dip often steeply at angles more than 50°. Steeply to vertically dipping strata of clastic sedimentary rocks of Middle Triassic are accumulated in the east and the southern central part of the zone.

The zone is located within Da River mobile belt and complex folding is believed to have been formed. Data at the surface indicate the repetition of anticlines and synclines around north-south trending axes with a wavelength of about 500 m where clastic sedimentary rocks interbed with limestone of Middle Triassic.

Faults in the zone trend N-S, NNE-SSW and NW-SE. The Middle Triassic abuts against the Lower Triassic with N-S trending faults.

(3) Mineralization

Lead and zinc mineralization is known at Suoi Boc and Suoi Cu.

No outcrop exists at the mineralized zone of Suoi Boc. Float of ore is observed in the dump derived from pits sunk by Geological Survey. Five pits were sunk in the vicinity of the adit, but mouths of all pits collapsed. The pits are of 8 to 10 m in depth. One of the pits is recorded to have delineated a mineralized zone of galena and sphalerite ranging from 0.1 to 1.0 m in width. Ores collected around the pits consist of cerussite and sphalerite, with small amounts of concomitant pyrite, galena and anglesite.

Two trenches have been excavated at the mineral showing of Suoi Cu. At the eastern trench, a block of 130 by 70 cm of massive ore in brecciated limestone is noticed on the western wall. Interstices of breccia are filled up with soil. The block of ore consists chiefly of smithsonite and cerussite and accompanies small amounts of sphalerite and anglesite.

3-3. Suoi Boc zone in Van Yen Area

3-3-1. Geochemical survey of soil

(1) Outline

The geochemical survey over an area of 4 sq. km aims at detecting of promising zone for mineral prospect in the surrounds of the mineralized zone of Suoi Boc.

Sampling was of intervals of 100 m on geophysical traverse lines, except the vicinity of mineralized zone at Suoi Boc where the 50 meter interval was adopted.

(2) Result

Anomalous zones of zinc were observed at three places in the west and one in the central part.

3-3-2. Geophysical survey

(1) Outline

The geophysical survey aims at narrowing the promising zone for mineral prospect by sorting of IP anomalies related to mineralization.

Resistivity and time-domain IP methods were conducted by the graded electrode configuration on an area of 3 sq. km, with 306 stations in total on the traverse lines of 15.8 km in length.

(2) Results

Noticed is a zone of low resistivity, extending from the northeast to the central part. In the laboratory, limestone is of high resistivity and mudstone is of low resistivity. From these, the zone of low resistivity is inferred to correspond to a distribution of mudstone, and high resistivity indicates an area of limestone.

Intensive IP anomalies have been detected at the northeast end and the central part. Chargeability of cores drilled in these zones gave high values correlative to field measurements. The microscopic observation indicates that the intensive IP anomalies are of graphite in origin.

In the laboratory, the chargeability of ore is moderate and no difference is discriminated against that of sandstone. IP anomalies were undetected at the vicinity of pits in the mineralized zone of Suoi Boc, probably due to the chargeability of ore conjointly with a small scale of the zone.

3-3-3. Trenching

(1) Outline

Four blocks of anomalous zone have been delineated by geochemical survey of soil, in the surrounds, the south and the north of Suoi Boc mineralized zone, and the central part.

Three trenches were dug at blocks in the surrounds and the north of Suoi Boc mineralized zone to clarify the geology and its mineralization.

(2) Results

The silicified zone with concomitant quartz veins in the trench MJT-1 is of 1 m wide and strikes north-south with a dip of 80°E. At about 15 m south, there exists the pit which yielded ore of lead and zinc. The width of mineralized zone in the pit is similar to that of silicified zone in the trench, and from this, the silicified zone is assumed to form a series with mineralization in the pit.

In the anomalous block in the north of Suoi Boc mineralized zone, brecciated veins, stockworks or veinlets of limonite were observed in limestone. Zone of prevailing veins to veinlets roughly coincides with the anomalous zones of geochemical survey. Geochemical anomaly of zinc is inferred to have delineated the mineralized zone comprising brecciated veins, stockworks or veinlets in limestone.

3-3-4. Drilling

(1) Out line

Four holes were drilled totaling 742.70 m to investigate mineralization in depths at anomalous areas of zinc in geochemical and of chargeability in geophysical survey.

(2) Results

With combination of surface and subsurface geology of drilled holes, a monoclinal structure with a strike of N-S to NNE-SSW and a dip ranging from 20° to 70°E, becoming steeper toward east side. Lithology is, from the bottom to upward, of limestone, sandstone and siltstone and mudstone.

Ore minerals in drilled cores consist of pyrite, chalcopyrite, hematite and goethite.

Gangue minerals are of carbonates and quartz.

Mineralization is displayed in forms of small vein to stockwork and dissemination in clastic sedimentary rocks and of brecciated vein, and small vein to stockwork in limestone. Contrary to expectation, skarn minerals were not found in limestone and in clastic sedimentary rocks. Alteration is only of weak silicification in clastic sedimentary rocks. Possibility of skarn deposits in the west is regarded to be small.

Veins, stockworks and small veins are accompanied only with iron oxides such as limonite. No lead or zinc minerals are observed in drilled cores. An analysis reveals that these veins are almost free from lead and zinc.

Limestone caves are common in limestone, allowing free flow of underground water to depths. Oxidation and leaching advanced to depths, and possibility is deemed to be small of primary sulfide minerals remained within drilled depths. Thus, lead and zinc deposits in a large scale cannot be expected in a shallow depth of anomalous zones delineated by the geochemical survey.

3-4. Regional survey of Western Thanh Area

3-4-1. Geological survey

(1) Stratigraphy

【Cambrian】

The Cambrian System lies at the northeastern end and the southwestern end of the area.

At the northeastern end, rocks consist chiefly of pelitic schist. The System is estimated to be of 500 m thick.

At the southwestern end, the System is composite bodies comprising granodiorite to diorite, their gneisses and pelitic schist. Unmetamorphosed bodies are chiefly made up of coarse-grained biotite granodiorite.

The System abuts against the Middle Triassic by faults at the northeastern end. At the southwestern end, it abuts against unclassified Jurassic or is unconformably overlain by the latter.

【Upper Ordovician to Silurian】

The System forms three elevated zones in the vicinity at the south of Bu Ginh Mountain in the central area and in the vicinity of Chu River in the southeast. The elevated zones are in a line extending NW-SE. The System is unconformably overlain by the Middle Triassic or unclassified Jurassic, and intruded by granite, etc. in some places.

The System at the southeast is made up with phyllitic mudstone. At the central area, the

System consists of banded pelitic schist, most of which is metamorphosed into medium-grained hornfels associated with biotite and hornblende.

The System is estimated to be of 1,500 m thick.

【Silurian to Lower Devonian】

The System is distributed at the northern end of the area. It abuts by faults against gabbro and granitic body at the south and against the Middle Triassic at the north. The eastern end of the System is unconformably overlain by the Middle Triassic. The System is intruded by gabbro in places.

The System consists chiefly of fine-grained massive sandstone and phyllitic mudstone and is estimated to be around 1,000 m thick.

【Upper Devonian】

The Upper Devonian is situated only in the northeastern end, and abuts against the Middle Triassic of the northwest side by faults of NNW-SSE, and against the Upper Permian to Lower Triassic of south side by faults.

The System is made up of clastic sedimentary rocks in the major part, with the preponderance of mudstone, and limestone intercalated at lower and upper horizons. The total thickness of the system is assumed to be 2,000 m.

【Carboniferous to Permian】

The System is situated in the left bank of Am River in the southeast, and abuts against the Upper Permian to Lower Triassic by faults.

The System is made up of massive limestone and is estimated to exceed 1,000 m thick.

【Upper Permian to Lower Triassic】

The System lies broadly in the eastern area and abuts at the left bank of Am River against the Middle Triassic by faults of NNW-SSE trend. In the southern area, the System is overlain unconformably by the unclassified Jurassic System.

The System consists of clastic sedimentary rocks in the major part, and limestone intercalated at middle and upper horizons. Generally, clastic sedimentary rocks are widely distributed and limestone is of limited spread. The sedimentary rocks are chiefly made up of mudstone. Most limestone is of poorly bedded.

The thickness is inferred to exceed 1,500 m.

【Middle Triassic】

The Middle Triassic is distributed in the east, the northwestern end and the western end. In the east, the System generally abuts by faults of N-S and NNW-SSE directions against other geological units including some of intrusive rocks. At the northwestern end, the System is intruded by intrusive rocks and is overlain by the unclassified Jurassic. At the western end, the System abuts by faults against the unclassified Jurassic or is overlain unconformably by the latter.

The System consists of clastic sedimentary rocks in the principal part and intercalated limestone layers in lower and upper parts. The clastic sediments in the east are mainly formed of interbeds of mudstone with siltstone. The limestone is massive and divided into three members of lower, middle and upper horizons. The System at the western end is made up of limestone.

The total thickness of the System is estimated to be of 2,000 to 3,000 m.

【Unclassified Jurassic】

The Jurassic System lies widely in the southwestern side of the line connecting the southeast end with northwest end.

The System is characterized with felsic volcanic activities and displays almost homogeneous rock facies over a wide range, consisting chiefly of massive dacitic crystal tuff. The thickness is estimated to be of 2,000 to 3,000 m.

【Quaternary】

The Quaternary System refers to alluvium of Holocene including sediments of fans in mountainous basins and of running rivers. Sediments are of gravel, sand, silt and clay.

(2) Intrusive rocks

【Gabbroic rocks of Late Triassic】

The gabbroic rocks intrude mainly into the Middle Triassic. The rocks are of medium- to coarse-grained, compact holocrystalline. Under the microscope, the rocks are made up of clinopyroxene and plagioclase being of the maximum diameter of 10 mm, with secondary minerals of chlorite and actinolite in places.

【Granitic rocks of Late Cretaceous to Paleogene Tertiary】

The granitic rocks intrude into the Lower Paleozoic, the Middle Triassic, the unclassified Jurassic and gabbro.

The rocks of biotite granite are of medium- to coarse-grained holocrystalline. A large amount of potassium feldspar of 10 mm in diameter is included in part. A part of granitic rocks in the vicinity of Bu Me is porphyritic in texture.

【Syenitic rocks of late Cretaceous to Paleogene Tertiary】

The syenitic rocks intrude into the same geological units which are intruded by granitic rocks of Late Cretaceous to Paleogene Tertiary. An outcrop on the right bank of Chu River is of medium-grained holocrystalline with a large amount of amphiboles and plagioclase. The two occurrence in the north of Bu Me Mountain are of dikes which are porphyritic in texture.

【Dikes of felsic rocks of late Cretaceous to Paleogene Tertiary】

The dikes are of dacite porphyry and rhyolitic rocks.

(3) Geological structure

【Folding】

Schistosity and bedding are developed in metamorphic and sedimentary rocks of Paleozoic System through out of the area, but except a part of pelitic rock, the most of the Upper Permian to Middle Triassic and the unclassified Jurassic are massive. Thus, details of folding are not clarified. Megascopic trends of NW-SE to NNW-SSE of metamorphic and sedimentary rocks and intrusive rocks of each period, indicate repetitions of folding around axes of these trends.

【Faults】

According to the analysis of HRV images in XS mode of SPOT, the area is divided in to three blocks by two faults, one being of a N-S trend in the west and another being of a NNW-SSE trend in the east. The western fault extends toward north beyond the area with divergence of similar directions and controls geological distribution around the area. Sandstone and tuff along this fault are mylonitized.

(4) Mineralization and alteration

Mineralized zones and mineral showings of gold, copper, tin and tungsten are known at Luong Son, Hon Mo, Hon Mo north, and Bu Me.

【Mineralized zone of Luong Son】

Details of this zone are given afterwards.

【Mineralized zone of Hon Mo】

Hon Mo prospect is situated in the western branch of the upper reaches of Hon Luo River which runs southerly on the eastern central part of the area. The zone is supposed to have been mined for copper around 1930 by Chinese people. Old adits are not known, but a waste dump of 50 × 20 × 1.9 m remains. A small pit is located beyond a brook at the north, where a massive sulfide ore of 70 cm long, 160 cm wide and 50 cm high as exposed, is observed in diorite. The ore comprises pyrite, pyrrhotite and sporadically scattered chalcopyrite in quartz.

【Mineralized zone of Hon Mo north】

The mineralized zone is located at around 800 m north of Hon Mo prospect. The zone is of calcite vein disseminated with pyrite and chalcopyrite. The vein is of 0.25 m wide in marble of the middle Triassic.

【Mineralized zone of Bu Me】

Tin and tungsten mineralizations are developed around porphyritic granite and hornfels. Cassiterite, wolframite, pyrite and pyrrhotite occur with forms of vein, stockwork and dissemination in quartz.

There are two blocks. The north block extends 1,200 m in N-S direction and 400 m in E-W direction. The mineralized zone is mainly around porphyritic granite and around zones of hornfels in its vicinity. A previous investigation by trenching returned an average grade of 0.33 % Sn+W.

At the south block, the zone is seemed to be subdivided into three orebodies in slightly altered siltstone of the Triassic. A larger orebody is of 400 by 300 m and a smaller orebody is 100 m by 100 m in size. Orebodies are of low density in general. Trenching totaled some 390 m in length, but only one assay was recorded being of 0.42 % Sn+W.

3-4-2. Geochemical survey

(1) Geochemical survey of stream sediments

Based on a geochemical feature of the area, the geochemical survey was carried out at all over of the western Thanh Hoa Area, to select promising zones for mineral prospects. Among anomalous zones obtained, the origins of anomaly are assumed at the following places.

An anomaly of arsenic at 18 km west-northwest of Thuong Xuan lies on an area of Jurassic. A small zone disseminated with pyrite at the upper reaches is supposed to be an origin of the anomaly, though a content of arsenic has not been assayed.

An anomaly of tin at 12 km west-southwest of Thuong Xuan also lies on an area of Jurassic. Quartz veins are situated at the upper reaches and an anomaly of tungsten is located at the further upper reaches. Granitic rocks are distributed in the east and in the west of the anomalous zone.

Geochemical anomalies of tungsten are concentrated in an area of 1.5 by 2.5 km, centered by Bu Me mine. An anomaly of arsenic is found in the northwest of this area. The Bu Me mine comprises veins and stockworks of quartz-cassiterite-wolframite, disseminated ore of cassiterite, and occurrences of arsenopyrite in porphyritic granite and hornfels. The combination of these minerals stands for geochemical anomalies of tin and arsenic.

An anomalous zone of tungsten has been obtained in an area centered by Te Leo Mountain at 17 km west-southwest of Thuong Xuan. The zone is underlain by granitic rocks.

(2) Geochemical survey of heavy minerals

Existing data show mineralized zones of gold and copper, and zones of tin, tungsten and molybdenum. The survey is to seize specific features of heavy minerals against these occurrences, and to discover new prospects.

Among heavy minerals extracted in this area, native gold, cassiterite and wolframite are considered to be directly related with the mineralized zones. One of these minerals is concentrated in some places, but the mineralized zone of Bu Me is only assigned its origin.

3-5. Luong Son zone

3-5-1. Detailed geological survey

(1) Geology

The area comprises sedimentary rocks of the Middle Triassic, gabbro of Late Triassic intrusion, pyroclastic rocks of the Jurassic, and unconsolidated sediments of the Quaternary.

The Middle Triassic is widely distributed through out of the area, and consists of fine- to medium-grained hard sandstone. Mudstone is intercalated in some places at the east.

The unclassified Jurassic is known at the narrow zone in the southeastern end, being of floats of dacitic crystal tuff, and is assumed to overlie unconformably the top of sandstone of the Middle Triassic.

Five bodies of coarse-grained intrusive rocks are found in the sandstone of the Middle Triassic, ranging from 100 to 300 m in width with elongation of a N-S direction.

(2) Geological structure

Most of sandstone of Middle Triassic are massive, and bedding planes are observed at six places only. Strikes of bedding are not consistent, probably extending toward a NNW-SSE direction.

Two faults are known in the east and in the south, running NNW-SSE and NW-SE respectively.

(3) Mineralization

Gold-bearing hydrothermal quartz veins are crowded into sandstone and mudstone of the Middle Triassic. Veins are of about 1 m in width and are made up of quartz with limonite and goethite. Under the microscope, a small amount of chalcopyrite is observed in some of the veins. Quartz is translucent and massive. Gold values graded up to 0.24 g/t.

Generally, sandstone and gabbro near veins are intensively silicified and a large amount of chlorite is yielded in part of gabbro. A wide zone of kaolinized hydrothermal alteration is observed to the east of gabbro in the central part of the area. Detailed geological survey shows that the zone is 600 m wide and elongated in a north-south direction.

3-5-2. Geochemical survey of soil

(1) Outline

Based of geochemical features of mineralized zones, the survey aims at finding of mineral prospects.

Sampling lines are spaced at intervals of 200 m at the area of small relief in the northeast, and are placed along ridges in other lands. Samples were collected at an interval of 100 m, totaling 207 in number.

(2) Results

Gold averaged 20 ppb with the maximum value of 220 ppb. Correlation of elements is generally small, and only small correlation is noticed in elements of Cu-Pb-Zn and As-Sb.

Patterns of anomalous zones of gold are not related with host rocks or distributions of quartz veins. Apparent continuity is not observed in allocations of zones anomalous in gold.

Chapter 4. Discussion and conclusion

4-1. Discussion

(1) Regional survey of Van Yen Area

Mineralizations of gold, copper, and lead zinc, and of platinum, copper and nickel are known in this area. Geological survey and assay results of samples indicate absence of remarkable mineralization of elements other than those mentioned above.

Gold occurs in bedded cupriferous pyrite deposits which associate with areas of mafic to intermediate alkali volcanic rocks. The mineralization is closely related with these volcanic activities which started at early Triassic. Da River mobile belt of this time was at the formative period of rifts. Brisk alkali volcanic activity seems to have arisen along zones of submergence in rift trough surrounded by many normal faults, and followed by mineralization of gold-bearing sulfide minerals.

Anomalies of gold and copper in the surrounds of Suoi Tiat mine correspond to the mineralization of bedded gold-bearing cupriferous pyrite deposits of Suoi Tiat.

As for copper, quartz veins with a small amount of copper minerals are developed in zones of the lower Triassic. Most veins are discordant against schistosity of wall rocks and not metamorphosed. Thus, the veins are inferred to be related with felsic volcanism during Cretaceous time.

Mineralizations of lead and zinc are of hydrothermal veins in wall rocks of the Middle Devonian, the Carboniferous to Permian or the Triassic limestone. Except the mineralized zone of Suoi Boc, mineral showings have not felsic igneous rocks in the vicinities, nor occur in fields of a specific structure.

Geochemical anomalies of lead and zinc have been delineated in an area of 10 by 4 km centered at 4 km northwest of Phu Yen in the northwest. The area is widely underlain by the Cretaceous which many bodies of syenite intruded in. The mineral showing at Ban Cho exists in this anomalous zone in a form of float of quartz accompanied with galena and sphalerite.

The character of mineralization of platinum, copper and nickel is of convergence in ultramafic rocks of small scale and their vicinities. Many ultramafic rocks of Triassic in age intruded widely from the west to the east. Mineralization of this type is of a low grade and does not give a pattern of anomalous dispersion of these elements in the geochemical survey.

(2) Suoi Boc zone

The character of the geological structure in Suoi Boc zone is of a N-S to NNE-SSW direction displayed by a strike of sedimentary rocks, a distribution of intrusive rocks, faults and the distribution of the Quaternary in the west.

Quartz veins and the silicified zone found at trenches in clastic sedimentary rocks in the west run in a N-S direction. Brecciated veins in limestone trend NNW-SSE, N-S or NNE-SSW.

A lump of ore containing lead and zinc was found in a pit at the mineralized zone of Suoi Boc. The ore consists chiefly of cerussite and sphalerite, with a small amount of pyrite, galena and anglesite. The mineralized zone is inferred to be of vein-type deposits of a N-S strike in clastic sedimentary rocks.

Thus, mineralized zones of lead and zinc are considered to be under the control of the geological structure of a N-S to NNE-SSW direction and accompanied with intrusions of dacite porphyry and aplite.

The geochemical survey of soil revealed an existence of four anomalous zones for zinc.

Trenches in the anomalous zone around Suoi Boc mineralized zone delineated two types of mineralization, one being of limonite-bearing silicified belt and another being of stockworks to narrow veins of limonite in limestone. The geochemical anomaly obtained in the vicinity of Suoi Boc mineralized zone is correlative with the vein-type mineralization in clastic sedimentary rocks and limestone.

Limonite-bearing breccia veins or stockworks to small veins were observed in limestone at the anomalous zone in the north of Suoi Boc mineralized zone. A zone where many veins predominate, roughly coincide with that of geochemical anomaly, and thereby geochemical anomalies for zinc are deemed to indicate a mineralized zone of breccia vein, or stockworks to narrow vein in limestone.

The geophysical survey with an IP method detected anomalous zones of high chargeability more than 60 ms, two places in the northeast of Suoi Boc, and one place in the central part. These are on a line of NNE-SSW trend in clastic sedimentary rocks adjacent to the boundary with limestone.

At two of three zones of anomalous high chargeability, holes of MJVS-1 and MJVS-4 were drilled. The geology in drilled holes is made up of black mudstone and crushed zone being of breccia of fine-grained sandstone, black mudstone, limestone and calcareous mudstone in pelitic matrix.

Laboratory study of cores assigned graphite for the origin of high chargeability, eliminating possibility of sulfide minerals.

Results of trenching and drilling suggest that ore deposits of skarn-type are not probable, due to lack of skarn minerals in clastic sedimentary rocks and limestone.

Ore deposits of vein-type occur mainly in limestone, in which many caves predominate. Oxidation and leaching of sulfide minerals extended to depths by free flow of ground-water. Grades of lead or zinc in veins have been lowered by oxidation and leaching within a range of, say, 200 m deep from the surface.

Limonite-bearing breccia veins within limestone in trenches are of the maximum width of 0.2 m. The similar veins in drilled holes range up to 1.5 m wide. A possibility of vein-type ore deposits of lead and zinc in a large scale seems to be low, because an increase of width of breccia vein is not expected in depths where sulfide minerals remain.

(3) Regional survey of Western Thanh Hoa Area

Western Thanh Hoa Area is divided into two, being of the zone of sedimentary rocks in the east and the zone of igneous rocks from the central part to the west. A distribution of mineral showings is concentrated mainly in the central part where igneous rocks prevail. Igneous activities commenced with intrusion of mafic rocks in Triassic, passing through prominent volcanic activities of felsic rocks in Jurassic, and ended with granite intrusions in Cretaceous in age.

Mafic rocks consist of several bodies in a line of NNW-SSE trend. Copper showing of a small scale was observed in the periphery of gabbro at the central part. Geochemical anomalies of copper are concentrated in the vicinity of mafic rocks, indicating connection between igneous activity and mineralization.

Mineralization of tin and tungsten is related with granite activity. In Bu Me mineralized zone, the mineralization of tin and tungsten is centered by small stock of porphyritic granite. Geochemical anomalies of these elements are concentrated in the vicinities of granitic rock bodies. Cassiterite and wolframite have been detected in granite regions and their vicinities. Thus, mineralization of tin and tungsten seems to be closely related with granites of Cretaceous in age.

Although many gold-bearing quartz veins are distributed, geochemical dispersion of gold is sporadic in all, and a sizable distribution was located at mineralized zone of Coc Thuong.

Potential of metallic ore deposits are summarized as follows.

【Gold】

Gold may occur with epithermal quartz veins, but quartz veins investigated were of a low grade.

【Copper】

Mineral showing and geochemical anomaly of copper are found in fields of mafic rocks centered at Hon Mo mineralized zone, being of a low grade. Copper deposits of a large scale does not seem to be probable, due to lack of intensive mineralization on the surface.

【Tin and tungsten】

The potential of tin and tungsten at Bu Me mineralized zone is to be brought to a conclusion with a detailed investigation and prospecting in future, but contents of tin and tungsten are not necessarily rich in existing data and samples assayed for reference.

Geochemical anomalies of tin and tungsten were found to be concentrated in stream sediments surrounding granite stocks at the southern end. A large number of cassiterite has been detected by panning, indicating a possibility of mineralized zone for tin and tungsten in the vicinities of granite.

(4) Luong Son zone in Western Thanh Hoa area

Quartz veins are distributed densely in Luong Son zone, being of low grade. An analysis yields 0.24 g/t Au. Many floats of quartz veins are also observed. Dispersion of gold in geochemical survey of soil is sporadic.

Thus, gold-bearing quartz veins of the zone are not continuous and of low grade.

4-2. Conclusion

(1) Van Yen Area

The results of regional geological survey and geochemical survey were summarized as follows.

Mineralizations in the area are of gold, copper, lead and zinc and of platinum, copper and nickel.

Gold is associated with bedded cupriferous pyrite deposits. This type of deposits is closely related with mafic to intermediate alkali volcanic activities of early Triassic in age. Suoi Tiat deposits of this type are of 1 to 6 g/t Au and 1 to 7 % Cu, but the scale of the deposits is small.

In addition to the bedded cupriferous pyrite deposits, copper is accompanied with quartz veins which are generally of large widths and contain copper minerals in part. But minable concentration of copper is not observed.

Several mineralized zones and mineral showings of vein-type of lead and zinc are known mainly in carbonate rocks of the middle Triassic. Some samples yielded high values of metal content, but a scale of deposits seems small.

Mineralization of platinum, copper and nickel occurs in ultramafic rocks and in their vicinities. Rock bodies are of a small scale being of less than 100 m in width. Metal contents are low.

Geochemical survey of stream sediments and panning did not reveal an anomalous zone which indicated noticeable mineralization.

(2) Suoi Boc zone

Surveys of geological, geochemical, and geophysical with an IP method were carried out with trenching and drilling at Suoi Boc zone in Van Yen Area. Results are summarized as follows.

Geological structure of the zone is characterized by the direction of N-S to NNE-SSW in general, displayed by strikes of sedimentary rocks and faults, distributions of intrusive rocks, and in addition, of Quaternary in the west.

Geochemical anomalies indicate an existence of vein-type deposits. No skarn minerals are noticed in anomalous zones of the middle Triassic, and a potential of presence of skarn-type deposits seems small.

Anomalies of high chargeability in geophysical survey are assigned to graphite in origin and occurrence of deposits with lead and zinc is not expected in the vicinity of anomalous field of chargeability.

Vein-type deposits, including lead and zinc, are expected in the zone, but a scale of them seems to be small.

(3) Western Thanh Hoa Area

The following conclusions were drawn from results of regional geological survey and geochemical survey.

Mineralized zones and mineral showings of gold, copper, tin and tungsten are developed in the area.

Gold-bearing veins are of low grade.

Hon Mo mineralized zone of copper, being of massive to disseminated, is in gabbro. A copper content at an outcrop is not attractive due to its small value.

Bu Me mineralized zone is of tin and tungsten mineralization and of pneumatolytic to hydrothermal related with activity of porphyritic granite. Trenches dug by Geological Survey, totaling some 320 m in length, yielded an average of 0.33 % Sn+W.

The geochemical survey indicated a high potential of tin and tungsten in the zone of granite in the southwest of the area. Yet, the present survey did not delineated an attractive zone of mineralization.

(4) Luong Son zone

Detailed geological survey and geochemical survey are implemented at Luong Son zone in Western Thanh Hoa Area. The following conclusion is drawn from the results.

Hydrothermal quartz veins are concentrated in the Middle Triassic and gabbroic rocks. A grade of gold in these veins is low with the highest value of 0.24 g/t.

Geochemical dispersion of gold is sporadic and soil samples rich in gold have not been obtained in geochemical survey of soil.

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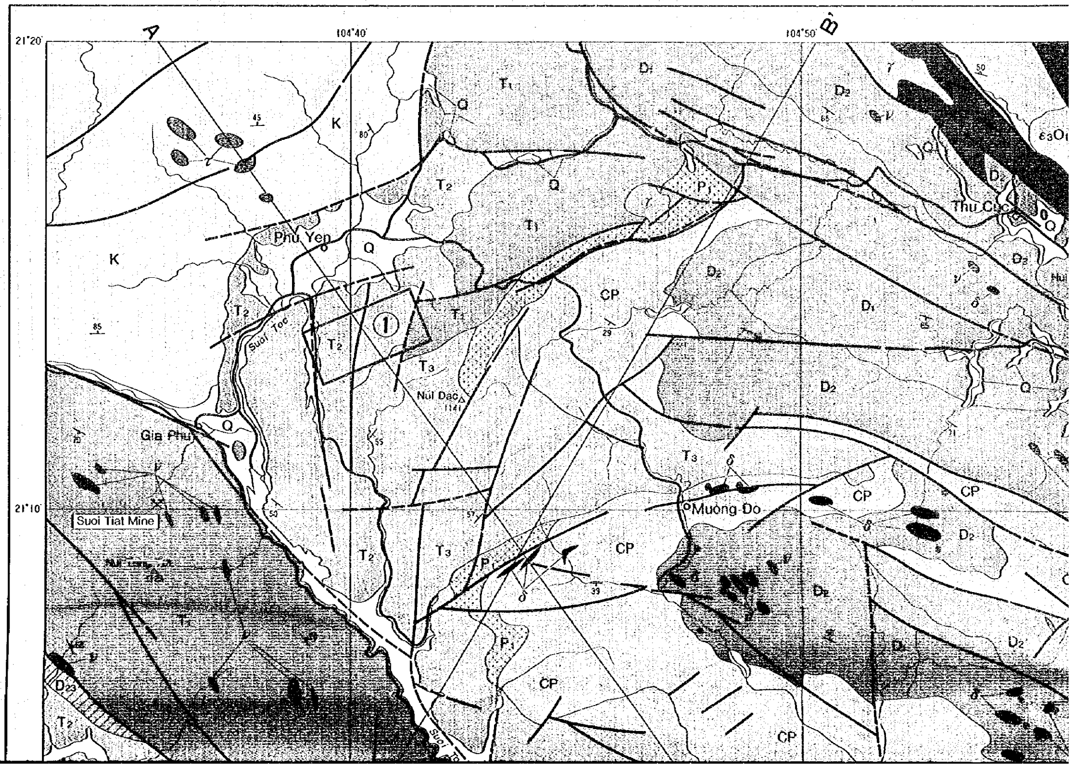
Van Yen Area



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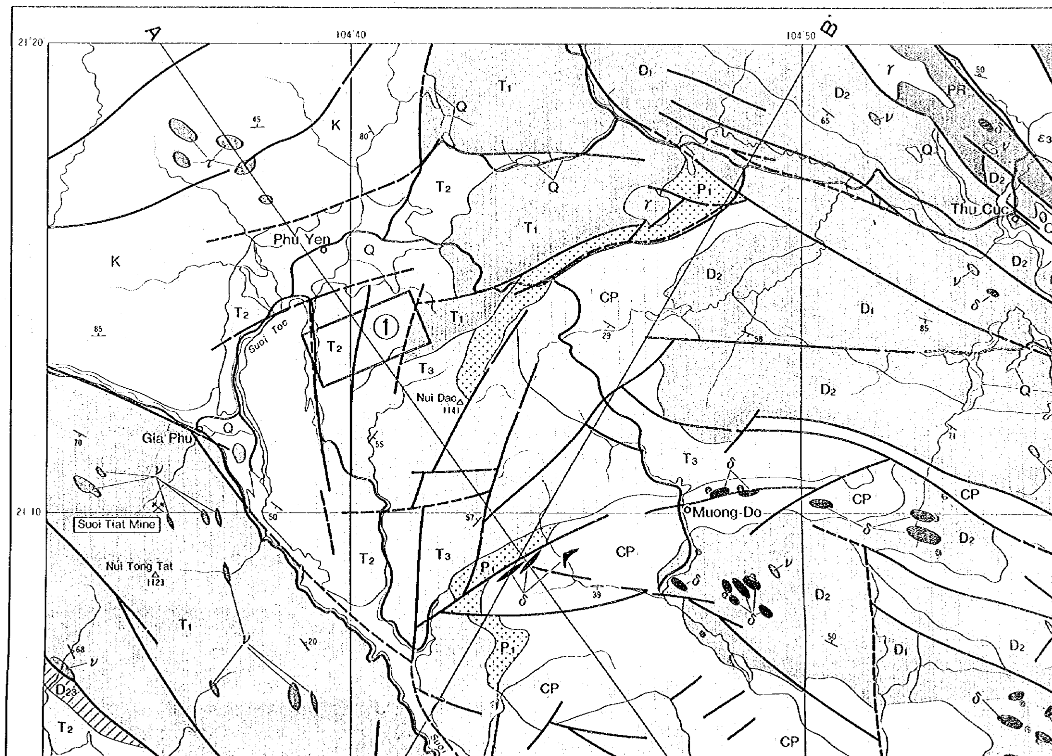

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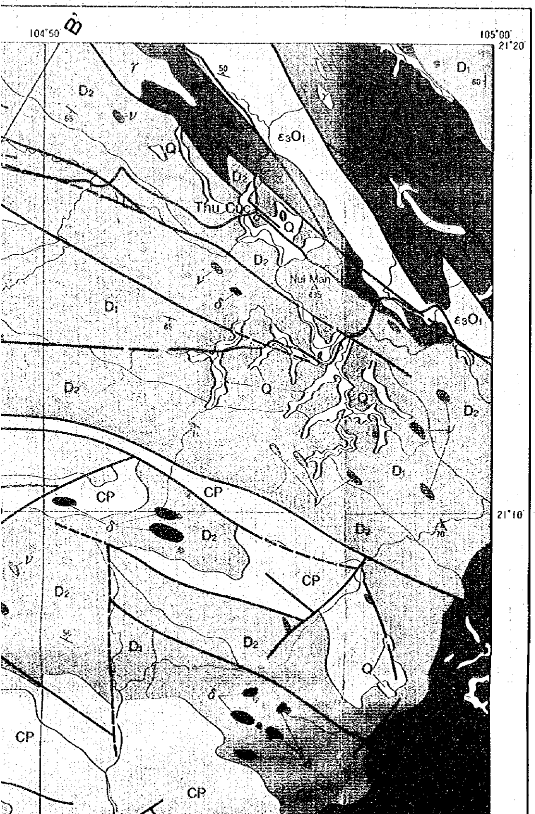

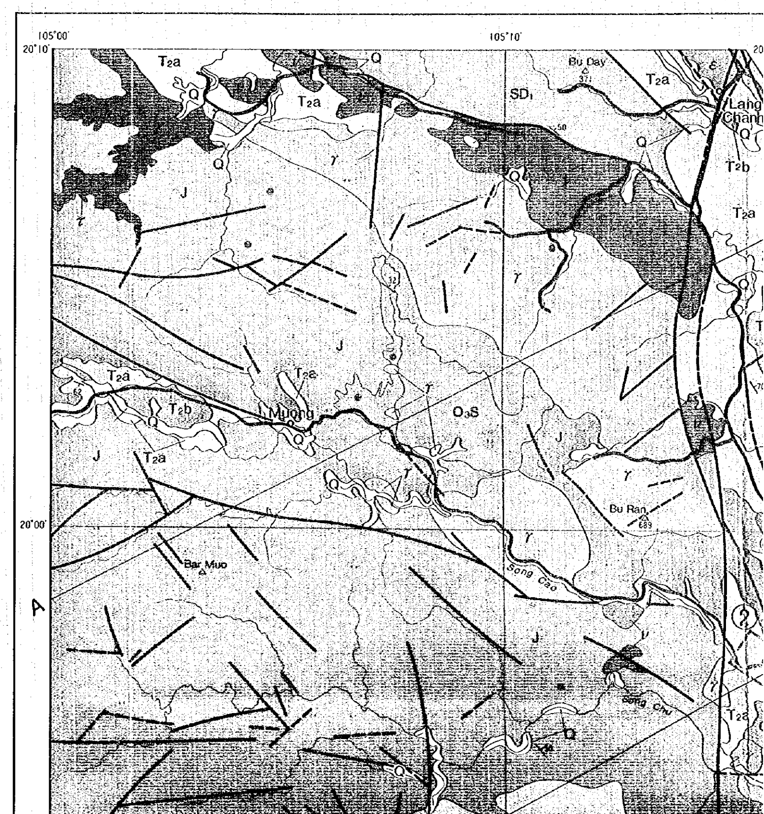

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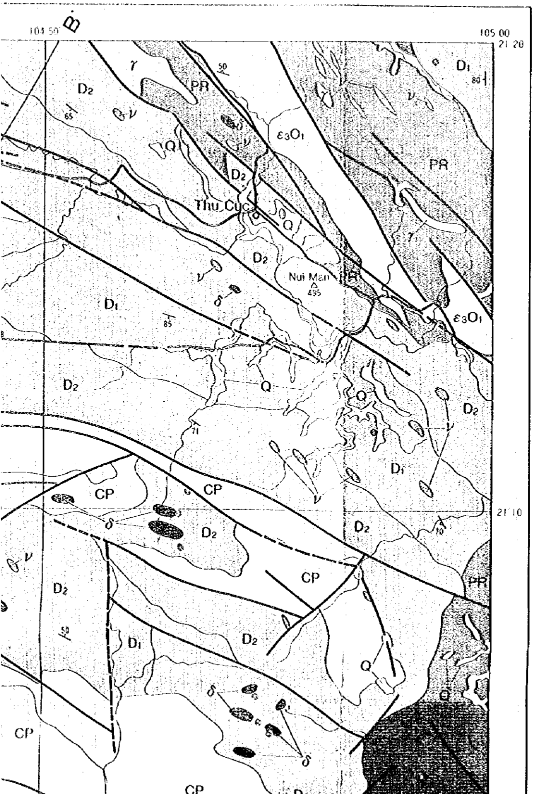

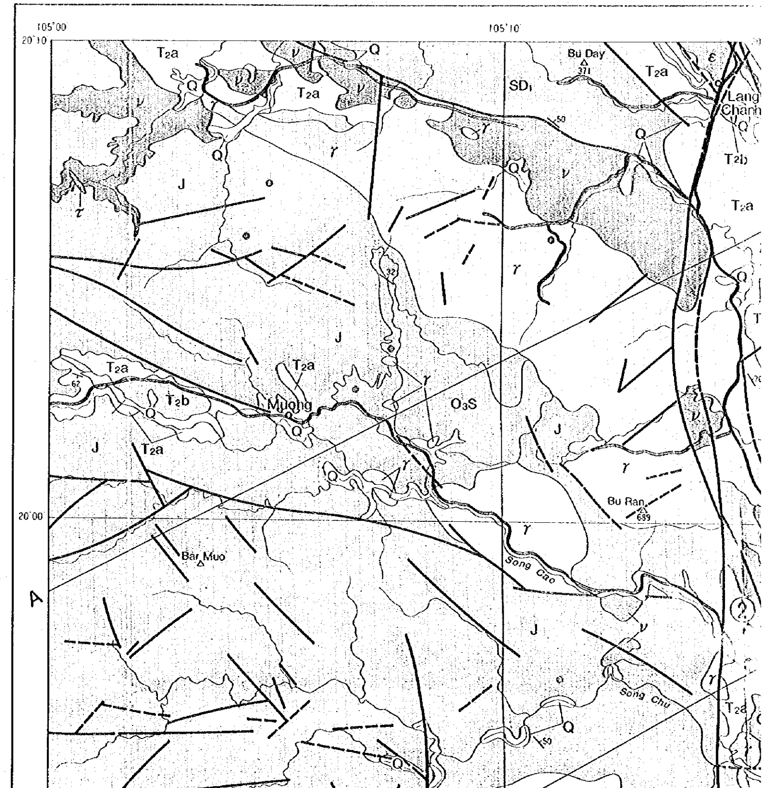

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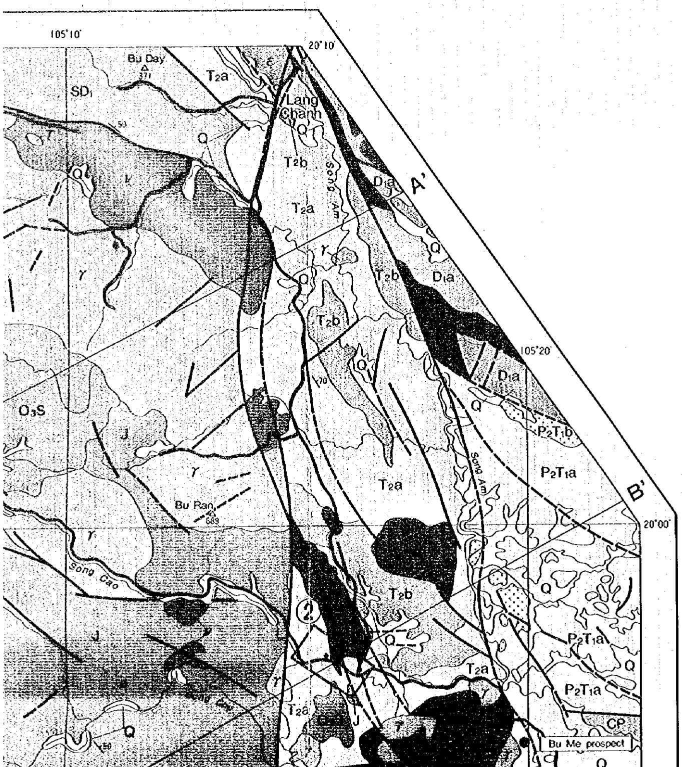

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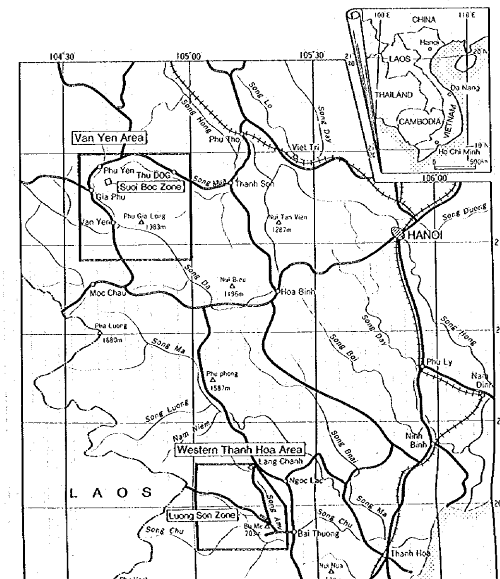

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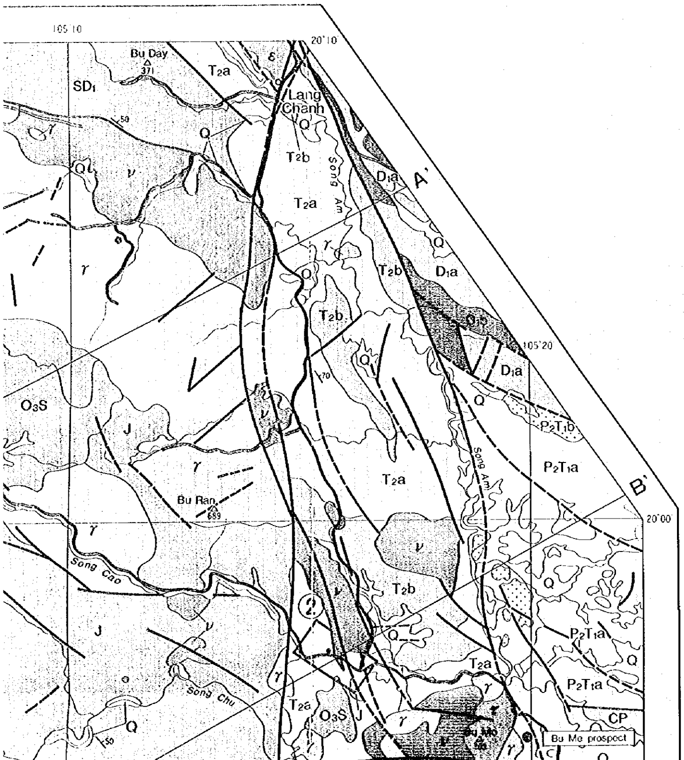

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