File No. U1045

REMARKS

Please note that the detection limits for certain Dissolved Metals have been increased for some of the samples reported in the following data tables due to sample matrix interferences.

In particular, the detection limits for the sample identified as "18588" and "18590" were increased due to limited sample volume. The detection limits for the sample identified as "18589" were increased due to elevated D-Nickel. The detection limits for the sample identified as "18591" were increased due to elevated D-Boron.

A Campbell Brothers Limited Company

File No. U1045

RESULTS OF ANALYSIS - Water

Sample ID			18588	18589	18590
ALS ID			*1*	*2*	*3*
Physical Tests					
Total Dissolved Solids			336	1600	2090
Dissolved Anions					
Chloride	Cl		0.84	29.6	198
Fluoride	F		0.254	<0.020	0.022
Nutrients					
Ammonia Nitrogen		N	0.096	0.392	0.030
Nitrite/Nitrate Nitrogen		N	0.0389	0.0814	<0.0050

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1045

RESULTS OF ANALYSIS - Water

Sample ID		18588	18588 HVAAS	18589	18589	18590
ALS ID		*1*	*1a*	*2*	*2a*	*3*
Dissolved Metals						
Aluminum	D-Al	0.303	-	0.121	-	0.0066
Antimony	D-Sb	0.00783	0.0085	<0.0050	<0.0020	0.00145
Arsenic	D-As	0.0237	0.0266	<0.0050	0.0184	0.00135
Barium	D-Ba	0.00143	-	0.0431	-	0.0537
Beryllium	D-Be	<0.0010	-	<0.025	-	<0.0010
Bismuth	D-Bi	<0.0010	-	<0.025	-	<0.0010
Boron	D-B	0.222	-	<0.50	-	0.025
Cadmium	D-Cd	<0.00010	-	0.0773	-	<0.00010
Calcium	D-Ca	1.19	-	21.3	-	14.1
Chromium	D-Cr	<0.0010	-	<0.025	-	<0.0010
Cobalt	D-Co	<0.00020	-	4.81	-	0.00044
Copper	D-Cu	0.00225	-	0.0752	-	0.00577
Iron	D-Fe	0.062	-	176	-	<0.030
Lead	D-Pb	0.00030	-	0.0140	-	0.00020
Lithium	D-Li	<0.010	-	<0.25	-	<0.010
Magnesium	D-Mg	0.72	-	22.3	-	58.7
Manganese	D-Mn	0.00258	-	9.81	-	0.00848
Mercury	D-Hg	<0.000050	-	<0.000050	-	<0.000050
Molybdenum	D-Mo	0.0295	-	<0.0025	-	0.00157
Nickel	D-Ni	<0.0010	-	276	-	0.0169
Phosphorus	D-P	<0.30	-	<0.60	-	<0.30
Potassium	D-K	8.3	-	<4.0	-	34.7
Selenium	D-Se	<0.0020	0.00100	<0.025	0.0170	<0.0020
Silicon	D-Si	2.39	-	2.56	-	4.70
Silver	D-Ag	0.000126	-	<0.00050	-	<0.000020
Sodium	D-Na	29.5	-	18.1	-	29.6
Strontium	D-Sr	0.0227	-	0.301	-	0.0921
Thallium	D-Tl	<0.00020	-	<0.0050	-	<0.00020
Tin	D-Sn	0.00032	-	<0.0050	-	0.00052
Titanium	D-Ti	<0.010	-	<0.020	-	<0.010
Uranium	D-U	0.000195	-	<0.00050	-	<0.000020
Vanadium	D-V	0.0033	-	<0.050	-	<0.0020
Zinc	D-Zn	<0.0020	-	2.48	-	0.0025

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1045

RESULTS OF ANALYSIS - Water

Sample ID			18591	18592
ALS ID			*4*	*5*
Physical Tests				
Total Dissolved Solids			2870	4190
Dissolved Anions				
Chloride	Cl		34.0	1.82
Fluoride	F		0.022	0.248
Nutrients				
Ammonia Nitrogen		N	0.051	0.154
Nitrite/Nitrate Nitrogen		N	<0.0050	0.0404

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1045

RESULTS OF ANALYSIS - Water

Sample ID		18590	18591	18591	18592	18592
ALS ID		*3a*	*4*	*4a*	*5*	*5a*
Dissolved Metals						
Aluminum	D-Al	-	<0.0050	-	0.196	-
Antimony	D-Sb	<0.0020	0.00129	<0.0020	0.00940	0.0095
Arsenic	D-As	0.00090	0.00111	0.00150	0.0132	0.0132
Barium	D-Ba	-	0.0182	-	0.00232	-
Beryllium	D-Be	-	<0.0025	-	<0.00050	-
Bismuth	D-Bi	-	<0.0025	-	<0.00050	-
Boron	D-B	-	2.50	-	0.258	-
Cadmium	D-Cd	-	<0.00025	-	<0.000050	-
Calcium	D-Ca	-	11.8	-	4.38	-
Chromium	D-Cr	-	<0.0025	-	<0.00050	-
Cobalt	D-Co	-	0.00184	-	<0.00010	-
Copper	D-Cu	-	0.0594	-	0.00149	-
Iron	D-Fe	-	<0.030	-	<0.030	-
Lead	D-Pb	-	<0.00025	-	0.000195	-
Lithium	D-Li	-	<0.025	-	0.0129	-
Magnesium	D-Mg	-	68.8	-	1.92	-
Manganese	D-Mn	-	0.0105	-	0.00335	-
Mercury	D-Hg	-	0.000079	-	<0.000050	-
Molybdenum	D-Mo	-	0.00194	-	0.0105	-
Nickel	D-Ni	-	0.121	-	0.00056	-
Phosphorus	D-P	-	<0.30	-	<0.30	-
Potassium	D-K	-	43.2	-	14.7	-
Selenium	D-Se	<0.00050	<0.0050	0.00230	0.00097	0.00100
Silicon	D-Si	-	3.84	-	2.54	-
Silver	D-Ag	-	0.000899	-	0.000038	-
Sodium	D-Na	-	79.4	-	33.0	-
Strontium	D-Sr	-	0.162	-	0.0647	-
Thallium	D-Tl	-	<0.00050	-	<0.00010	-
Tin	D-Sn	-	<0.00050	-	0.00049	-
Titanium	D-Ti	-	<0.010	-	<0.010	-
Uranium	D-U	-	<0.000050	-	0.000239	-
Vanadium	D-V	-	<0.0050	-	0.0035	-
Zinc	D-Zn	-	<0.0050	-	<0.0010	-

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1045

Appendix 1 - QUALITY CONTROL - Replicates

Water			18590	18590	18590	18590
				QC # 377152		QC # 377581
Dissolved Anions						
Chloride	Cl		198	198	-	-
Fluoride	F		0.022	0.028	-	-
Nutrients						
Ammonia Nitrogen		N	0.030	0.040	-	-
Nitrite/Nitrate Nitrogen		N	<0.0050	<0.0050	-	-

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1045

Appendix 1 - QUALITY CONTROL - Replicates

Water		18590	18590 QC # 377152	18590	18590 QC # 377581
Dissolved Metals					
Aluminum	D-Al	0.0066	0.0066	-	-
Antimony	D-Sb	0.00145	0.00148	<0.0020	<0.0020
Arsenic	D-As	0.00135	0.00148	0.00090	0.00078
Barium	D-Ba	0.0537	0.0560	-	-
Beryllium	D-Be	<0.0010	<0.0010	-	-
Bismuth	D-Bi	<0.0010	<0.0010	-	-
Boron	D-B	0.025	0.024	-	-
Cadmium	D-Cd	<0.00010	<0.00010	-	-
Calcium	D-Ca	14.1	13.9	-	-
Chromium	D-Cr	<0.0010	<0.0010	-	-
Cobalt	D-Co	0.00044	0.00042	-	-
Copper	D-Cu	0.00577	0.00584	-	-
Iron	D-Fe	<0.030	<0.030	-	-
Lead	D-Pb	0.00020	0.00020	-	-
Lithium	D-Li	<0.010	<0.010	-	-
Magnesium	D-Mg	58.7	57.6	-	-
Manganese	D-Mn	0.00848	0.00848	-	-
Mercury	D-Hg	<0.000050	<0.000050	-	-
Molybdenum	D-Mo	0.00157	0.00161	-	-
Nickel	D-Ni	0.0169	0.0165	-	-
Phosphorus	D-P	<0.30	<0.30	-	-
Potassium	D-K	34.7	34.3	-	-
Selenium	D-Se	<0.0020	<0.0020	<0.00050	<0.00050
Silicon	D-Si	4.70	4.64	-	-
Silver	D-Ag	<0.000020	<0.000020	-	-
Sodium	D-Na	29.6	28.7	-	-
Strontium	D-Sr	0.0921	0.0943	-	-
Thallium	D-Tl	<0.00020	<0.00020	-	-
Tin	D-Sn	0.00052	0.00055	-	-
Titanium	D-Ti	<0.010	<0.010	-	-
Uranium	D-U	<0.000020	<0.000020	-	-
Vanadium	D-V	<0.0020	<0.0020	-	-
Zinc	D-Zn	0.0025	0.0026	-	-

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1045

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
ULTRA SCIENTIFIC, ULTMIX							
Total Metals							
Bismuth	T-Bi	1.06	1.00	mg/L	0.1	377363	a
Bismuth	T-Bi	1.01	1.00	mg/L	0.1	377588	a
Bismuth	T-Bi	1.02	1.00	mg/L	0.05	377827	b
Lithium	T-Li	0.205	0.200	mg/L	0.01	377363	a
Lithium	T-Li	0.202	0.200	mg/L	0.01	377588	a
Lithium	T-Li	<0.50	<0.50	mg/L	0.5	377827	b
Phosphorus	T-P	2.08	2.00	mg/L	0.3	377363	a
Phosphorus	T-P	2.05	2.00	mg/L	0.3	377588	a
Silicon	T-Si	1.03	1.00	mg/L	0.05	377363	a
Silicon	T-Si	1.02	1.00	mg/L	0.05	377588	a
Tin	T-Sn	1.04	1.00	mg/L	0.03	377363	a
Tin	T-Sn	1.01	1.00	mg/L	0.03	377588	a
Tin	T-Sn	1.02	1.00	mg/L	0.01	377827	b
Titanium	T-Ti	0.206	0.200	mg/L	0.01	377363	a
Titanium	T-Ti	0.202	0.200	mg/L	0.01	377588	a
NRC Ottawa River Water, SLRS-4							
Dissolved Metals							
Aluminum	D-Al	0.0562	0.0540	mg/L	0.001	377826	b
Antimony	D-Sb	0.000258	0.000230	mg/L	0.00005	377826	b
Arsenic	D-As	0.00074	0.00068	mg/L	0.0001	377826	b
Barium	D-Ba	0.0132	0.0122	mg/L	0.00005	377826	b
Beryllium	D-Be	<0.00050	<0.00050	mg/L	0.0005	377826	b
Cadmium	D-Cd	<0.000050	<0.000050	mg/L	0.00005	377826	b
Calcium	D-Ca	5.90	6.20	mg/L	0.02	377826	b
Chromium	D-Cr	<0.00050	<0.00050	mg/L	0.0005	377826	b
Cobalt	D-Co	<0.00010	<0.00010	mg/L	0.0001	377826	b
Copper	D-Cu	0.00183	0.00181	mg/L	0.0001	377826	b
Lead	D-Pb	0.000081	0.000086	mg/L	0.00005	377826	b
Magnesium	D-Mg	1.51	1.60	mg/L	0.005	377826	b
Manganese	D-Mn	0.00338	0.00337	mg/L	0.00005	377826	b
Molybdenum	D-Mo	0.000207	0.000210	mg/L	0.00005	377826	b
Nickel	D-Ni	0.00067	0.00067	mg/L	0.0001	377826	b
Potassium	D-K	0.664	0.680	mg/L	0.01	377826	b

Methods:
a = ICPOES
b = ICPMS

A Campbell Brothers Limited Company

File No. U1045

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

			Result	Target	Units	DL	ALSQC#	Method
NRC Ottawa River Water, SLRS-4								
Dissolved Metals								
Strontium	D-Sr		0.0290	0.0263	mg/L	0.0001	377826	a
Uranium	D-U		0.000051	0.000050	mg/L	0.00001	377826	a
Vanadium	D-V		<0.0010	<0.0010	mg/L	0.001	377826	a
Zinc	D-Zn		0.0012	<0.0010	mg/L	0.001	377826	a
SPEX Anions, 22-120AS								
Dissolved Anions								
Chloride	Cl		15.3	15.0	mg/L	0.5	377460	b
Chloride	Cl		15.3	15.0	mg/L	0.5	378006	b
Fluoride	F		2.08	2.00	mg/L	0.02	377460	b
Fluoride	F		2.07	2.00	mg/L	0.02	378006	b
Nutrients								
Nitrite/Nitrate Nitrogen		N	6.97	6.80	mg/L	0.005	378006	b
APG Trace Metals, 31381-31382								
Total Metals								
Aluminum	T-Al		0.196	0.152	mg/L	0.01	377828	a
Antimony	T-Sb		0.308	0.262	mg/L	0.0002	377652	c
Antimony	T-Sb		0.272	0.262	mg/L	0.001	377828	a
Arsenic	T-As		0.149	0.152	mg/L	0.001	377828	a
Arsenic	T-As		0.144	0.152	mg/L	0.0002	377835	c
Barium	T-Ba		0.438	0.438	mg/L	0.0005	377828	a
Beryllium	T-Be		0.0366	0.0367	mg/L	0.005	377828	a
Boron	T-B		0.12	0.10	mg/L	0.1	377828	a
Cadmium	T-Cd		0.0748	0.0767	mg/L	0.0005	377828	a
Chromium	T-Cr		0.121	0.125	mg/L	0.005	377828	a
Cobalt	T-Co		0.222	0.225	mg/L	0.001	377828	a
Copper	T-Cu		0.301	0.309	mg/L	0.001	377828	a
Lead	T-Pb		0.385	0.402	mg/L	0.0005	377828	a
Manganese	T-Mn		0.326	0.339	mg/L	0.0005	377828	a
Molybdenum	T-Mo		0.0979	0.0950	mg/L	0.0005	377828	a
Nickel	T-Ni		0.207	0.203	mg/L	0.005	377828	a
Selenium	T-Se		0.0367	0.0365	mg/L	0.0005	377473	c

Methods:
a = ICPMS
b = Ion Chromatography
c = HVAAS

A Campbell Brothers Limited Company

File No. U1045

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Trace Metals, 31381-31382							
Total Metals							
Selenium	T-Se	0.0374	0.0365	mg/L	0.005	377828	a
Silver	T-Ag	0.0717	0.0733	mg/L	0.0001	377828	a
Strontium	T-Sr	0.351	0.354	mg/L	0.001	377828	a
Thallium	T-Tl	0.105	0.111	mg/L	0.001	377828	a
Vanadium	T-V	0.191	0.194	mg/L	0.01	377828	a
Zinc	T-Zn	0.156	0.151	mg/L	0.01	377828	a
APG Trace Metals, 31652-31653							
Total Metals							
Aluminum	T-Al	0.99	1.00	mg/L	0.2	377364	b
Aluminum	T-Al	1.06	1.00	mg/L	0.2	377589	b
Antimony	T-Sb	0.28	0.28	mg/L	0.2	377364	b
Antimony	T-Sb	0.26	0.28	mg/L	0.2	377589	b
Arsenic	T-As	0.50	0.49	mg/L	0.2	377364	b
Arsenic	T-As	0.47	0.49	mg/L	0.2	377589	b
Barium	T-Ba	0.540	0.525	mg/L	0.01	377364	b
Barium	T-Ba	0.518	0.525	mg/L	0.01	377589	b
Beryllium	T-Be	0.403	0.397	mg/L	0.005	377364	b
Beryllium	T-Be	0.387	0.397	mg/L	0.005	377589	b
Boron	T-B	0.36	0.28	mg/L	0.1	377364	b
Boron	T-B	0.34	0.28	mg/L	0.1	377589	b
Cadmium	T-Cd	0.358	0.353	mg/L	0.01	377364	b
Cadmium	T-Cd	0.349	0.353	mg/L	0.01	377589	b
Chromium	T-Cr	0.171	0.167	mg/L	0.01	377364	b
Chromium	T-Cr	0.167	0.167	mg/L	0.01	377589	b
Cobalt	T-Co	0.248	0.240	mg/L	0.01	377364	b
Cobalt	T-Co	0.241	0.240	mg/L	0.01	377589	b
Copper	T-Cu	0.403	0.391	mg/L	0.01	377364	b
Copper	T-Cu	0.394	0.391	mg/L	0.01	377589	b
Iron	T-Fe	1.02	1.01	mg/L	0.03	377364	b
Iron	T-Fe	0.975	1.01	mg/L	0.03	377589	b
Lead	T-Pb	0.868	0.857	mg/L	0.05	377364	b
Lead	T-Pb	0.842	0.857	mg/L	0.05	377589	b
Manganese	T-Mn	2.29	2.26	mg/L	0.005	377364	b

Methods:
a = ICPMS
b = ICPOES

A Campbell Brothers Limited Company

File No. U1045

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Trace Metals, 31652-31653							
Total Metals							
Manganese	T-Mn	2.23	2.26	mg/L	0.005	377589	a
Molybdenum	T-Mo	0.098	0.097	mg/L	0.03	377364	a
Molybdenum	T-Mo	0.093	0.097	mg/L	0.03	377589	a
Nickel	T-Ni	0.605	0.611	mg/L	0.05	377364	a
Nickel	T-Ni	0.616	0.611	mg/L	0.05	377589	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	377364	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	377589	a
Silver	T-Ag	0.213	0.210	mg/L	0.01	377364	a
Silver	T-Ag	0.212	0.210	mg/L	0.01	377589	a
Strontium	T-Sr	0.111	0.104	mg/L	0.005	377364	a
Strontium	T-Sr	0.106	0.104	mg/L	0.005	377589	a
Thallium	T-Tl	0.49	0.38	mg/L	0.2	377364	a
Thallium	T-Tl	0.39	0.38	mg/L	0.2	377589	a
Titanium	T-Ti	0.193	0.192	mg/L	0.01	377364	a
Titanium	T-Ti	0.190	0.192	mg/L	0.01	377589	a
Vanadium	T-V	1.53	1.50	mg/L	0.03	377364	a
Vanadium	T-V	1.48	1.50	mg/L	0.03	377589	a
Zinc	T-Zn	0.124	0.121	mg/L	0.005	377364	a
Zinc	T-Zn	0.119	0.121	mg/L	0.005	377589	a
ALS Environmental Hg Water RM, Hg RM 002							
Total Metals							
Mercury	T-Hg	0.0102	0.0100	mg/L	0.00001	377763	b
Mercury	T-Hg	0.00973	0.0100	mg/L	0.00001	377937	b
ERA WasteWatR, P094506							
Dissolved Anions							
Fluoride	F	1.01	1.02	mg/L	0.02	377822	c
APG Minerals, 32993-32994							
Total Metals							
Calcium	T-Ca	15.7	15.6	mg/L	0.05	377362	a

Methods:
a = ICPOES
b = CVAFS
c = Electrode

A Campbell Brothers Limited Company

File No. U1045

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

			Result	Target	Units	DL	ALSQC#	Method
APG Minerals, 32993-32994								
Total Metals								
Calcium	T-Ca		15.7	15.6	mg/L	0.05	377587	a
Calcium	T-Ca		15.4	15.6	mg/L	0.04	377825	b
Magnesium	T-Mg		5.86	5.85	mg/L	0.1	377362	a
Magnesium	T-Mg		5.72	5.85	mg/L	0.1	377587	a
Magnesium	T-Mg		5.38	5.85	mg/L	0.01	377825	b
Potassium	T-K		34.4	33.1	mg/L	2	377362	a
Potassium	T-K		34.3	33.1	mg/L	2	377587	a
Potassium	T-K		34.9	33.1	mg/L	0.1	377825	b
Sodium	T-Na		40.9	39.1	mg/L	2	377362	a
Sodium	T-Na		40.9	39.1	mg/L	2	377587	a
Sodium	T-Na		41.1	39.1	mg/L	0.02	377825	b
SPEX Nutrients, 16-1 Nut1								
Nutrients								
Ammonia Nitrogen		N	11.3	11.4	mg/L	0.02	377834	c
APG Trace Metals, 35299-35300								
Total Metals								
Aluminum	T-Al		<0.20	<0.20	mg/L	0.2	377361	a
Aluminum	T-Al		0.51	<0.20	mg/L	0.2	377586	a
Antimony	T-Sb		<0.20	<0.20	mg/L	0.2	377361	a
Antimony	T-Sb		<0.20	<0.20	mg/L	0.2	377586	a
Arsenic	T-As		<0.20	<0.20	mg/L	0.2	377361	a
Arsenic	T-As		<0.20	<0.20	mg/L	0.2	377586	a
Barium	T-Ba		0.345	0.338	mg/L	0.01	377361	a
Barium	T-Ba		0.338	0.338	mg/L	0.01	377586	a
Beryllium	T-Be		0.0784	0.0751	mg/L	0.005	377361	a
Beryllium	T-Be		0.0769	0.0751	mg/L	0.005	377586	a
Boron	T-B		0.21	0.23	mg/L	0.1	377361	a
Boron	T-B		0.21	0.23	mg/L	0.1	377586	a
Cadmium	T-Cd		0.087	0.088	mg/L	0.01	377361	a
Cadmium	T-Cd		0.091	0.088	mg/L	0.01	377586	a
Chromium	T-Cr		0.219	0.218	mg/L	0.01	377361	a

Methods:
a = ICPOES
b = ICPMS
c = Electrode

A Campbell Brothers Limited Company

File No. U1045

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Trace Metals, 35299-35300							
Total Metals							
Chromium	T-Cr	0.225	0.218	mg/L	0.01	377586	a
Cobalt	T-Co	0.290	0.280	mg/L	0.01	377361	a
Cobalt	T-Co	0.289	0.280	mg/L	0.01	377586	a
Copper	T-Cu	0.299	0.287	mg/L	0.01	377361	a
Copper	T-Cu	0.296	0.287	mg/L	0.01	377586	a
Iron	T-Fe	0.380	0.368	mg/L	0.03	377361	a
Iron	T-Fe	0.378	0.368	mg/L	0.03	377586	a
Lead	T-Pb	0.253	0.264	mg/L	0.05	377361	a
Lead	T-Pb	0.266	0.264	mg/L	0.05	377586	a
Manganese	T-Mn	0.488	0.479	mg/L	0.005	377361	a
Manganese	T-Mn	0.492	0.479	mg/L	0.005	377586	a
Molybdenum	T-Mo	0.155	0.149	mg/L	0.03	377361	a
Molybdenum	T-Mo	0.151	0.149	mg/L	0.03	377586	a
Nickel	T-Ni	0.097	0.078	mg/L	0.05	377361	a
Nickel	T-Ni	0.093	0.078	mg/L	0.05	377586	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	377361	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	377586	a
Silver	T-Ag	0.066	0.063	mg/L	0.01	377361	a
Silver	T-Ag	0.066	0.063	mg/L	0.01	377586	a
Strontium	T-Sr	0.358	0.367	mg/L	0.005	377361	a
Strontium	T-Sr	0.360	0.367	mg/L	0.005	377586	a
Thallium	T-Tl	<0.20	<0.20	mg/L	0.2	377361	a
Thallium	T-Tl	<0.20	<0.20	mg/L	0.2	377586	a
Tin	T-Sn	0.880	0.890	mg/L	0.03	377361	a
Tin	T-Sn	0.873	0.890	mg/L	0.03	377586	a
Titanium	T-Ti	0.093	0.093	mg/L	0.01	377361	a
Titanium	T-Ti	0.095	0.093	mg/L	0.01	377586	a
Vanadium	T-V	0.097	0.097	mg/L	0.03	377361	a
Vanadium	T-V	0.106	0.097	mg/L	0.03	377586	a
Zinc	T-Zn	0.158	0.148	mg/L	0.005	377361	a
Zinc	T-Zn	0.152	0.148	mg/L	0.005	377586	a
ERA Minerals, POO96506							
Physical Tests							
Total Dissolved Solids		229	236	mg/L	10	378357	b

Methods:
a = ICPOES
b = Gravimetry

A Campbell Brothers Limited Company

File No. U1045

Appendix 1 - QUALITY CONTROL - Blanks

Water

			Result	Target	Units	DL	ALSQC#	Method
Physical Tests								
Total Dissolved Solids			<10	<10	mg/L	10	378354	a
Dissolved Anions								
Chloride	Cl		<0.50	<0.50	mg/L	0.5	377455	b
Chloride	Cl		<0.50	<0.50	mg/L	0.5	377999	b
Fluoride	F		<0.020	<0.020	mg/L	0.02	377455	b
Fluoride	F		<0.02	<0.02	mg/L	0.02	377816	c
Fluoride	F		<0.020	<0.020	mg/L	0.02	377999	b
Nutrients								
Ammonia Nitrogen		N	<0.02	<0.02	mg/L	0.02	377833	c
Nitrite/Nitrate Nitrogen		N	<0.0050	<0.0050	mg/L	0.005	377999	b
Dissolved Metals								
Aluminum	D-Al		<0.0010	<0.0010	mg/L	0.001	378137	d
Antimony	D-Sb		<0.00020	<0.00020	mg/L	0.0002	378132	e
Antimony	D-Sb		<0.00010	<0.00010	mg/L	0.0001	378137	d
Arsenic	D-As		<0.00020	<0.00020	mg/L	0.0002	378132	e
Arsenic	D-As		<0.00010	<0.00010	mg/L	0.0001	378137	d
Barium	D-Ba		<0.000050	<0.000050	mg/L	0.00005	378137	d
Beryllium	D-Be		<0.00050	<0.00050	mg/L	0.0005	378137	d
Bismuth	D-Bi		<0.00050	<0.00050	mg/L	0.0005	378137	d
Boron	D-B		<0.010	<0.010	mg/L	0.01	378137	d
Cadmium	D-Cd		<0.000050	<0.000050	mg/L	0.00005	378137	d
Calcium	D-Ca		<0.050	<0.050	mg/L	0.05	378137	f
Chromium	D-Cr		<0.00050	<0.00050	mg/L	0.0005	378137	d
Cobalt	D-Co		<0.00010	<0.00010	mg/L	0.0001	378137	d
Copper	D-Cu		<0.00010	<0.00010	mg/L	0.0001	378137	d
Iron	D-Fe		<0.030	<0.030	mg/L	0.03	378137	f
Lead	D-Pb		<0.000050	<0.000050	mg/L	0.00005	378137	d
Lithium	D-Li		<0.0050	<0.0050	mg/L	0.005	378137	d
Magnesium	D-Mg		<0.10	<0.10	mg/L	0.1	378137	f
Manganese	D-Mn		<0.000050	<0.000050	mg/L	0.00005	378137	d
Mercury	D-Hg		<0.000050	<0.000050	mg/L	0.00005	378137	g
Molybdenum	D-Mo		<0.000050	<0.000050	mg/L	0.00005	378137	d
Nickel	D-Ni		<0.00050	<0.00050	mg/L	0.0005	378137	d
Phosphorus	D-P		<0.30	<0.30	mg/L	0.3	378137	f
Potassium	D-K		<2.0	<2.0	mg/L	2	378137	f
Selenium	D-Se		<0.00050	<0.00050	mg/L	0.0005	378132	e

Methods:
a = Gravimetry
b = Ion Chromatography
c = Electrode
d = ICPMS
e = HVAAS
f = ICPOES
g = WM_D_BrCl_CVAFS

A Campbell Brothers Limited Company

File No. U1045

Appendix 1 - QUALITY CONTROL - Blanks

Water

		Result	Target	Units	DL	ALSQC#	Method
Dissolved Metals							
Selenium	D-Se	<0.0010	<0.0010	mg/L	0.001	378137	a
Silicon	D-Si	<0.050	<0.050	mg/L	0.05	378137	b
Silver	D-Ag	<0.000010	<0.000010	mg/L	0.00001	378137	a
Sodium	D-Na	<2.0	<2.0	mg/L	2	378137	b
Strontium	D-Sr	<0.00010	<0.00010	mg/L	0.0001	378137	a
Thallium	D-Tl	<0.00010	<0.00010	mg/L	0.0001	378137	a
Tin	D-Sn	<0.00010	<0.00010	mg/L	0.0001	378137	a
Titanium	D-Ti	<0.010	<0.010	mg/L	0.01	378137	b
Uranium	D-U	<0.000010	<0.000010	mg/L	0.00001	378137	a
Vanadium	D-V	<0.0010	<0.0010	mg/L	0.001	378137	a
Zinc	D-Zn	<0.0010	<0.0010	mg/L	0.001	378137	a

Methods:
a = ICPMS
b = ICPOES

A Campbell Brothers Limited Company

Appendix 2 - METHODOLOGY

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Solids in Water

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total dissolved solids (TDS) and total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius, TSS is determined by drying the filter at 104 degrees celsius. Total solids are determined by evaporating a sample to dryness at 104 degrees celsius. Fixed and volatile solids are determined by igniting a dried sample residue at 550 degrees celsius.

Recommended Holding Time:
- Sample: 7 days
- Reference: APHA
- For more detail see ALS Environmental "Collection & Sampling Guide"

Dissolved Anions in Water by Ion Chromatography

This analysis is carried out using procedures adapted from APHA Method 4110 "Determination of Anions by Ion Chromatography" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Anions are determined by filtering the sample through a 0.45 micron membrane filter and injecting the filtrate onto a Dionex IonPac AG17 anion exchange column with a hydroxide eluent stream. Anions routinely determined by this method include: bromide, chloride, fluoride, nitrate, nitrite and sulphate.

Recommended Holding Time:
- Sample: 28 days (bromide, chloride, fluoride, sulphate)
- Sample: 2 days (nitrate, nitrite)
- Reference: APHA and EPA
- For more detail see ALS Environmental "Collection & Sampling Guide"

Ammonia in Water by Selective Ion Electrode

This analysis is carried out, on sulphuric acid preserved samples, using procedures adapted from APHA Method 4500-NH3 "Nitrogen (Ammonia)". Ammonia is determined using an ammonia selective electrode.

Recommended Holding Time:
- Sample: 28 days
- Reference: APHA
- For more detail see ALS Environmental "Collection & Sampling Guide"

A Campbell Brothers Limited Company

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:

Sample:	6 months
Reference:	EPA
For more detail see:	ALS "Collection & Sampling Guide"

Mercury in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic absorption and/or fluorescence spectrophotometry (EPA Method 7470A/7471A/245.7).

Recommended Holding Time:

Sample:	28 days
Reference:	EPA

For more detail see ALS Environmental "Collection & Sampling Guide"

Fluoride in Water

This analysis is carried out using procedures adapted from APHA Method 4500-F "Fluoride". Fluoride is determined using a selective ion electrode.

Recommended Holding Time:

Sample: 28 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

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Appendix 2 - METHODOLOGY - Continued

Results contained within this report relate only to the samples as submitted.

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End of Report

A Campbell Brothers Limited Company

ALS Environmental

CHEMICAL ANALYSIS REPORT

Date:	March 11, 2004
ALS File No.	U1206 - Week 2
Report On:	Release 1443 Water Analysis
Report To:	**Canadian Environmental and** Metallurgical Inc. 1636 West 75th Avenue Vancouver, BC V6P 6G2
Attention:	**Mr. Sohan Basra**
Received:	March 4, 2004

ALS ENVIRONMENTAL
per:

Leanne Harris, B.Sc. - Project Chemist
Joanne Patrick, B.Sc. - Project Chemist

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File No. U1206

REMARKS

Please note that the detection limits for certain Dissolved Metals have been increased for some of the samples reported in the following data tables due to sample matrix interferences.

In particular, the detection limits for the sample identified as "18649" were increased due to elevated D-Nickel.

A Campbell Brothers Limited Company

File No. U1206

RESULTS OF ANALYSIS - Water

Sample ID		18648	18649	18650	18651	18652
ALS ID		*1*	*2*	*3*	*4*	*5*
Dissolved Metals						
Aluminum	D-Al	0.22	<0.40	<0.20	<0.20	0.33
Antimony	D-Sb	<0.20	<0.40	<0.20	<0.20	<0.20
Arsenic	D-As	<0.20	<0.40	<0.20	<0.20	<0.20
Barium	D-Ba	<0.010	0.025	0.035	0.021	<0.010
Beryllium	D-Be	<0.0050	<0.010	<0.0050	<0.0050	<0.0050
Bismuth	D-Bi	<0.20	<0.40	<0.20	<0.20	<0.20
Boron	D-B	0.18	<0.20	<0.10	2.22	0.21
Cadmium	D-Cd	<0.010	<0.20	<0.010	<0.010	<0.010
Calcium	D-Ca	1.50	5.69	9.75	21.1	2.98
Chromium	D-Cr	<0.010	<0.10	<0.010	<0.010	<0.010
Cobalt	D-Co	<0.010	6.99	<0.010	<0.010	<0.010
Copper	D-Cu	<0.010	0.108	<0.010	0.020	<0.010
Iron	D-Fe	<0.030	219	<0.030	<0.030	<0.030
Lead	D-Pb	<0.050	0.17	<0.050	<0.050	<0.050
Lithium	D-Li	<0.010	<0.020	<0.010	<0.010	<0.010
Magnesium	D-Mg	0.89	9.75	26.3	64.6	1.22
Manganese	D-Mn	<0.0050	7.77	0.0052	0.0142	<0.0050
Molybdenum	D-Mo	<0.030	<0.060	<0.030	<0.030	<0.030
Nickel	D-Ni	<0.050	380	<0.050	0.109	<0.050
Phosphorus	D-P	<0.30	<0.60	<0.30	<0.30	<0.30
Potassium	D-K	7.7	<4.0	22.9	39.3	9.1
Selenium	D-Se	<0.20	<0.40	<0.20	<0.20	<0.20
Silicon	D-Si	2.31	1.97	4.23	2.72	2.56
Silver	D-Ag	<0.010	<0.020	<0.010	<0.010	<0.010
Sodium	D-Na	15.7	<4.0	14.6	48.7	17.4
Strontium	D-Sr	0.0371	0.046	0.0631	0.234	0.0491
Thallium	D-Tl	<0.20	<0.40	<0.20	<0.20	<0.20
Tin	D-Sn	<0.030	<0.060	<0.030	<0.030	<0.030
Titanium	D-Ti	<0.010	<0.020	<0.010	<0.010	<0.010
Vanadium	D-V	<0.030	<0.060	<0.030	<0.030	<0.030
Zinc	D-Zn	<0.0050	1.09	<0.0050	<0.0050	<0.0050

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1206

RESULTS OF ANALYSIS - Water

Sample ID	18653
ALS ID	*6*

Dissolved Metals

Aluminum	D-Al	0.21
Antimony	D-Sb	<0.20
Arsenic	D-As	<0.20
Barium	D-Ba	<0.010
Beryllium	D-Be	<0.0050
Bismuth	D-Bi	<0.20
Boron	D-B	0.16
Cadmium	D-Cd	<0.010
Calcium	D-Ca	1.45
Chromium	D-Cr	<0.010
Cobalt	D-Co	<0.010
Copper	D-Cu	<0.010
Iron	D-Fe	<0.030
Lead	D-Pb	<0.050
Lithium	D-Li	<0.010
Magnesium	D-Mg	0.86
Manganese	D-Mn	<0.0050
Molybdenum	D-Mo	<0.030
Nickel	D-Ni	<0.050
Phosphorus	D-P	<0.30
Potassium	D-K	8.1
Selenium	D-Se	<0.20
Silicon	D-Si	2.28
Silver	D-Ag	<0.010
Sodium	D-Na	15.3
Strontium	D-Sr	0.0365
Thallium	D-Tl	<0.20
Tin	D-Sn	<0.030
Titanium	D-Ti	<0.010
Vanadium	D-V	<0.030
Zinc	D-Zn	<0.0050

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1206

Appendix 1 - QUALITY CONTROL - Replicates

Water		18650	18650
			QC # 377903
Dissolved Metals			
Aluminum	D-Al	<0.20	<0.20
Antimony	D-Sb	<0.20	<0.20
Arsenic	D-As	<0.20	<0.20
Barium	D-Ba	0.035	0.035
Beryllium	D-Be	<0.0050	<0.0050
Bismuth	D-Bi	<0.20	<0.20
Boron	D-B	<0.10	<0.10
Cadmium	D-Cd	<0.010	<0.010
Calcium	D-Ca	9.75	9.82
Chromium	D-Cr	<0.010	<0.010
Cobalt	D-Co	<0.010	<0.010
Copper	D-Cu	<0.010	<0.010
Iron	D-Fe	<0.030	<0.030
Lead	D-Pb	<0.050	<0.050
Lithium	D-Li	<0.010	<0.010
Magnesium	D-Mg	26.3	26.6
Manganese	D-Mn	0.0052	<0.0050
Molybdenum	D-Mo	<0.030	<0.030
Nickel	D-Ni	<0.050	<0.050
Phosphorus	D-P	<0.30	<0.30
Potassium	D-K	22.9	23.5
Selenium	D-Se	<0.20	<0.20
Silicon	D-Si	4.23	4.27
Silver	D-Ag	<0.010	<0.010
Sodium	D-Na	14.6	14.6
Strontium	D-Sr	0.0631	0.0649
Thallium	D-Tl	<0.20	<0.20
Tin	D-Sn	<0.030	<0.030
Titanium	D-Ti	<0.010	<0.010
Vanadium	D-V	<0.030	<0.030
Zinc	D-Zn	<0.0050	<0.0050

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1206

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
ULTRA SCIENTIFIC, ULTMIX							
Total Metals							
Bismuth	T-Bi	1.04	1.00	mg/L	0.1	378031	a
Bismuth	T-Bi	1.06	1.00	mg/L	0.1	378385	a
Lithium	T-Li	0.205	0.200	mg/L	0.01	378031	a
Lithium	T-Li	0.204	0.200	mg/L	0.01	378385	a
Phosphorus	T-P	2.05	2.00	mg/L	0.3	378031	a
Phosphorus	T-P	2.01	2.00	mg/L	0.3	378385	a
Silicon	T-Si	1.02	1.00	mg/L	0.05	378031	a
Silicon	T-Si	1.00	1.00	mg/L	0.05	378385	a
Tin	T-Sn	1.04	1.00	mg/L	0.03	378031	a
Tin	T-Sn	0.995	1.00	mg/L	0.03	378385	a
Titanium	T-Ti	0.199	0.200	mg/L	0.01	378031	a
Titanium	T-Ti	0.197	0.200	mg/L	0.01	378385	a
APG Trace Metals, 31652-31653							
Total Metals							
Aluminum	T-Al	1.02	1.00	mg/L	0.2	378032	a
Aluminum	T-Al	1.03	1.00	mg/L	0.2	378386	a
Antimony	T-Sb	0.29	0.28	mg/L	0.2	378032	a
Antimony	T-Sb	0.28	0.28	mg/L	0.2	378386	a
Arsenic	T-As	0.49	0.49	mg/L	0.2	378032	a
Arsenic	T-As	0.49	0.49	mg/L	0.2	378386	a
Barium	T-Ba	0.528	0.525	mg/L	0.01	378032	a
Barium	T-Ba	0.528	0.525	mg/L	0.01	378386	a
Beryllium	T-Be	0.399	0.397	mg/L	0.005	378032	a
Beryllium	T-Be	0.396	0.397	mg/L	0.005	378386	a
Boron	T-B	0.36	0.28	mg/L	0.1	378032	a
Boron	T-B	0.35	0.28	mg/L	0.1	378386	a
Cadmium	T-Cd	0.355	0.353	mg/L	0.01	378032	a
Cadmium	T-Cd	0.355	0.353	mg/L	0.01	378386	a
Chromium	T-Cr	0.169	0.167	mg/L	0.01	378032	a
Chromium	T-Cr	0.167	0.167	mg/L	0.01	378386	a
Cobalt	T-Co	0.245	0.240	mg/L	0.01	378032	a
Cobalt	T-Co	0.242	0.240	mg/L	0.01	378386	a
Copper	T-Cu	0.397	0.391	mg/L	0.01	378032	a

Methods:
a = ICPOES

A Campbell Brothers Limited Company

File No. U1206

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Trace Metals, 31652-31653							
Total Metals							
Copper	T-Cu	0.389	0.391	mg/L	0.01	378386	a
Iron	T-Fe	1.02	1.01	mg/L	0.03	378032	a
Iron	T-Fe	1.01	1.01	mg/L	0.03	378386	a
Lead	T-Pb	0.886	0.857	mg/L	0.05	378032	a
Lead	T-Pb	0.885	0.857	mg/L	0.05	378386	a
Manganese	T-Mn	2.27	2.26	mg/L	0.005	378032	a
Manganese	T-Mn	2.29	2.26	mg/L	0.005	378386	a
Molybdenum	T-Mo	0.099	0.097	mg/L	0.03	378032	a
Molybdenum	T-Mo	0.098	0.097	mg/L	0.03	378386	a
Nickel	T-Ni	0.620	0.611	mg/L	0.05	378032	a
Nickel	T-Ni	0.643	0.611	mg/L	0.05	378386	a
Selenium	T-Se	0.22	<0.20	mg/L	0.2	378032	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	378386	a
Silver	T-Ag	0.211	0.210	mg/L	0.01	378032	a
Silver	T-Ag	0.209	0.210	mg/L	0.01	378386	a
Strontium	T-Sr	0.112	0.104	mg/L	0.005	378032	a
Strontium	T-Sr	0.105	0.104	mg/L	0.005	378386	a
Thallium	T-Tl	0.39	0.38	mg/L	0.2	378032	a
Thallium	T-Tl	0.37	0.38	mg/L	0.2	378386	a
Titanium	T-Ti	0.195	0.192	mg/L	0.01	378032	a
Titanium	T-Ti	0.192	0.192	mg/L	0.01	378386	a
Vanadium	T-V	1.52	1.50	mg/L	0.03	378032	a
Vanadium	T-V	1.49	1.50	mg/L	0.03	378386	a
Zinc	T-Zn	0.123	0.121	mg/L	0.005	378032	a
Zinc	T-Zn	0.121	0.121	mg/L	0.005	378386	a
APG Minerals, 32993-32994							
Total Metals							
Calcium	T-Ca	15.6	15.6	mg/L	0.05	378030	a
Calcium	T-Ca	15.8	15.6	mg/L	0.05	378384	a
Magnesium	T-Mg	5.59	5.85	mg/L	0.1	378030	a
Magnesium	T-Mg	5.76	5.85	mg/L	0.1	378384	a
Potassium	T-K	35.3	33.1	mg/L	2	378030	a
Potassium	T-K	33.5	33.1	mg/L	2	378384	a

Methods:
a = ICPOES

A Campbell Brothers Limited Company

File No. U1206

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Minerals, 32993-32994							
Total Metals							
Sodium	T-Na	40.8	39.1	mg/L	2	378030	a
Sodium	T-Na	39.8	39.1	mg/L	2	378384	a
APG Trace Metals, 35299-35300							
Total Metals							
Aluminum	T-Al	<0.20	<0.20	mg/L	0.2	378029	a
Aluminum	T-Al	<0.20	<0.20	mg/L	0.2	378383	a
Antimony	T-Sb	<0.20	<0.20	mg/L	0.2	378029	a
Antimony	T-Sb	<0.20	<0.20	mg/L	0.2	378383	a
Arsenic	T-As	<0.20	<0.20	mg/L	0.2	378029	a
Arsenic	T-As	<0.20	<0.20	mg/L	0.2	378383	a
Barium	T-Ba	0.340	0.338	mg/L	0.01	378029	a
Barium	T-Ba	0.348	0.338	mg/L	0.01	378383	a
Beryllium	T-Be	0.0774	0.0751	mg/L	0.005	378029	a
Beryllium	T-Be	0.0786	0.0751	mg/L	0.005	378383	a
Boron	T-B	0.21	0.23	mg/L	0.1	378029	a
Boron	T-B	0.19	0.23	mg/L	0.1	378383	a
Cadmium	T-Cd	0.091	0.088	mg/L	0.01	378029	a
Cadmium	T-Cd	0.090	0.088	mg/L	0.01	378383	a
Chromium	T-Cr	0.221	0.218	mg/L	0.01	378029	a
Chromium	T-Cr	0.230	0.218	mg/L	0.01	378383	a
Cobalt	T-Co	0.288	0.280	mg/L	0.01	378029	a
Cobalt	T-Co	0.295	0.280	mg/L	0.01	378383	a
Copper	T-Cu	0.297	0.287	mg/L	0.01	378029	a
Copper	T-Cu	0.297	0.287	mg/L	0.01	378383	a
Iron	T-Fe	0.383	0.368	mg/L	0.03	378029	a
Iron	T-Fe	0.394	0.368	mg/L	0.03	378383	a
Lead	T-Pb	0.268	0.264	mg/L	0.05	378029	a
Lead	T-Pb	0.242	0.264	mg/L	0.05	378383	a
Manganese	T-Mn	0.489	0.479	mg/L	0.005	378029	a
Manganese	T-Mn	0.505	0.479	mg/L	0.005	378383	a
Molybdenum	T-Mo	0.156	0.149	mg/L	0.03	378029	a
Molybdenum	T-Mo	0.156	0.149	mg/L	0.03	378383	a
Nickel	T-Ni	0.070	0.078	mg/L	0.05	378029	a

Methods:
a = ICPOES

A Campbell Brothers Limited Company

File No. U1206

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Trace Metals, 35299-35300							
Total Metals							
Nickel	T-Ni	0.071	0.078	mg/L	0.05	378383	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	378029	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	378383	a
Silver	T-Ag	0.061	0.063	mg/L	0.01	378029	a
Silver	T-Ag	0.063	0.063	mg/L	0.01	378383	a
Strontium	T-Sr	0.375	0.367	mg/L	0.005	378029	a
Strontium	T-Sr	0.371	0.367	mg/L	0.005	378383	a
Thallium	T-Tl	<0.20	<0.20	mg/L	0.2	378029	a
Thallium	T-Tl	<0.20	<0.20	mg/L	0.2	378383	a
Tin	T-Sn	0.900	0.890	mg/L	0.03	378029	a
Tin	T-Sn	0.916	0.890	mg/L	0.03	378383	a
Titanium	T-Ti	0.093	0.093	mg/L	0.01	378029	a
Titanium	T-Ti	0.095	0.093	mg/L	0.01	378383	a
Vanadium	T-V	0.095	0.097	mg/L	0.03	378029	a
Vanadium	T-V	0.104	0.097	mg/L	0.03	378383	a
Zinc	T-Zn	0.156	0.148	mg/L	0.005	378029	a
Zinc	T-Zn	0.150	0.148	mg/L	0.005	378383	a

Methods:
a = ICPOES

A Campbell Brothers Limited Company

File No. U1206

Appendix 1 - QUALITY CONTROL - Blanks

Water

		Result	Target	Units	DL	ALSQC#	Method
Dissolved Metals							
Aluminum	D-Al	<0.20	<0.20	mg/L	0.2	378700	a
Antimony	D-Sb	<0.20	<0.20	mg/L	0.2	378700	a
Arsenic	D-As	<0.20	<0.20	mg/L	0.2	378700	a
Barium	D-Ba	<0.010	<0.010	mg/L	0.01	378700	a
Beryllium	D-Be	<0.0050	<0.0050	mg/L	0.005	378700	a
Bismuth	D-Bi	<0.20	<0.20	mg/L	0.2	378700	a
Boron	D-B	<0.10	<0.10	mg/L	0.1	378700	a
Cadmium	D-Cd	<0.010	<0.010	mg/L	0.01	378700	a
Calcium	D-Ca	<0.050	<0.050	mg/L	0.05	378512	a
Calcium	D-Ca	<0.050	<0.050	mg/L	0.05	378700	a
Chromium	D-Cr	<0.010	<0.010	mg/L	0.01	378700	a
Cobalt	D-Co	<0.010	<0.010	mg/L	0.01	378700	a
Copper	D-Cu	<0.010	<0.010	mg/L	0.01	378700	a
Iron	D-Fe	<0.030	<0.030	mg/L	0.03	378512	a
Iron	D-Fe	<0.030	<0.030	mg/L	0.03	378700	a
Lead	D-Pb	<0.050	<0.050	mg/L	0.05	378700	a
Lithium	D-Li	<0.010	<0.010	mg/L	0.01	378700	a
Magnesium	D-Mg	<0.10	<0.10	mg/L	0.1	378512	a
Magnesium	D-Mg	<0.10	<0.10	mg/L	0.1	378700	a
Manganese	D-Mn	<0.0050	<0.0050	mg/L	0.005	378700	a
Molybdenum	D-Mo	<0.030	<0.030	mg/L	0.03	378700	a
Nickel	D-Ni	<0.050	<0.050	mg/L	0.05	378700	a
Phosphorus	D-P	<0.30	<0.30	mg/L	0.3	378700	a
Potassium	D-K	<2.0	<2.0	mg/L	2	378700	a
Selenium	D-Se	<0.20	<0.20	mg/L	0.2	378700	a
Silicon	D-Si	<0.050	<0.050	mg/L	0.05	378700	a
Silver	D-Ag	<0.010	<0.010	mg/L	0.01	378700	a
Sodium	D-Na	<2.0	<2.0	mg/L	2	378700	a
Strontium	D-Sr	<0.0050	<0.0050	mg/L	0.005	378700	a
Thallium	D-Tl	<0.20	<0.20	mg/L	0.2	378700	a
Tin	D-Sn	<0.030	<0.030	mg/L	0.03	378700	a
Titanium	D-Ti	<0.010	<0.010	mg/L	0.01	378700	a
Vanadium	D-V	<0.030	<0.030	mg/L	0.03	378700	a
Zinc	D-Zn	<0.0050	<0.0050	mg/L	0.005	378700	a

Methods:
a = ICPOES

A Campbell Brothers Limited Company

File No. U1206

Appendix 2 - METHODOLOGY

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:

Sample:	6 months
Reference:	EPA
For more detail see:	ALS "Collection & Sampling Guide"

Results contained within this report relate only to the samples as submitted.

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End of Report

A Campbell Brothers Limited Company

ALS Environmental

CHEMICAL ANALYSIS REPORT

Date:	March 22, 2004
ALS File No.	U1467 - Week 3
Report On:	Release 1455 Water Analysis
Report To:	**Canadian Environmental and** Metallurgical Inc. 1636 West 75th Avenue Vancouver, BC V6P 6G2
Attention:	**Mr. Sohan Basra**
Received:	March 11, 2004

ALS ENVIRONMENTAL
per:

Leanne Harris

Leanne Harris, B.Sc. - Project Chemist
Brent C. Mack, B.Sc. - Project Chemist

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A Campbell Brothers Limited Company

REMARKS

Please note that the detection limits for certain Dissolved Metals have been increased for some of the samples reported in the following data tables due to sample matrix interferences.

In particular, the detection limits for the samples identified as "18767" and "18771" were increased due to elevated D-Nickel. The detection limits for the sample identified as "18768" were increased due to elevated Chloride. The detection limits for the sample identified as "18769" were increased due to elevated D-Boron.

D-Arsenic by HVAAS analysis for the sample identified as "18768 HVAAS" was not possible as the sample volume was exhausted due the selection of this sample for laboratory replicate analysis.

A Campbell Brothers Limited Company

File No. U1467

RESULTS OF ANALYSIS - Water

Sample ID			18766	18767	18768
ALS ID			*1*	*2*	*3*
Physical Tests					
Total Dissolved Solids			50	2180	186
Dissolved Anions					
Chloride	Cl		<0.50	3.82	54.9
Fluoride	F		0.094	2.6	<0.020
Nutrients					
Ammonia Nitrogen		N	0.081	0.090	0.022
Nitrite/Nitrate Nitrogen		N	0.0231	0.059	<0.0050

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1467

RESULTS OF ANALYSIS - Water

Sample ID		18766	18766 HVAAS	18767	18767 HVAAS	18768
ALS ID		*1*	*1 a*	*2*	*2 a*	*3*
Dissolved Metals						
Aluminum	D-Al	0.162	-	0.12	-	0.0031
Antimony	D-Sb	0.00596	0.00594	<0.010	0.00252	0.00100
Arsenic	D-As	0.0257	0.0243	<0.010	0.0120	0.00323
Barium	D-Ba	0.000638	-	0.0214	-	0.0360
Beryllium	D-Be	<0.00050	-	<0.050	-	<0.00050
Bismuth	D-Bi	<0.00050	-	<0.050	-	<0.00050
Boron	D-B	0.120	-	<1.0	-	0.012
Cadmium	D-Cd	<0.000050	-	0.0612	-	<0.000050
Calcium	D-Ca	2.75	-	4.08	-	9.87
Chromium	D-Cr	<0.00050	-	<0.050	-	<0.00050
Cobalt	D-Co	0.00013	-	8.21	-	0.00014
Copper	D-Cu	0.00149	-	0.818	-	0.00104
Iron	D-Fe	<0.030	-	290	-	<0.030
Lead	D-Pb	0.000323	-	0.0525	-	0.000156
Lithium	D-Li	0.0095	-	<0.50	-	<0.0050
Magnesium	D-Mg	1.62	-	9.42	-	19.2
Manganese	D-Mn	0.00379	-	9.20	-	0.00336
Mercury	D-Hg	<0.000050	-	<0.000050	-	<0.000050
Molybdenum	D-Mo	0.0159	-	0.0060	-	0.00106
Nickel	D-Ni	<0.00050	-	405	-	0.00401
Phosphorus	D-P	<0.30	-	<0.60	-	<0.30
Potassium	D-K	6.9	-	<4.0	-	18.7
Selenium	D-Se	<0.0010	<0.00050	<0.10	0.0497	<0.0010
Silicon	D-Si	2.31	-	1.95	-	4.07
Silver	D-Ag	0.000139	-	<0.0010	-	<0.000010
Sodium	D-Na	10.7	-	<4.0	-	10.7
Strontium	D-Sr	0.0530	-	0.029	-	0.0518
Thallium	D-Tl	<0.00010	-	<0.010	-	<0.00010
Tin	D-Sn	0.00019	-	<0.010	-	0.00039
Titanium	D-Ti	<0.010	-	<0.020	-	<0.010
Uranium	D-U	0.000091	-	<0.0010	-	<0.000010
Vanadium	D-V	0.0022	-	<0.10	-	<0.0010
Zinc	D-Zn	<0.0010	-	0.89	-	<0.0010

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1467

RESULTS OF ANALYSIS - Water

Sample ID			18769	18770
ALS ID			*4*	*5*
Physical Tests				
Total Dissolved Solids			512	78
Dissolved Anions				
Chloride	Cl		7.07	0.89
Fluoride	F		<0.020	0.191
Nutrients				
Ammonia Nitrogen		N	<0.020	0.060
Nitrite/Nitrate Nitrogen		N	<0.0050	0.0359

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1467

RESULTS OF ANALYSIS - Water

Sample ID		18768 HVAAS	18769	18769 HVAAS	18770	18770 HVAAS
ALS ID		*3 a*	*4*	*4 a*	*5*	*5 a*
Dissolved Metals						
Aluminum	D-Al	-	<0.0050	-	0.296	-
Antimony	D-Sb	0.00080	<0.0010	0.00130	0.00530	0.00530
Arsenic	D-As	see below[1]	<0.0020	0.00242	0.0253	0.0233
Barium	D-Ba	-	0.0196	-	0.00115	-
Beryllium	D-Be	-	<0.0025	-	<0.00050	-
Bismuth	D-Bi	-	<0.0025	-	<0.00050	-
Boron	D-B	-	1.77	-	0.170	-
Cadmium	D-Cd	-	<0.00025	-	<0.000050	-
Calcium	D-Ca	-	20.3	-	4.33	-
Chromium	D-Cr	-	<0.0025	-	<0.00050	-
Cobalt	D-Co	-	0.00226	-	<0.00010	-
Copper	D-Cu	-	0.0128	-	0.00163	-
Iron	D-Fe	-	<0.030	-	<0.030	-
Lead	D-Pb	-	0.00051	-	0.000177	-
Lithium	D-Li	-	<0.025	-	0.0090	-
Magnesium	D-Mg	-	47.1	-	1.61	-
Manganese	D-Mn	-	0.0121	-	0.00151	-
Mercury	D-Hg	-	0.000052	-	<0.000050	-
Molybdenum	D-Mo	-	0.00054	-	0.00871	-
Nickel	D-Ni	-	0.101	-	<0.00050	-
Phosphorus	D-P	-	<0.30	-	<0.30	-
Potassium	D-K	-	32.3	-	8.5	-
Selenium	D-Se	<0.00050	<0.0050	0.00216	0.0014	0.00137
Silicon	D-Si	-	2.57	-	2.54	-
Silver	D-Ag	-	0.000388	-	0.000070	-
Sodium	D-Na	-	29.8	-	13.1	-
Strontium	D-Sr	-	0.160	-	0.0540	-
Thallium	D-Tl	-	<0.00050	-	<0.00010	-
Tin	D-Sn	-	0.00056	-	0.00053	-
Titanium	D-Ti	-	<0.010	-	<0.010	-
Uranium	D-U	-	<0.000050	-	0.000142	-
Vanadium	D-V	-	<0.0050	-	0.0062	-
Zinc	D-Zn	-	<0.0050	-	<0.0010	-

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
[1]see remark

A Campbell Brothers Limited Company

File No. U1467

RESULTS OF ANALYSIS - Water

Sample ID		18771	18771 HVAAS
ALS ID		*6*	*6 a*
Dissolved Metals			
Aluminum	D-Al	<0.10	-
Antimony	D-Sb	<0.010	0.00254
Arsenic	D-As	<0.010	0.0123
Barium	D-Ba	0.0196	-
Beryllium	D-Be	<0.050	-
Bismuth	D-Bi	<0.050	-
Boron	D-B	<1.0	-
Cadmium	D-Cd	0.0533	-
Calcium	D-Ca	4.11	-
Chromium	D-Cr	<0.050	-
Cobalt	D-Co	7.57	-
Copper	D-Cu	0.754	-
Iron	D-Fe	293	-
Lead	D-Pb	0.0462	-
Lithium	D-Li	<0.50	-
Magnesium	D-Mg	9.57	-
Manganese	D-Mn	8.47	-
Mercury	D-Hg	<0.000050	-
Molybdenum	D-Mo	<0.0050	-
Nickel	D-Ni	377	-
Phosphorus	D-P	<0.60	-
Potassium	D-K	<4.0	-
Selenium	D-Se	<0.10	0.0503
Silicon	D-Si	1.99	-
Silver	D-Ag	<0.0010	-
Sodium	D-Na	<4.0	-
Strontium	D-Sr	0.026	-
Thallium	D-Tl	<0.010	-
Tin	D-Sn	<0.010	-
Titanium	D-Ti	<0.020	-
Uranium	D-U	<0.0010	-
Vanadium	D-V	<0.10	-
Zinc	D-Zn	0.84	-

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

Appendix 1 - QUALITY CONTROL - Replicates

Water			18768	18768
				QC # 378883
Dissolved Anions				
Chloride	Cl		54.9	54.9
Fluoride	F		<0.020	<0.020
Nutrients				
Ammonia Nitrogen		N	0.022	<0.020

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1467

Appendix 1 - QUALITY CONTROL - Replicates

Water		18768	18768
			QC # 378883
Dissolved Metals			
Aluminum	D-Al	0.0031	0.0018
Antimony	D-Sb	0.00100	0.00099
Arsenic	D-As	0.00323	0.00327
Barium	D-Ba	0.0360	0.0365
Beryllium	D-Be	<0.00050	<0.00050
Bismuth	D-Bi	<0.00050	<0.00050
Boron	D-B	0.012	0.012
Cadmium	D-Cd	<0.000050	<0.000050
Calcium	D-Ca	9.87	9.84
Chromium	D-Cr	<0.00050	<0.00050
Cobalt	D-Co	0.00014	0.00013
Copper	D-Cu	0.00104	0.00105
Iron	D-Fe	<0.030	<0.030
Lead	D-Pb	0.000156	0.000124
Lithium	D-Li	<0.0050	<0.0050
Magnesium	D-Mg	19.2	19.3
Manganese	D-Mn	0.00336	0.00338
Mercury	D-Hg	<0.000050	<0.000050
Molybdenum	D-Mo	0.00106	0.00107
Nickel	D-Ni	0.00401	0.00332
Phosphorus	D-P	<0.30	<0.30
Potassium	D-K	18.7	19.2
Selenium	D-Se	<0.0010	<0.0010
Silicon	D-Si	4.07	4.05
Silver	D-Ag	<0.000010	<0.000010
Sodium	D-Na	10.7	10.5
Strontium	D-Sr	0.0518	0.0521
Thallium	D-Tl	<0.00010	0.00010
Tin	D-Sn	0.00039	0.00039
Titanium	D-Ti	<0.010	<0.010
Uranium	D-U	<0.000010	<0.000010
Vanadium	D-V	<0.0010	<0.0010
Zinc	D-Zn	<0.0010	<0.0010

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1467

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
ULTRA SCIENTIFIC, ULTMIX							
Total Metals							
Bismuth	T-Bi	0.99	1.00	mg/L	0.1	379216	a
Bismuth	T-Bi	1.00	1.00	mg/L	0.1	379293	a
Bismuth	T-Bi	1.02	1.00	mg/L	0.05	379413	b
Lithium	T-Li	0.201	0.200	mg/L	0.01	379216	a
Lithium	T-Li	0.198	0.200	mg/L	0.01	379293	a
Lithium	T-Li	<0.50	<0.50	mg/L	0.5	379413	b
Phosphorus	T-P	2.05	2.00	mg/L	0.3	379216	a
Phosphorus	T-P	1.95	2.00	mg/L	0.3	379293	a
Silicon	T-Si	1.01	1.00	mg/L	0.05	379216	a
Silicon	T-Si	1.00	1.00	mg/L	0.05	379293	a
Tin	T-Sn	1.03	1.00	mg/L	0.03	379216	a
Tin	T-Sn	1.04	1.00	mg/L	0.03	379293	a
Tin	T-Sn	1.04	1.00	mg/L	0.01	379413	b
Titanium	T-Ti	0.192	0.200	mg/L	0.01	379216	a
Titanium	T-Ti	0.195	0.200	mg/L	0.01	379293	a
NRC Ottawa River Water, SLRS-4							
Dissolved Metals							
Aluminum	D-Al	0.0568	0.0540	mg/L	0.001	379412	b
Antimony	D-Sb	0.000259	0.000230	mg/L	0.00005	379412	b
Arsenic	D-As	0.00073	0.00068	mg/L	0.0001	379412	b
Barium	D-Ba	0.0131	0.0122	mg/L	0.00005	379412	b
Beryllium	D-Be	<0.00050	<0.00050	mg/L	0.0005	379412	b
Cadmium	D-Cd	<0.000050	<0.000050	mg/L	0.00005	379412	b
Calcium	D-Ca	6.02	6.20	mg/L	0.02	379412	b
Chromium	D-Cr	<0.00050	<0.00050	mg/L	0.0005	379412	b
Cobalt	D-Co	<0.00010	<0.00010	mg/L	0.0001	379412	b
Copper	D-Cu	0.00188	0.00181	mg/L	0.0001	379412	b
Lead	D-Pb	0.000086	0.000086	mg/L	0.00005	379412	b
Magnesium	D-Mg	1.69	1.60	mg/L	0.005	379412	b
Manganese	D-Mn	0.00319	0.00337	mg/L	0.00005	379412	b
Molybdenum	D-Mo	0.000206	0.000210	mg/L	0.00005	379412	b
Nickel	D-Ni	0.00070	0.00067	mg/L	0.0001	379412	b
Potassium	D-K	0.663	0.680	mg/L	0.01	379412	b

Methods:
a = ICPOES
b = ICPMS

A Campbell Brothers Limited Company

File No. U1467

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

			Result	Target	Units	DL	ALSQC#	Method
NRC Ottawa River Water, SLRS-4								
Dissolved Metals								
Strontium	D-Sr		0.0287	0.0263	mg/L	0.0001	379412	a
Uranium	D-U		0.000049	0.000050	mg/L	0.00001	379412	a
Vanadium	D-V		<0.0010	<0.0010	mg/L	0.001	379412	a
Zinc	D-Zn		0.0011	<0.0010	mg/L	0.001	379412	a
SPEX Anions, 22-120AS								
Dissolved Anions								
Chloride	Cl		15.2	15.0	mg/L	0.5	379004	b
Fluoride	F		2.06	2.00	mg/L	0.02	379004	b
Nutrients								
Nitrite/Nitrate Nitrogen		N	7.04	6.80	mg/L	0.005	379004	b
Nitrite/Nitrate Nitrogen		N	7.02	6.80	mg/L	0.005	379397	c
APG Trace Metals, 31381-31382								
Total Metals								
Aluminum	T-Al		0.205	0.152	mg/L	0.01	379414	a
Antimony	T-Sb		0.278	0.262	mg/L	0.001	379414	a
Arsenic	T-As		0.152	0.152	mg/L	0.001	379414	a
Barium	T-Ba		0.447	0.438	mg/L	0.0005	379414	a
Beryllium	T-Be		0.0380	0.0367	mg/L	0.005	379414	a
Boron	T-B		0.13	0.10	mg/L	0.1	379414	a
Cadmium	T-Cd		0.0766	0.0767	mg/L	0.0005	379414	a
Chromium	T-Cr		0.126	0.125	mg/L	0.005	379414	a
Cobalt	T-Co		0.224	0.225	mg/L	0.001	379414	a
Copper	T-Cu		0.309	0.309	mg/L	0.001	379414	a
Lead	T-Pb		0.397	0.402	mg/L	0.0005	379414	a
Manganese	T-Mn		0.314	0.339	mg/L	0.0005	379414	a
Molybdenum	T-Mo		0.0950	0.0950	mg/L	0.0005	379414	a
Nickel	T-Ni		0.211	0.203	mg/L	0.005	379414	a
Selenium	T-Se		0.0367	0.0365	mg/L	0.005	379414	a
Silver	T-Ag		0.0722	0.0733	mg/L	0.0001	379414	a
Strontium	T-Sr		0.353	0.354	mg/L	0.001	379414	a
Thallium	T-Tl		0.109	0.111	mg/L	0.001	379414	a

Methods:
a = ICPMS
b = Ion Chromatography
c = Colourimetry

A Campbell Brothers Limited Company

File No. U1467

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Trace Metals, 31381-31382							
Total Metals							
Vanadium	T-V	0.199	0.194	mg/L	0.01	379414	a
Zinc	T-Zn	0.151	0.151	mg/L	0.01	379414	a
APG Trace Metals, 31652-31653							
Total Metals							
Aluminum	T-Al	0.99	1.00	mg/L	0.2	379217	b
Aluminum	T-Al	1.01	1.00	mg/L	0.2	379294	b
Antimony	T-Sb	0.26	0.28	mg/L	0.2	379217	b
Antimony	T-Sb	0.28	0.28	mg/L	0.2	379294	b
Arsenic	T-As	0.48	0.49	mg/L	0.2	379217	b
Arsenic	T-As	0.48	0.49	mg/L	0.2	379294	b
Barium	T-Ba	0.525	0.525	mg/L	0.01	379217	b
Barium	T-Ba	0.527	0.525	mg/L	0.01	379294	b
Beryllium	T-Be	0.398	0.397	mg/L	0.005	379217	b
Beryllium	T-Be	0.395	0.397	mg/L	0.005	379294	b
Boron	T-B	0.36	0.28	mg/L	0.1	379217	b
Boron	T-B	0.35	0.28	mg/L	0.1	379294	b
Cadmium	T-Cd	0.353	0.353	mg/L	0.01	379217	b
Cadmium	T-Cd	0.352	0.353	mg/L	0.01	379294	b
Chromium	T-Cr	0.170	0.167	mg/L	0.01	379217	b
Chromium	T-Cr	0.166	0.167	mg/L	0.01	379294	b
Cobalt	T-Co	0.240	0.240	mg/L	0.01	379217	b
Cobalt	T-Co	0.243	0.240	mg/L	0.01	379294	b
Copper	T-Cu	0.393	0.391	mg/L	0.01	379217	b
Copper	T-Cu	0.394	0.391	mg/L	0.01	379294	b
Iron	T-Fe	1.00	1.01	mg/L	0.03	379217	b
Iron	T-Fe	1.00	1.01	mg/L	0.03	379294	b
Lead	T-Pb	0.840	0.857	mg/L	0.05	379217	b
Lead	T-Pb	0.894	0.857	mg/L	0.05	379294	b
Manganese	T-Mn	2.26	2.26	mg/L	0.005	379217	b
Manganese	T-Mn	2.27	2.26	mg/L	0.005	379294	b
Molybdenum	T-Mo	0.101	0.097	mg/L	0.03	379217	b
Molybdenum	T-Mo	0.101	0.097	mg/L	0.03	379294	b
Nickel	T-Ni	0.623	0.611	mg/L	0.05	379217	b

Methods:
a = ICPMS
b = ICPOES

A Campbell Brothers Limited Company

File No. U1467

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Trace Metals, 31652-31653							
Total Metals							
Nickel	T-Ni	0.616	0.611	mg/L	0.05	379294	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	379217	a
Selenium	T-Se	0.20	<0.20	mg/L	0.2	379294	a
Silver	T-Ag	0.211	0.210	mg/L	0.01	379217	a
Silver	T-Ag	0.210	0.210	mg/L	0.01	379294	a
Strontium	T-Sr	0.105	0.104	mg/L	0.005	379217	a
Strontium	T-Sr	0.103	0.104	mg/L	0.005	379294	a
Thallium	T-Tl	0.31	0.38	mg/L	0.2	379217	a
Thallium	T-Tl	0.34	0.38	mg/L	0.2	379294	a
Titanium	T-Ti	0.194	0.192	mg/L	0.01	379217	a
Titanium	T-Ti	0.195	0.192	mg/L	0.01	379294	a
Vanadium	T-V	1.50	1.50	mg/L	0.03	379217	a
Vanadium	T-V	1.51	1.50	mg/L	0.03	379294	a
Zinc	T-Zn	0.122	0.121	mg/L	0.005	379217	a
Zinc	T-Zn	0.119	0.121	mg/L	0.005	379294	a
ALS Environmental Hg Water RM, Hg RM 002							
Total Metals							
Mercury	T-Hg	0.00983	0.0100	mg/L	0.00001	379209	b
ERA WasteWatR, P094506							
Dissolved Anions							
Fluoride	F	1.07	1.02	mg/L	0.02	379189	c
APG Minerals, 32993-32994							
Total Metals							
Calcium	T-Ca	15.6	15.6	mg/L	0.05	379215	a
Calcium	T-Ca	15.4	15.6	mg/L	0.05	379292	a
Calcium	T-Ca	15.5	15.6	mg/L	0.04	379411	d
Magnesium	T-Mg	5.73	5.85	mg/L	0.1	379215	a
Magnesium	T-Mg	5.76	5.85	mg/L	0.1	379292	a
Magnesium	T-Mg	5.94	5.85	mg/L	0.01	379411	d

Methods:
a = ICPOES
b = CVAFS
c = Electrode
d = ICPMS

A Campbell Brothers Limited Company

File No. U1467

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

			Result	Target	Units	DL	ALSQC#	Method
APG Minerals, 32993-32994								
Total Metals								
Potassium	T-K		34.3	33.1	mg/L	2	379215	a
Potassium	T-K		33.9	33.1	mg/L	2	379292	a
Potassium	T-K		34.5	33.1	mg/L	0.1	379411	b
Sodium	T-Na		40.2	39.1	mg/L	2	379215	a
Sodium	T-Na		40.0	39.1	mg/L	2	379292	a
Sodium	T-Na		40.2	39.1	mg/L	0.02	379411	b
SPEX Nutrients, 16-1 Nut1								
Nutrients								
Ammonia Nitrogen		N	11.8	11.4	mg/L	0.02	379386	c
APG Trace Metals, 35299-35300								
Total Metals								
Aluminum	T-Al		<0.20	<0.20	mg/L	0.2	379214	a
Aluminum	T-Al		<0.20	<0.20	mg/L	0.2	379291	a
Antimony	T-Sb		<0.20	<0.20	mg/L	0.2	379214	a
Antimony	T-Sb		<0.20	<0.20	mg/L	0.2	379291	a
Arsenic	T-As		<0.20	<0.20	mg/L	0.2	379214	a
Arsenic	T-As		<0.20	<0.20	mg/L	0.2	379291	a
Arsenic	T-As		0.125	0.128	mg/L	0.0002	379387	d
Barium	T-Ba		0.339	0.338	mg/L	0.01	379214	a
Barium	T-Ba		0.340	0.338	mg/L	0.01	379291	a
Beryllium	T-Be		0.0760	0.0751	mg/L	0.005	379214	a
Beryllium	T-Be		0.0782	0.0751	mg/L	0.005	379291	a
Boron	T-B		0.20	0.23	mg/L	0.1	379214	a
Boron	T-B		0.21	0.23	mg/L	0.1	379291	a
Cadmium	T-Cd		0.091	0.088	mg/L	0.01	379214	a
Cadmium	T-Cd		0.089	0.088	mg/L	0.01	379291	a
Chromium	T-Cr		0.215	0.218	mg/L	0.01	379214	a
Chromium	T-Cr		0.228	0.218	mg/L	0.01	379291	a
Cobalt	T-Co		0.276	0.280	mg/L	0.01	379214	a
Cobalt	T-Co		0.285	0.280	mg/L	0.01	379291	a
Copper	T-Cu		0.285	0.287	mg/L	0.01	379214	a

Methods:
a = ICPOES
b = ICPMS
c = Electrode
d = HVAAS

A Campbell Brothers Limited Company

File No. U1467

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Trace Metals, 35299-35300							
Total Metals							
Copper	T-Cu	0.294	0.287	mg/L	0.01	379291	a
Iron	T-Fe	0.378	0.368	mg/L	0.03	379214	a
Iron	T-Fe	0.381	0.368	mg/L	0.03	379291	a
Lead	T-Pb	0.242	0.264	mg/L	0.05	379214	a
Lead	T-Pb	0.278	0.264	mg/L	0.05	379291	a
Manganese	T-Mn	0.482	0.479	mg/L	0.005	379214	a
Manganese	T-Mn	0.495	0.479	mg/L	0.005	379291	a
Molybdenum	T-Mo	0.141	0.149	mg/L	0.03	379214	a
Molybdenum	T-Mo	0.156	0.149	mg/L	0.03	379291	a
Nickel	T-Ni	0.076	0.078	mg/L	0.05	379214	a
Nickel	T-Ni	0.073	0.078	mg/L	0.05	379291	a
Selenium	T-Se	0.0325	0.0307	mg/L	0.0005	379073	b
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	379214	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	379291	a
Silver	T-Ag	0.061	0.063	mg/L	0.01	379214	a
Silver	T-Ag	0.060	0.063	mg/L	0.01	379291	a
Strontium	T-Sr	0.367	0.367	mg/L	0.005	379214	a
Strontium	T-Sr	0.382	0.367	mg/L	0.005	379291	a
Thallium	T-Tl	<0.20	<0.20	mg/L	0.2	379214	a
Thallium	T-Tl	<0.20	<0.20	mg/L	0.2	379291	a
Tin	T-Sn	0.873	0.890	mg/L	0.03	379214	a
Tin	T-Sn	0.897	0.890	mg/L	0.03	379291	a
Titanium	T-Ti	0.096	0.093	mg/L	0.01	379214	a
Titanium	T-Ti	0.099	0.093	mg/L	0.01	379291	a
Vanadium	T-V	0.085	0.097	mg/L	0.03	379214	a
Vanadium	T-V	0.101	0.097	mg/L	0.03	379291	a
Zinc	T-Zn	0.147	0.148	mg/L	0.005	379214	a
Zinc	T-Zn	0.150	0.148	mg/L	0.005	379291	a
ERA Minerals, P102506							
Physical Tests							
Total Dissolved Solids		303	314	mg/L	10	379734	c

Methods:
a = ICPOES
b = HVAAS
c = Gravimetry

A Campbell Brothers Limited Company

File No. U1467

Appendix 1 - QUALITY CONTROL - Blanks

Water

			Result	Target	Units	DL	ALSQC#	Method
Physical Tests								
Total Dissolved Solids			<10	<10	mg/L	10	379731	a
Dissolved Anions								
Chloride	Cl		<0.50	<0.50	mg/L	0.5	379001	b
Fluoride	F		<0.020	<0.020	mg/L	0.02	379001	b
Fluoride	F		<0.02	<0.02	mg/L	0.02	379187	c
Nutrients								
Ammonia Nitrogen		N	<0.02	<0.02	mg/L	0.02	379384	c
Nitrite/Nitrate Nitrogen		N	<0.0050	<0.0050	mg/L	0.005	379001	b
Nitrite/Nitrate Nitrogen		N	<0.005	<0.005	mg/L	0.005	379396	d
Dissolved Metals								
Aluminum	D-Al		<0.0010	<0.0010	mg/L	0.001	379485	e
Antimony	D-Sb		<0.00020	<0.00020	mg/L	0.0002	379484	f
Antimony	D-Sb		<0.00010	<0.00010	mg/L	0.0001	379485	e
Arsenic	D-As		<0.00020	<0.00020	mg/L	0.0002	379484	f
Arsenic	D-As		<0.00010	<0.00010	mg/L	0.0001	379485	e
Barium	D-Ba		<0.000050	<0.000050	mg/L	0.00005	379485	e
Beryllium	D-Be		<0.00050	<0.00050	mg/L	0.0005	379485	e
Bismuth	D-Bi		<0.00050	<0.00050	mg/L	0.0005	379485	e
Boron	D-B		<0.010	<0.010	mg/L	0.01	379485	e
Cadmium	D-Cd		<0.000050	<0.000050	mg/L	0.00005	379485	e
Calcium	D-Ca		<0.050	<0.050	mg/L	0.05	379485	g
Chromium	D-Cr		<0.00050	<0.00050	mg/L	0.0005	379485	e
Cobalt	D-Co		<0.00010	<0.00010	mg/L	0.0001	379485	e
Copper	D-Cu		<0.00010	<0.00010	mg/L	0.0001	379485	e
Iron	D-Fe		<0.030	<0.030	mg/L	0.03	379485	g
Lead	D-Pb		<0.000050	<0.000050	mg/L	0.00005	379485	e
Lithium	D-Li		<0.0050	<0.0050	mg/L	0.005	379485	e
Magnesium	D-Mg		<0.10	<0.10	mg/L	0.1	379485	g
Manganese	D-Mn		<0.000050	<0.000050	mg/L	0.00005	379485	e
Mercury	D-Hg		<0.000050	<0.000050	mg/L	0.00005	379485	h
Molybdenum	D-Mo		<0.000050	<0.000050	mg/L	0.00005	379485	e
Nickel	D-Ni		<0.00050	<0.00050	mg/L	0.0005	379485	e
Phosphorus	D-P		<0.30	<0.30	mg/L	0.3	379485	g
Potassium	D-K		<2.0	<2.0	mg/L	2	379485	g
Selenium	D-Se		<0.00050	<0.00050	mg/L	0.0005	379484	f
Selenium	D-Se		<0.0010	<0.0010	mg/L	0.001	379485	e

Methods:
a = Gravimetry
b = Ion Chromatography
c = Electrode
d = Colourimetry
e = ICPMS
f = HVAAS
g = ICPOES
h = WM_D_BrCl_CVAFS

A Campbell Brothers Limited Company

File No. U1467

Appendix 1 - QUALITY CONTROL - Blanks

Water

		Result	Target	Units	DL	ALSQC#	Method
Dissolved Metals							
Silicon	D-Si	<0.050	<0.050	mg/L	0.05	379485	a
Silver	D-Ag	<0.000010	<0.000010	mg/L	0.00001	379485	b
Sodium	D-Na	<2.0	<2.0	mg/L	2	379485	a
Strontium	D-Sr	<0.00010	<0.00010	mg/L	0.0001	379485	b
Thallium	D-Tl	<0.00010	<0.00010	mg/L	0.0001	379485	b
Tin	D-Sn	<0.00010	<0.00010	mg/L	0.0001	379485	b
Titanium	D-Ti	<0.010	<0.010	mg/L	0.01	379485	a
Uranium	D-U	<0.000010	<0.000010	mg/L	0.00001	379485	b
Vanadium	D-V	<0.0010	<0.0010	mg/L	0.001	379485	b
Zinc	D-Zn	<0.0010	<0.0010	mg/L	0.001	379485	b

Methods:
a = ICPOES
b = ICPMS

A Campbell Brothers Limited Company

Appendix 2 - METHODOLOGY

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Solids in Water

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total dissolved solids (TDS) and total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius, TSS is determined by drying the filter at 104 degrees celsius. Total solids are determined by evaporating a sample to dryness at 104 degrees celsius. Fixed and volatile solids are determined by igniting a dried sample residue at 550 degrees celsius.

Recommended Holding Time:
Sample: 7 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Dissolved Anions in Water by Ion Chromatography

This analysis is carried out using procedures adapted from APHA Method 4110 "Determination of Anions by Ion Chromatography" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Anions are determined by filtering the sample through a 0.45 micron membrane filter and injecting the filtrate onto a Dionex IonPac AG17 anion exchange column with a hydroxide eluent stream. Anions routinely determined by this method include: bromide, chloride, fluoride, nitrate, nitrite and sulphate.

Recommended Holding Time:
Sample: 28 days (bromide, chloride, fluoride, sulphate)
Sample: 2 days (nitrate, nitrite)
Reference: APHA and EPA
For more detail see ALS Environmental "Collection & Sampling Guide"

Ammonia in Water by Selective Ion Electrode

This analysis is carried out, on sulphuric acid preserved samples, using procedures adapted from APHA Method 4500-NH3 "Nitrogen (Ammonia)". Ammonia is determined using an ammonia selective electrode.

Recommended Holding Time:
Sample: 28 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

A Campbell Brothers Limited Company

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:

Sample:	6 months
Reference:	EPA
For more detail see:	ALS "Collection & Sampling Guide"

Mercury in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic absorption and/or fluorescence spectrophotometry (EPA Method 7470A/7471A/245.7).

Recommended Holding Time:

Sample:	28 days
Reference:	EPA

For more detail see ALS Environmental "Collection & Sampling Guide"

Fluoride in Water

This analysis is carried out using procedures adapted from APHA Method 4500-F "Fluoride". Fluoride is determined using a selective ion electrode.

Recommended Holding Time:
Sample: 28 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

A Campbell Brothers Limited Company

Nitrate and Nitrite in Water by Colourimetry

This analysis is carried out using procedures adapted from APHA Method 4500-NO2 "Nitrogen (Nitrite)" and Method 4500-NO3 "Nitrogen (Nitrate)". Nitrite is determined using the azo dye colourimetric method. Nitrate is determined using the cadmium reduction colourimetric method. Nitrate/nitrite is the sum of the concentrations of nitrate and nitrite present in the sample.

Recommended Holding Time:
Sample: 2 days
Reference: APHA and EPA
For more detail see ALS Environmental "Collection & Sampling Guide"

Results contained within this report relate only to the samples as submitted.

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End of Report

A Campbell Brothers Limited Company

ALS Environmental

CHEMICAL ANALYSIS REPORT

Date:	March 23, 2004
ALS File No.	U1605 - Week 4
Report On:	Release 1464 Water Analysis
Report To:	**Canadian Environmental and** Metallurgical Inc. 1636 West 75th Avenue Vancouver, BC V6P 6G2
Attention:	**Mr. Sohan Basra**
Received:	March 17, 2004

ALS ENVIRONMENTAL
per:

Leanne Harris, B.Sc. - Project Chemist
Joanne Patrick, B.Sc. - Project Chemist

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File No. U1605

REMARKS

Please note that the detection limits for certain Dissolved Metals have been increased for some of the samples reported in the following data tables due to sample matrix interferences.

In particular, the detection limits for the sample identified as "18824" were increased due to elevated D-Nickel.

A Campbell Brothers Limited Company

File No. U1605

RESULTS OF ANALYSIS - Water

Sample ID		18823	18824	18825	18826	18827
ALS ID		*1*	*2*	*3*	*4*	*5*
Dissolved Metals						
Aluminum	D-Al	<0.20	<0.40	<0.20	<0.20	0.21
Antimony	D-Sb	<0.20	<0.40	<0.20	<0.20	<0.20
Arsenic	D-As	<0.20	<0.40	<0.20	<0.20	<0.20
Barium	D-Ba	<0.010	0.024	0.034	0.023	<0.010
Beryllium	D-Be	<0.0050	<0.010	<0.0050	<0.0050	<0.0050
Bismuth	D-Bi	<0.20	<0.40	<0.20	<0.20	<0.20
Boron	D-B	0.11	<0.20	<0.10	1.76	0.15
Cadmium	D-Cd	<0.010	<0.10	<0.010	<0.010	<0.010
Calcium	D-Ca	3.90	3.85	9.68	20.7	5.22
Chromium	D-Cr	<0.010	<0.10	<0.010	<0.010	<0.010
Cobalt	D-Co	<0.010	8.95	<0.010	<0.010	<0.010
Copper	D-Cu	<0.010	0.794	<0.010	0.022	<0.010
Iron	D-Fe	<0.030	246	<0.030	<0.030	<0.030
Lead	D-Pb	<0.050	<0.10	<0.050	<0.050	<0.050
Lithium	D-Li	0.013	<0.020	<0.010	<0.010	<0.010
Magnesium	D-Mg	2.41	9.35	14.9	38.4	1.82
Manganese	D-Mn	0.0062	10.9	<0.0050	0.0135	<0.0050
Molybdenum	D-Mo	<0.030	<0.060	<0.030	<0.030	<0.030
Nickel	D-Ni	<0.050	427	<0.050	0.070	<0.050
Phosphorus	D-P	<0.30	<0.60	<0.30	<0.30	<0.30
Potassium	D-K	5.4	<4.0	16.1	27.1	6.6
Selenium	D-Se	<0.20	<0.40	<0.20	<0.20	<0.20
Silicon	D-Si	2.23	2.01	3.64	2.59	2.43
Silver	D-Ag	<0.010	<0.020	<0.010	<0.010	<0.010
Sodium	D-Na	9.2	<4.0	8.7	19.8	10.3
Strontium	D-Sr	0.0769	0.031	0.0504	0.138	0.0607
Thallium	D-Tl	<0.20	<0.40	<0.20	<0.20	<0.20
Tin	D-Sn	<0.030	<0.060	<0.030	<0.030	<0.030
Titanium	D-Ti	<0.010	<0.020	<0.010	<0.010	<0.010
Vanadium	D-V	<0.030	<0.060	<0.030	<0.030	<0.030
Zinc	D-Zn	0.0063	1.01	0.0053	0.0124	0.0083

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1605

Appendix 1 - QUALITY CONTROL - Replicates

Water		18826	18826
			QC # 379447
Dissolved Metals			
Aluminum	D-Al	<0.20	<0.20
Antimony	D-Sb	<0.20	<0.20
Arsenic	D-As	<0.20	<0.20
Barium	D-Ba	0.023	0.023
Beryllium	D-Be	<0.0050	<0.0050
Bismuth	D-Bi	<0.20	<0.20
Boron	D-B	1.76	1.77
Cadmium	D-Cd	<0.010	<0.010
Calcium	D-Ca	20.7	20.6
Chromium	D-Cr	<0.010	<0.010
Cobalt	D-Co	<0.010	<0.010
Copper	D-Cu	0.022	0.019
Iron	D-Fe	<0.030	<0.030
Lead	D-Pb	<0.050	<0.050
Lithium	D-Li	<0.010	0.014
Magnesium	D-Mg	38.4	38.4
Manganese	D-Mn	0.0135	0.0145
Molybdenum	D-Mo	<0.030	<0.030
Nickel	D-Ni	0.070	<0.050
Phosphorus	D-P	<0.30	<0.30
Potassium	D-K	27.1	25.7
Selenium	D-Se	<0.20	<0.20
Silicon	D-Si	2.59	2.58
Silver	D-Ag	<0.010	<0.010
Sodium	D-Na	19.8	20.2
Strontium	D-Sr	0.138	0.138
Thallium	D-Tl	<0.20	<0.20
Tin	D-Sn	<0.030	<0.030
Titanium	D-Ti	<0.010	<0.010
Vanadium	D-V	<0.030	<0.030
Zinc	D-Zn	0.0124	0.0124

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1605

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
ULTRA SCIENTIFIC, ULTMIX							
Total Metals							
Bismuth	T-Bi	1.02	1.00	mg/L	0.1	379763	a
Lithium	T-Li	0.200	0.200	mg/L	0.01	379763	a
Phosphorus	T-P	2.11	2.00	mg/L	0.3	379763	a
Silicon	T-Si	1.02	1.00	mg/L	0.05	379763	a
Tin	T-Sn	1.05	1.00	mg/L	0.03	379763	a
Titanium	T-Ti	0.200	0.200	mg/L	0.01	379763	a
APG Trace Metals, 31652-31653							
Total Metals							
Aluminum	T-Al	1.05	1.00	mg/L	0.2	379764	a
Antimony	T-Sb	0.28	0.28	mg/L	0.2	379764	a
Arsenic	T-As	0.46	0.49	mg/L	0.2	379764	a
Barium	T-Ba	0.524	0.525	mg/L	0.01	379764	a
Beryllium	T-Be	0.398	0.397	mg/L	0.005	379764	a
Boron	T-B	0.35	0.28	mg/L	0.1	379764	a
Cadmium	T-Cd	0.355	0.353	mg/L	0.01	379764	a
Chromium	T-Cr	0.169	0.167	mg/L	0.01	379764	a
Cobalt	T-Co	0.241	0.240	mg/L	0.01	379764	a
Copper	T-Cu	0.390	0.391	mg/L	0.01	379764	a
Iron	T-Fe	1.02	1.01	mg/L	0.03	379764	a
Lead	T-Pb	0.852	0.857	mg/L	0.05	379764	a
Manganese	T-Mn	2.26	2.26	mg/L	0.005	379764	a
Molybdenum	T-Mo	0.099	0.097	mg/L	0.03	379764	a
Nickel	T-Ni	0.628	0.611	mg/L	0.05	379764	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	379764	a
Silver	T-Ag	0.211	0.210	mg/L	0.01	379764	a
Strontium	T-Sr	0.105	0.104	mg/L	0.005	379764	a
Thallium	T-Tl	0.37	0.38	mg/L	0.2	379764	a
Titanium	T-Ti	0.195	0.192	mg/L	0.01	379764	a
Vanadium	T-V	1.50	1.50	mg/L	0.03	379764	a
Zinc	T-Zn	0.122	0.121	mg/L	0.005	379764	a

Methods:
a = ICPOES

A Campbell Brothers Limited Company

File No. U1605

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Minerals, 32993-32994							
Total Metals							
Calcium	T-Ca	15.5	15.6	mg/L	0.05	379762	a
Magnesium	T-Mg	5.79	5.85	mg/L	0.1	379762	a
Potassium	T-K	34.4	33.1	mg/L	2	379762	a
Sodium	T-Na	39.3	39.1	mg/L	2	379762	a
APG Trace Metals, 35299-35300							
Total Metals							
Aluminum	T-Al	<0.20	<0.20	mg/L	0.2	379761	a
Antimony	T-Sb	<0.20	<0.20	mg/L	0.2	379761	a
Arsenic	T-As	<0.20	<0.20	mg/L	0.2	379761	a
Barium	T-Ba	0.343	0.338	mg/L	0.01	379761	a
Beryllium	T-Be	0.0762	0.0751	mg/L	0.005	379761	a
Boron	T-B	0.19	0.23	mg/L	0.1	379761	a
Cadmium	T-Cd	0.092	0.088	mg/L	0.01	379761	a
Chromium	T-Cr	0.223	0.218	mg/L	0.01	379761	a
Cobalt	T-Co	0.288	0.280	mg/L	0.01	379761	a
Copper	T-Cu	0.294	0.287	mg/L	0.01	379761	a
Iron	T-Fe	0.388	0.368	mg/L	0.03	379761	a
Lead	T-Pb	0.258	0.264	mg/L	0.05	379761	a
Manganese	T-Mn	0.490	0.479	mg/L	0.005	379761	a
Molybdenum	T-Mo	0.142	0.149	mg/L	0.03	379761	a
Nickel	T-Ni	0.061	0.078	mg/L	0.05	379761	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	379761	a
Silver	T-Ag	0.062	0.063	mg/L	0.01	379761	a
Strontium	T-Sr	0.374	0.367	mg/L	0.005	379761	a
Thallium	T-Tl	<0.20	<0.20	mg/L	0.2	379761	a
Tin	T-Sn	0.908	0.890	mg/L	0.03	379761	a
Titanium	T-Ti	0.099	0.093	mg/L	0.01	379761	a
Vanadium	T-V	0.103	0.097	mg/L	0.03	379761	a
Zinc	T-Zn	0.150	0.148	mg/L	0.005	379761	a

Methods:
a = ICPOES

A Campbell Brothers Limited Company

File No. U1605

Appendix 1 - QUALITY CONTROL - Blanks

Water

		Result	Target	Units	DL	ALSQC#	Method
Dissolved Metals							
Aluminum	D-Al	<0.20	<0.20	mg/L	0.2	379973	a
Antimony	D-Sb	<0.20	<0.20	mg/L	0.2	379973	a
Arsenic	D-As	<0.20	<0.20	mg/L	0.2	379973	a
Barium	D-Ba	<0.010	<0.010	mg/L	0.01	379973	a
Beryllium	D-Be	<0.0050	<0.0050	mg/L	0.005	379973	a
Bismuth	D-Bi	<0.20	<0.20	mg/L	0.2	379973	a
Boron	D-B	<0.10	<0.10	mg/L	0.1	379973	a
Cadmium	D-Cd	<0.010	<0.010	mg/L	0.01	379973	a
Calcium	D-Ca	<0.050	<0.050	mg/L	0.05	379973	a
Chromium	D-Cr	<0.010	<0.010	mg/L	0.01	379973	a
Cobalt	D-Co	<0.010	<0.010	mg/L	0.01	379973	a
Copper	D-Cu	<0.010	<0.010	mg/L	0.01	379973	a
Iron	D-Fe	<0.030	<0.030	mg/L	0.03	379973	a
Lead	D-Pb	<0.050	<0.050	mg/L	0.05	379973	a
Lithium	D-Li	<0.010	<0.010	mg/L	0.01	379973	a
Magnesium	D-Mg	<0.10	<0.10	mg/L	0.1	379973	a
Manganese	D-Mn	<0.0050	<0.0050	mg/L	0.005	379973	a
Molybdenum	D-Mo	<0.030	<0.030	mg/L	0.03	379973	a
Nickel	D-Ni	<0.050	<0.050	mg/L	0.05	379973	a
Phosphorus	D-P	<0.30	<0.30	mg/L	0.3	379973	a
Potassium	D-K	<2.0	<2.0	mg/L	2	379973	a
Selenium	D-Se	<0.20	<0.20	mg/L	0.2	379973	a
Silicon	D-Si	<0.050	<0.050	mg/L	0.05	379973	a
Silver	D-Ag	<0.010	<0.010	mg/L	0.01	379973	a
Sodium	D-Na	<2.0	<2.0	mg/L	2	379973	a
Strontium	D-Sr	<0.0050	<0.0050	mg/L	0.005	379973	a
Thallium	D-Tl	<0.20	<0.20	mg/L	0.2	379973	a
Tin	D-Sn	<0.030	<0.030	mg/L	0.03	379973	a
Titanium	D-Ti	<0.010	<0.010	mg/L	0.01	379973	a
Vanadium	D-V	<0.030	<0.030	mg/L	0.03	379973	a
Zinc	D-Zn	<0.0050	<0.0050	mg/L	0.005	379973	a

Methods:
a = ICPOES

A Campbell Brothers Limited Company

File No. U1605

Appendix 2 - METHODOLOGY

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:

Sample:	6 months
Reference:	EPA
For more detail see:	ALS "Collection & Sampling Guide"

Results contained within this report relate only to the samples as submitted.

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End of Report

A Campbell Brothers Limited Company

ALS Environmental

CHEMICAL ANALYSIS REPORT

Date:	April 7, 2004
ALS File No.	U1828 - Week 5
Report On:	Release 1499 Water Analysis
Report To:	**Canadian Environmental and** Metallurgical Inc. 1636 West 75th Avenue Vancouver, BC V6P 6G2
Attention:	**Mr. Sohan Basra**
Received:	March 24, 2004

ALS ENVIRONMENTAL
per:

Leanne Harris, B.Sc. - Project Chemist
Joanne Patrick, B.Sc. - Project Chemist

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REMARKS

Please note that the detection limits for certain Dissolved Metals have been increased for some of the samples reported in the following data tables due to sample matrix interferences.

In particular, the detection limits for the sample identified as "18891" were increased due to elevated D-Nickel.

Please note the detection limits for D-Arsenic for all samples submitted and run by Hydride Vapour Atomic Absorption Spectrophotometry (HVAAS) analysis were increased due to unusual matrix interferences present. Sample spikes were conducted by the laboratory for these HVAAS samples, and due to poor recoveries, dilutions were conducted on these specific samples to reduce matrix interferences. These diluted samples were then re-spiked and sample spike recoveries of 86.8% were accepted; however, the dilutions conducted resulted in detection limit increases for D-Arsenic.

A Campbell Brothers Limited Company

File No. U1828

RESULTS OF ANALYSIS - Water

Sample ID			18890	18891	18892
Sample Date			04-03-23	04-03-23	04-03-23
Sample Time			08:00	08:00	08:00
ALS ID			*1*	*2*	*3*
Physical Tests					
Total Dissolved Solids			66	1900	139
Dissolved Anions					
Chloride	Cl		<0.50	12.3	38.4
Fluoride	F		0.053	0.025	0.050
Nutrients					
Ammonia Nitrogen		N	0.033	0.042	<0.020
Nitrite/Nitrate Nitrogen		N	0.0130	0.0801	0.0054

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1828

RESULTS OF ANALYSIS - Water

Sample ID		18890	18890 HVAAS	18891	18891 HVAAS	18892
Sample Date		04-03-23	04-03-23	04-03-23	04-03-23	04-03-23
Sample Time		08:00	08:00	08:00	08:00	08:00
ALS ID		*1*	*1 a*	*2*	*2 a*	*3*
Dissolved Metals						
Aluminum	D-Al	0.0873	-	0.30	-	0.0026
Antimony	D-Sb	0.00487	0.0044	<0.010	<0.0020	0.00064
Arsenic	D-As	0.0233	0.0329	<0.010	0.00635	0.00048
Barium	D-Ba	0.000681	-	0.0147	-	0.0336
Beryllium	D-Be	<0.00050	-	<0.050	-	<0.00050
Bismuth	D-Bi	<0.00050	-	<0.050	-	<0.00050
Boron	D-B	0.099	-	<1.0	-	0.010
Cadmium	D-Cd	<0.000050	-	0.0254	-	<0.000050
Calcium	D-Ca	4.62	-	2.08	-	10.3
Chromium	D-Cr	<0.00050	-	<0.050	-	<0.00050
Cobalt	D-Co	0.00021	-	6.78	-	<0.00010
Copper	D-Cu	0.00079	-	0.634	-	0.00094
Iron	D-Fe	<0.030	-	232	-	<0.030
Lead	D-Pb	0.000070	-	0.0490	-	0.000104
Lithium	D-Li	0.0086	-	<0.50	-	<0.0050
Magnesium	D-Mg	2.89	-	6.53	-	14.4
Manganese	D-Mn	0.00745	-	7.82	-	0.00283
Mercury	D-Hg	<0.000050	-	0.000190	-	<0.000050
Molybdenum	D-Mo	0.0121	-	<0.0050	-	0.000687
Nickel	D-Ni	0.00063	-	338	-	0.00205
Phosphorus	D-P	<0.30	-	<0.60	-	<0.30
Potassium	D-K	4.4	-	<4.0	-	15.3
Selenium	D-Se	<0.0010	0.00066	<0.10	0.0365	<0.0010
Silicon	D-Si	2.16	-	2.00	-	3.70
Silver	D-Ag	0.000022	-	<0.0010	-	0.000218
Sodium	D-Na	8.2	-	<4.0	-	7.9
Strontium	D-Sr	0.0878	-	0.015	-	0.0469
Thallium	D-Tl	<0.00010	-	<0.010	-	<0.00010
Tin	D-Sn	0.00010	-	<0.010	-	0.00164
Titanium	D-Ti	<0.010	-	<0.020	-	<0.010
Uranium	D-U	0.000115	-	<0.0010	-	<0.000010
Vanadium	D-V	0.0016	-	<0.10	-	<0.0010
Zinc	D-Zn	0.0015	-	0.32	-	0.0011

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1828

RESULTS OF ANALYSIS - Water

Sample ID			18893	18894
Sample Date			04-03-23	04-03-23
Sample Time			08:00	08:00
ALS ID			*4*	*5*
Physical Tests				
Total Dissolved Solids			448	66
Dissolved Anions				
Chloride	Cl		130	1.55
Fluoride	F		0.025	0.067
Nutrients				
Ammonia Nitrogen		N	<0.020	<0.020
Nitrite/Nitrate Nitrogen		N	0.0076	0.0174

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1828

RESULTS OF ANALYSIS - Water

Sample ID		18892 HVAAS	18893	18893 HVAAS	18894	18894 HVAAS
Sample Date		04-03-23	04-03-23	04-03-23	04-03-23	04-03-23
Sample Time		08:00	08:00	08:00	08:00	08:00
ALS ID		*3 a*	*4*	*4 a*	*5*	*5 a*
Dissolved Metals						
Aluminum	D-Al	-	0.0022	-	0.155	-
Antimony	D-Sb	<0.0020	0.00059	<0.0020	0.00332	0.0024
Arsenic	D-As	0.00060	0.00053	0.00120	0.0200	0.0264
Barium	D-Ba	-	0.0186	-	0.00176	-
Beryllium	D-Be	-	<0.00050	-	<0.00050	-
Bismuth	D-Bi	-	<0.00050	-	<0.00050	-
Boron	D-B	-	1.42	-	0.133	-
Cadmium	D-Cd	-	<0.000050	-	<0.000050	-
Calcium	D-Ca	-	22.9	-	6.58	-
Chromium	D-Cr	-	<0.00050	-	<0.00050	-
Cobalt	D-Co	-	0.00178	-	<0.00010	-
Copper	D-Cu	-	0.0118	-	0.00122	-
Iron	D-Fe	-	<0.030	-	<0.030	-
Lead	D-Pb	-	<0.000050	-	0.000055	-
Lithium	D-Li	-	<0.0050	-	0.0092	-
Magnesium	D-Mg	-	40.2	-	2.10	-
Manganese	D-Mn	-	0.0149	-	0.00239	-
Mercury	D-Hg	-	0.000166	-	<0.000050	-
Molybdenum	D-Mo	-	0.000516	-	0.00567	-
Nickel	D-Ni	-	0.0703	-	<0.00050	-
Phosphorus	D-P	-	<0.30	-	<0.30	-
Potassium	D-K	-	27.4	-	6.7	-
Selenium	D-Se	<0.00050	0.0025	0.00236	<0.0010	0.00126
Silicon	D-Si	-	2.33	-	2.36	-
Silver	D-Ag	-	0.000406	-	<0.000010	-
Sodium	D-Na	-	20.0	-	8.7	-
Strontium	D-Sr	-	0.113	-	0.0665	-
Thallium	D-Tl	-	<0.00010	-	<0.00010	-
Tin	D-Sn	-	0.00019	-	0.00017	-
Titanium	D-Ti	-	<0.010	-	<0.010	-
Uranium	D-U	-	<0.000010	-	0.000194	-
Vanadium	D-V	-	<0.0010	-	0.0033	-
Zinc	D-Zn	-	0.0035	-	0.0012	-

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U1828

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
ULTRA SCIENTIFIC, ULTMIX							
Total Metals							
Bismuth	T-Bi	1.02	1.00	mg/L	0.1	380488	a
Bismuth	T-Bi	1.04	1.00	mg/L	0.05	381034	b
Lithium	T-Li	0.203	0.200	mg/L	0.01	380488	a
Lithium	T-Li	<0.50	<0.50	mg/L	0.5	381034	b
Phosphorus	T-P	1.97	2.00	mg/L	0.3	380488	a
Silicon	T-Si	1.01	1.00	mg/L	0.05	380488	a
Tin	T-Sn	1.03	1.00	mg/L	0.03	380488	a
Tin	T-Sn	1.07	1.00	mg/L	0.01	381034	b
Titanium	T-Ti	0.195	0.200	mg/L	0.01	380488	a
NRC Ottawa River Water, SLRS-4							
Dissolved Metals							
Aluminum	D-Al	0.0538	0.0540	mg/L	0.001	381033	b
Antimony	D-Sb	0.000261	0.000230	mg/L	0.00005	381033	b
Arsenic	D-As	0.00072	0.00068	mg/L	0.0001	381033	b
Barium	D-Ba	0.0131	0.0122	mg/L	0.00005	381033	b
Beryllium	D-Be	<0.00050	<0.00050	mg/L	0.0005	381033	b
Cadmium	D-Cd	<0.000050	<0.000050	mg/L	0.00005	381033	b
Calcium	D-Ca	5.63	6.20	mg/L	0.02	381033	b
Chromium	D-Cr	<0.00050	<0.00050	mg/L	0.0005	381033	b
Cobalt	D-Co	<0.00010	<0.00010	mg/L	0.0001	381033	b
Copper	D-Cu	0.00182	0.00181	mg/L	0.0001	381033	b
Lead	D-Pb	0.000079	0.000086	mg/L	0.00005	381033	b
Magnesium	D-Mg	1.54	1.60	mg/L	0.005	381033	b
Manganese	D-Mn	0.00342	0.00337	mg/L	0.00005	381033	b
Molybdenum	D-Mo	0.000207	0.000210	mg/L	0.00005	381033	b
Nickel	D-Ni	0.00064	0.00067	mg/L	0.0001	381033	b
Potassium	D-K	0.668	0.680	mg/L	0.01	381033	b
Strontium	D-Sr	0.0282	0.0263	mg/L	0.0001	381033	b
Uranium	D-U	0.000049	0.000050	mg/L	0.00001	381033	b
Vanadium	D-V	<0.0010	<0.0010	mg/L	0.001	381033	b
Zinc	D-Zn	0.0011	<0.0010	mg/L	0.001	381033	b

Methods:
a = ICPOES
b = ICPMS

A Campbell Brothers Limited Company

File No. U1828

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

			Result	Target	Units	DL	ALSQC#	Method
SPEX Anions, 22-120AS								
Nutrients								
Nitrite/Nitrate Nitrogen		N	7.27	6.80	mg/L	0.005	381133	a
APG Trace Metals, 31381-31382								
Total Metals								
Aluminum	T-Al		0.189	0.152	mg/L	0.01	381035	b
Antimony	T-Sb		0.283	0.262	mg/L	0.001	381035	b
Arsenic	T-As		0.155	0.152	mg/L	0.001	381035	b
Barium	T-Ba		0.444	0.438	mg/L	0.0005	381035	b
Beryllium	T-Be		0.0388	0.0367	mg/L	0.005	381035	b
Boron	T-B		0.14	0.10	mg/L	0.1	381035	b
Cadmium	T-Cd		0.0756	0.0767	mg/L	0.0005	381035	b
Chromium	T-Cr		0.121	0.125	mg/L	0.005	381035	b
Cobalt	T-Co		0.221	0.225	mg/L	0.001	381035	b
Copper	T-Cu		0.299	0.309	mg/L	0.001	381035	b
Lead	T-Pb		0.401	0.402	mg/L	0.0005	381035	b
Manganese	T-Mn		0.327	0.339	mg/L	0.0005	381035	b
Molybdenum	T-Mo		0.100	0.0950	mg/L	0.0005	381035	b
Nickel	T-Ni		0.204	0.203	mg/L	0.005	381035	b
Selenium	T-Se		0.0380	0.0365	mg/L	0.005	381035	b
Silver	T-Ag		0.0739	0.0733	mg/L	0.0001	381035	b
Strontium	T-Sr		0.355	0.354	mg/L	0.001	381035	b
Thallium	T-Tl		0.110	0.111	mg/L	0.001	381035	b
Vanadium	T-V		0.194	0.194	mg/L	0.01	381035	b
Zinc	T-Zn		0.162	0.151	mg/L	0.01	381035	b
APG Trace Metals, 31652-31653								
Total Metals								
Aluminum	T-Al		1.00	1.00	mg/L	0.2	380489	c
Antimony	T-Sb		<0.20	0.28	mg/L	0.2	380489	c
Arsenic	T-As		0.50	0.49	mg/L	0.2	380489	c
Barium	T-Ba		0.537	0.525	mg/L	0.01	380489	c
Beryllium	T-Be		0.399	0.397	mg/L	0.005	380489	c

Methods:
a = Colourimetry
b = ICPMS
c = ICPOES

A Campbell Brothers Limited Company

File No. U1828

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Trace Metals, 31652-31653							
Total Metals							
Boron	T-B	0.35	0.28	mg/L	0.1	380489	a
Cadmium	T-Cd	0.362	0.353	mg/L	0.01	380489	a
Chromium	T-Cr	0.170	0.167	mg/L	0.01	380489	a
Cobalt	T-Co	0.247	0.240	mg/L	0.01	380489	a
Copper	T-Cu	0.397	0.391	mg/L	0.01	380489	a
Iron	T-Fe	1.02	1.01	mg/L	0.03	380489	a
Lead	T-Pb	0.884	0.857	mg/L	0.05	380489	a
Manganese	T-Mn	2.31	2.26	mg/L	0.005	380489	a
Molybdenum	T-Mo	0.106	0.097	mg/L	0.03	380489	a
Nickel	T-Ni	0.636	0.611	mg/L	0.05	380489	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	380489	a
Silver	T-Ag	0.212	0.210	mg/L	0.01	380489	a
Strontium	T-Sr	0.105	0.104	mg/L	0.005	380489	a
Thallium	T-Tl	0.40	0.38	mg/L	0.2	380489	a
Titanium	T-Ti	0.197	0.192	mg/L	0.01	380489	a
Vanadium	T-V	1.52	1.50	mg/L	0.03	380489	a
Zinc	T-Zn	0.123	0.121	mg/L	0.005	380489	a
ALS Environmental Hg Water RM, Hg RM 002							
Total Metals							
Mercury	T-Hg	0.0102	0.0100	mg/L	0.00001	380644	b
ERA WasteWatR, P094506							
Dissolved Anions							
Fluoride	F	0.988	1.02	mg/L	0.02	380581	c
APG Minerals, 32993-32994							
Total Metals							
Calcium	T-Ca	15.6	15.6	mg/L	0.05	380487	a
Calcium	T-Ca	14.4	15.6	mg/L	0.04	381032	d

Methods:
a = ICPOES
b = CVAFS
c = Electrode
d = ICPMS

A Campbell Brothers Limited Company

File No. U1828

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

			Result	Target	Units	DL	ALSQC#	Method
APG Minerals, 32993-32994								
Total Metals								
Magnesium	T-Mg		5.77	5.85	mg/L	0.1	380487	a
Magnesium	T-Mg		5.63	5.85	mg/L	0.01	381032	b
Potassium	T-K		34.0	33.1	mg/L	2	380487	a
Potassium	T-K		35.8	33.1	mg/L	0.1	381032	b
Sodium	T-Na		41.3	39.1	mg/L	2	380487	a
Sodium	T-Na		39.7	39.1	mg/L	0.02	381032	b
SPEX Nutrients, 16-1 Nut1								
Nutrients								
Ammonia Nitrogen		N	11.5	11.4	mg/L	0.02	380452	c
APG Trace Metals, 35299-35300								
Total Metals								
Aluminum	T-Al		<0.20	<0.20	mg/L	0.2	380486	a
Antimony	T-Sb		<0.20	<0.20	mg/L	0.2	380486	a
Antimony	T-Sb		0.0292	0.0272	mg/L	0.0002	380865	d
Arsenic	T-As		<0.20	<0.20	mg/L	0.2	380486	a
Arsenic	T-As		0.130	0.128	mg/L	0.0002	381157	d
Barium	T-Ba		0.348	0.338	mg/L	0.01	380486	a
Beryllium	T-Be		0.0778	0.0751	mg/L	0.005	380486	a
Boron	T-B		0.22	0.23	mg/L	0.1	380486	a
Cadmium	T-Cd		0.094	0.088	mg/L	0.01	380486	a
Chromium	T-Cr		0.222	0.218	mg/L	0.01	380486	a
Cobalt	T-Co		0.290	0.280	mg/L	0.01	380486	a
Copper	T-Cu		0.296	0.287	mg/L	0.01	380486	a
Iron	T-Fe		0.375	0.368	mg/L	0.03	380486	a
Lead	T-Pb		0.263	0.264	mg/L	0.05	380486	a
Manganese	T-Mn		0.495	0.479	mg/L	0.005	380486	a
Molybdenum	T-Mo		0.155	0.149	mg/L	0.03	380486	a
Nickel	T-Ni		0.092	0.078	mg/L	0.05	380486	a
Selenium	T-Se		<0.20	<0.20	mg/L	0.2	380486	a

Methods:
a = ICPOES
b = ICPMS
c = Electrode
d = HVAAS

A Campbell Brothers Limited Company

File No. U1828

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Trace Metals, 35299-35300							
Total Metals							
Selenium	T-Se	0.0303	0.0307	mg/L	0.0005	380541	a
Silver	T-Ag	0.067	0.063	mg/L	0.01	380486	b
Strontium	T-Sr	0.375	0.367	mg/L	0.005	380486	b
Thallium	T-Tl	<0.20	<0.20	mg/L	0.2	380486	b
Tin	T-Sn	0.880	0.890	mg/L	0.03	380486	b
Titanium	T-Ti	0.097	0.093	mg/L	0.01	380486	b
Vanadium	T-V	0.102	0.097	mg/L	0.03	380486	b
Zinc	T-Zn	0.150	0.148	mg/L	0.005	380486	b
SPEX Minerals, 19-45M, 19.-46M							
Dissolved Anions							
Chloride	Cl	79.7	77.9	mg/L	0.5	380989	c
SPEX Minerals (10xD), 19-45M, 19-46M							
Dissolved Anions							
Chloride	Cl	8.42	7.79	mg/L	0.5	380988	c
SPEX Minerals (2xC), 19-45M, 19-46M							
Dissolved Anions							
Chloride	Cl	160	156	mg/L	0.5	380990	c
ERA Minerals, P102506							
Physical Tests							
Total Dissolved Solids		308	314	mg/L	10	381424	d

Methods:
a = HVAAS
b = ICPOES
c = Colourimetry
d = Gravimetry

A Campbell Brothers Limited Company

File No. U1828

Appendix 1 - QUALITY CONTROL - Blanks

Water

			Result	Target	Units	DL	ALSQC#	Method
Physical Tests								
Total Dissolved Solids			<10	<10	mg/L	10	381423	a
Dissolved Anions								
Chloride	Cl		<0.5	<0.5	mg/L	0.5	380983	b
Fluoride	F		<0.02	<0.02	mg/L	0.02	380580	c
Nutrients								
Ammonia Nitrogen		N	<0.02	<0.02	mg/L	0.02	380450	c
Nitrite/Nitrate Nitrogen		N	<0.005	<0.005	mg/L	0.005	381132	b
Dissolved Metals								
Aluminum	D-Al		<0.0010	<0.0010	mg/L	0.001	382092	d
Antimony	D-Sb		<0.00010	<0.00010	mg/L	0.0001	382092	d
Antimony	D-Sb		<0.00020	<0.00020	mg/L	0.0002	382093	e
Arsenic	D-As		<0.00010	<0.00010	mg/L	0.0001	382092	d
Arsenic	D-As		<0.00020	<0.00020	mg/L	0.0002	382093	e
Barium	D-Ba		<0.000050	<0.000050	mg/L	0.00005	382092	d
Beryllium	D-Be		<0.00050	<0.00050	mg/L	0.0005	382092	d
Bismuth	D-Bi		<0.00050	<0.00050	mg/L	0.0005	382092	d
Boron	D-B		<0.010	<0.010	mg/L	0.01	382092	d
Cadmium	D-Cd		<0.000050	<0.000050	mg/L	0.00005	382092	d
Calcium	D-Ca		<0.050	<0.050	mg/L	0.05	382092	f
Chromium	D-Cr		<0.00050	<0.00050	mg/L	0.0005	382092	d
Cobalt	D-Co		<0.00010	<0.00010	mg/L	0.0001	382092	d
Copper	D-Cu		<0.00010	<0.00010	mg/L	0.0001	382092	d
Iron	D-Fe		<0.030	<0.030	mg/L	0.03	382092	f
Lead	D-Pb		<0.000050	<0.000050	mg/L	0.00005	382092	d
Lithium	D-Li		<0.0050	<0.0050	mg/L	0.005	382092	d
Magnesium	D-Mg		<0.10	<0.10	mg/L	0.1	382092	f
Manganese	D-Mn		<0.000050	<0.000050	mg/L	0.00005	382092	d
Mercury	D-Hg		<0.000050	<0.000050	mg/L	0.00005	382092	g
Molybdenum	D-Mo		<0.000050	<0.000050	mg/L	0.00005	382092	d
Nickel	D-Ni		<0.00050	<0.00050	mg/L	0.0005	382092	d
Phosphorus	D-P		<0.30	<0.30	mg/L	0.3	382092	f
Potassium	D-K		<2.0	<2.0	mg/L	2	382092	f
Selenium	D-Se		<0.0010	<0.0010	mg/L	0.001	382092	d
Selenium	D-Se		<0.00050	<0.00050	mg/L	0.0005	382093	e

Methods:
a = Gravimetry
b = Colourimetry
c = Electrode
d = ICPMS
e = HVAAS
f = ICPOES
g = CVAFS

A Campbell Brothers Limited Company

File No. U1828

Appendix 1 - QUALITY CONTROL - Blanks

Water

		Result	Target	Units	DL	ALSQC#	Method
Dissolved Metals							
Silicon	D-Si	<0.050	<0.050	mg/L	0.05	382092	a
Silver	D-Ag	<0.000010	<0.000010	mg/L	0.00001	382092	b
Sodium	D-Na	<2.0	<2.0	mg/L	2	382092	a
Strontium	D-Sr	<0.00010	<0.00010	mg/L	0.0001	382092	b
Thallium	D-Tl	<0.00010	<0.00010	mg/L	0.0001	382092	b
Tin	D-Sn	<0.00010	<0.00010	mg/L	0.0001	382092	b
Titanium	D-Ti	<0.010	<0.010	mg/L	0.01	382092	a
Uranium	D-U	<0.000010	<0.000010	mg/L	0.00001	382092	b
Vanadium	D-V	<0.0010	<0.0010	mg/L	0.001	382092	b
Zinc	D-Zn	<0.0010	<0.0010	mg/L	0.001	382092	b

Methods:
a = ICPOES
b = ICPMS

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Appendix 2 - METHODOLOGY

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Solids in Water

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total dissolved solids (TDS) and total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius, TSS is determined by drying the filter at 104 degrees celsius. Total solids are determined by evaporating a sample to dryness at 104 degrees celsius. Fixed and volatile solids are determined by igniting a dried sample residue at 550 degrees celsius.

Recommended Holding Time:
Sample: 7 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Chloride in Water

This analysis is carried out using procedures adapted from APHA Method 4500 "Chloride". Chloride is determined using the ferricyanide colourimetric method.

Recommended Holding Time:
Sample: 28 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Fluoride in Water

This analysis is carried out using procedures adapted from APHA Method 4500-F "Fluoride". Fluoride is determined using a selective ion electrode.

Recommended Holding Time:
Sample: 28 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Ammonia in Water by Selective Ion Electrode

This analysis is carried out, on sulphuric acid preserved samples, using procedures adapted from APHA Method 4500-NH3 "Nitrogen (Ammonia)". Ammonia is determined using an ammonia selective electrode.

Recommended Holding Time:
Sample: 28 days
Reference: APHA

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Appendix 2 - METHODOLOGY - Continued

For more detail see ALS Environmental "Collection & Sampling Guide"

Nitrate and Nitrite in Water by Colourimetry

This analysis is carried out using procedures adapted from APHA Method 4500-NO2 "Nitrogen (Nitrite)" and Method 4500-NO3 "Nitrogen (Nitrate)". Nitrite is determined using the azo dye colourimetric method. Nitrate is determined using the cadmium reduction colourimetric method. Nitrate/nitrite is the sum of the concentrations of nitrate and nitrite present in the sample.

Recommended Holding Time:
Sample: 2 days
Reference: APHA and EPA
For more detail see ALS Environmental "Collection & Sampling Guide"

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:

Sample:	6 months
Reference:	EPA
For more detail see:	ALS "Collection & Sampling Guide"

Mercury in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic absorption and/or fluorescence spectrophotometry (EPA Method 7470A/7471A/245.7).

Recommended Holding Time:

Sample:	28 days
Reference:	EPA

For more detail see ALS Environmental "Collection & Sampling Guide"

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Appendix 2 - METHODOLOGY - Continued

Results contained within this report relate only to the samples as submitted.

This Chemical Analysis Report shall only be reproduced in full, except with the written approval of ALS Environmental.

End of Report

A Campbell Brothers Limited Company

ALS Environmental

CHEMICAL ANALYSIS REPORT

Date:	April 7, 2004
ALS File No.	U2129 - Week 6
Report On:	Release 1508 Water Analysis
Report To:	**Canadian Environmental and** Metallurgical Inc. 1636 West 75th Avenue Vancouver, BC V6P 6G2
Attention:	**Mr. Sohan Basra**
Received:	March 31, 2004

ALS ENVIRONMENTAL
per:

Leanne Harris, B.Sc. - Project Chemist
Joanne Patrick, B.Sc. - Project Chemist

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File No. U2129

REMARKS

Please note that the detection limits for certain Dissolved Metals have been increased for some of the samples reported in the following data tables due to sample matrix interferences.

In particular, the detection limits for the sample identified as "18945" were increased due to elevated D-Nickel.

A Campbell Brothers Limited Company

File No. U2129

RESULTS OF ANALYSIS - Water

Sample ID		18944	18945	18946	18947	18948
ALS ID		*1*	*2*	*3*	*4*	*5*
Dissolved Anions						
Sulphate	SO4	29.7	1060	7.5	121	22.0
Dissolved Metals						
Aluminum	D-Al	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony	D-Sb	<0.20	<0.30	<0.20	<0.20	<0.20
Arsenic	D-As	<0.20	<0.20	<0.20	<0.20	<0.20
Barium	D-Ba	<0.010	<0.010	0.033	0.022	<0.010
Beryllium	D-Be	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth	D-Bi	<0.20	<0.20	<0.20	<0.20	<0.20
Boron	D-B	<0.10	<0.10	<0.10	1.64	<0.10
Cadmium	D-Cd	<0.010	<0.10	<0.010	<0.010	<0.010
Calcium	D-Ca	5.19	1.92	10.9	22.9	7.79
Chromium	D-Cr	<0.010	<0.10	<0.010	<0.010	<0.010
Cobalt	D-Co	<0.010	6.31	<0.010	<0.010	<0.010
Copper	D-Cu	<0.010	0.405	<0.010	0.016	<0.010
Iron	D-Fe	0.055	209	<0.030	<0.030	<0.030
Lead	D-Pb	<0.050	<0.050	<0.050	<0.050	<0.050
Lithium	D-Li	0.012	<0.010	<0.010	<0.010	0.016
Magnesium	D-Mg	3.31	6.15	14.7	37.7	2.31
Manganese	D-Mn	0.0081	7.43	<0.0050	0.0183	<0.0050
Molybdenum	D-Mo	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	D-Ni	<0.050	320	<0.050	0.072	<0.050
Phosphorus	D-P	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	D-K	3.7	<2.0	15.4	24.9	6.4
Selenium	D-Se	<0.20	<0.20	<0.20	<0.20	<0.20
Silicon	D-Si	2.24	2.10	4.04	2.34	2.38
Silver	D-Ag	<0.010	<0.010	<0.010	<0.010	<0.010
Sodium	D-Na	9.0	<2.0	7.4	16.3	7.8
Strontium	D-Sr	0.0973	0.0160	0.0511	0.100	0.0760
Thallium	D-Tl	<0.20	<0.20	<0.20	<0.20	<0.20
Tin	D-Sn	<0.030	<0.030	<0.030	<0.030	<0.030
Titanium	D-Ti	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium	D-V	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	D-Zn	0.0145	<0.31	0.0114	0.0175	0.0074

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U2129

RESULTS OF ANALYSIS - Water

Sample ID		18949
ALS ID		*6*
Dissolved Metals		
Aluminum	D-Al	<0.20
Antimony	D-Sb	<0.20
Arsenic	D-As	<0.20
Barium	D-Ba	0.039
Beryllium	D-Be	<0.0050
Bismuth	D-Bi	<0.20
Boron	D-B	<0.10
Cadmium	D-Cd	<0.010
Calcium	D-Ca	10.8
Chromium	D-Cr	<0.010
Cobalt	D-Co	<0.010
Copper	D-Cu	<0.010
Iron	D-Fe	<0.030
Lead	D-Pb	<0.050
Lithium	D-Li	<0.010
Magnesium	D-Mg	14.6
Manganese	D-Mn	<0.0050
Molybdenum	D-Mo	<0.030
Nickel	D-Ni	<0.050
Phosphorus	D-P	<0.30
Potassium	D-K	14.1
Selenium	D-Se	<0.20
Silicon	D-Si	4.01
Silver	D-Ag	<0.010
Sodium	D-Na	7.3
Strontium	D-Sr	0.0500
Thallium	D-Tl	<0.20
Tin	D-Sn	<0.030
Titanium	D-Ti	<0.010
Vanadium	D-V	<0.030
Zinc	D-Zn	0.0104

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U2129

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
ULTRA SCIENTIFIC, ULTMIX							
Total Metals							
Bismuth	T-Bi	1.01	1.00	mg/L	0.1	381833	a
Lithium	T-Li	0.213	0.200	mg/L	0.01	381833	a
Phosphorus	T-P	1.86	2.00	mg/L	0.3	381833	a
Silicon	T-Si	0.999	1.00	mg/L	0.05	381833	a
Tin	T-Sn	1.06	1.00	mg/L	0.03	381833	a
Titanium	T-Ti	0.197	0.200	mg/L	0.01	381833	a
APG Trace Metals, 31652-31653							
Total Metals							
Aluminum	T-Al	0.97	1.00	mg/L	0.2	381834	a
Antimony	T-Sb	0.26	0.28	mg/L	0.2	381834	a
Arsenic	T-As	0.45	0.49	mg/L	0.2	381834	a
Barium	T-Ba	0.502	0.525	mg/L	0.01	381834	a
Beryllium	T-Be	0.380	0.397	mg/L	0.005	381834	a
Boron	T-B	0.35	0.28	mg/L	0.1	381834	a
Cadmium	T-Cd	0.340	0.353	mg/L	0.01	381834	a
Chromium	T-Cr	0.165	0.167	mg/L	0.01	381834	a
Cobalt	T-Co	0.235	0.240	mg/L	0.01	381834	a
Copper	T-Cu	0.383	0.391	mg/L	0.01	381834	a
Iron	T-Fe	0.979	1.01	mg/L	0.03	381834	a
Lead	T-Pb	0.797	0.857	mg/L	0.05	381834	a
Manganese	T-Mn	2.17	2.26	mg/L	0.005	381834	a
Molybdenum	T-Mo	0.099	0.097	mg/L	0.03	381834	a
Nickel	T-Ni	0.613	0.611	mg/L	0.05	381834	a
Selenium	T-Se	0.22	<0.20	mg/L	0.2	381834	a
Silver	T-Ag	0.201	0.210	mg/L	0.01	381834	a
Strontium	T-Sr	0.0981	0.104	mg/L	0.005	381834	a
Thallium	T-Tl	0.38	0.38	mg/L	0.2	381834	a
Titanium	T-Ti	0.194	0.192	mg/L	0.01	381834	a
Vanadium	T-V	1.45	1.50	mg/L	0.03	381834	a
Zinc	T-Zn	0.119	0.121	mg/L	0.005	381834	a

Methods:
a = ICPOES

A Campbell Brothers Limited Company

File No. U2129

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Minerals, 32993-32994							
Total Metals							
Calcium	T-Ca	15.2	15.6	mg/L	0.05	381832	a
Magnesium	T-Mg	5.74	5.85	mg/L	0.1	381832	a
Potassium	T-K	34.4	33.1	mg/L	2	381832	a
Sodium	T-Na	42.8	39.1	mg/L	2	381832	a
APG Trace Metals, 35299-35300							
Total Metals							
Aluminum	T-Al	<0.20	<0.20	mg/L	0.2	381831	a
Antimony	T-Sb	<0.20	<0.20	mg/L	0.2	381831	a
Arsenic	T-As	<0.20	<0.20	mg/L	0.2	381831	a
Barium	T-Ba	0.329	0.338	mg/L	0.01	381831	a
Beryllium	T-Be	0.0759	0.0751	mg/L	0.005	381831	a
Boron	T-B	0.25	0.23	mg/L	0.1	381831	a
Cadmium	T-Cd	0.081	0.088	mg/L	0.01	381831	a
Chromium	T-Cr	0.215	0.218	mg/L	0.01	381831	a
Cobalt	T-Co	0.281	0.280	mg/L	0.01	381831	a
Copper	T-Cu	0.289	0.287	mg/L	0.01	381831	a
Iron	T-Fe	0.378	0.368	mg/L	0.03	381831	a
Lead	T-Pb	0.255	0.264	mg/L	0.05	381831	a
Manganese	T-Mn	0.473	0.479	mg/L	0.005	381831	a
Molybdenum	T-Mo	0.149	0.149	mg/L	0.03	381831	a
Nickel	T-Ni	0.074	0.078	mg/L	0.05	381831	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	381831	a
Silver	T-Ag	0.063	0.063	mg/L	0.01	381831	a
Strontium	T-Sr	0.363	0.367	mg/L	0.005	381831	a
Thallium	T-Tl	<0.20	<0.20	mg/L	0.2	381831	a
Tin	T-Sn	0.919	0.890	mg/L	0.03	381831	a
Titanium	T-Ti	0.100	0.093	mg/L	0.01	381831	a
Vanadium	T-V	0.100	0.097	mg/L	0.03	381831	a
Zinc	T-Zn	0.147	0.148	mg/L	0.005	381831	a
SPEX Minerals (2xC), 19-45M, 19-46M							
Dissolved Anions							
Sulphate	SO4	32.6	31.6	mg/L	1	381548	b

Methods:
a = ICPOES
b = Turbidimetry

A Campbell Brothers Limited Company

File No. U2129

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

	Result	Target	Units	DL	ALSQC#	Method
SPEX Minerals (4xC), 19-45M, 19-46M						
Dissolved Anions						
Sulphate SO4	64.0	63.0	mg/L	1	381549	a
SPEX Minerals (10xC), 19-45M, 19-46M						
Dissolved Anions						
Sulphate SO4	165	158	mg/L	1	381550	a

Methods:
a = Turbidimetry

A Campbell Brothers Limited Company

File No. U2129

Appendix 1 - QUALITY CONTROL - Blanks

Water

		Result	Target	Units	DL	ALSQC#	Method
Dissolved Anions							
Sulphate	SO4	<1	<1	mg/L	1	381545	a
Dissolved Metals							
Aluminum	D-Al	<0.20	<0.20	mg/L	0.2	381956	b
Antimony	D-Sb	<0.20	<0.20	mg/L	0.2	381956	b
Arsenic	D-As	<0.20	<0.20	mg/L	0.2	381956	b
Barium	D-Ba	<0.010	<0.010	mg/L	0.01	381956	b
Beryllium	D-Be	<0.0050	<0.0050	mg/L	0.005	381956	b
Bismuth	D-Bi	<0.20	<0.20	mg/L	0.2	381956	b
Boron	D-B	<0.10	<0.10	mg/L	0.1	381956	b
Cadmium	D-Cd	<0.010	<0.010	mg/L	0.01	381956	b
Calcium	D-Ca	<0.050	<0.050	mg/L	0.05	381956	b
Chromium	D-Cr	<0.010	<0.010	mg/L	0.01	381956	b
Cobalt	D-Co	<0.010	<0.010	mg/L	0.01	381956	b
Copper	D-Cu	<0.010	<0.010	mg/L	0.01	381956	b
Iron	D-Fe	<0.030	<0.030	mg/L	0.03	381956	b
Lead	D-Pb	<0.050	<0.050	mg/L	0.05	381956	b
Lithium	D-Li	<0.010	<0.010	mg/L	0.01	381956	b
Magnesium	D-Mg	<0.10	<0.10	mg/L	0.1	381956	b
Manganese	D-Mn	<0.0050	<0.0050	mg/L	0.005	381956	b
Molybdenum	D-Mo	<0.030	<0.030	mg/L	0.03	381956	b
Nickel	D-Ni	<0.050	<0.050	mg/L	0.05	381956	b
Phosphorus	D-P	<0.30	<0.30	mg/L	0.3	381956	b
Potassium	D-K	<2.0	<2.0	mg/L	2	381956	b
Selenium	D-Se	<0.20	<0.20	mg/L	0.2	381956	b
Silicon	D-Si	<0.050	<0.050	mg/L	0.05	381956	b
Silver	D-Ag	<0.010	<0.010	mg/L	0.01	381956	b
Sodium	D-Na	<2.0	<2.0	mg/L	2	381956	b
Strontium	D-Sr	<0.0050	<0.0050	mg/L	0.005	381956	b
Thallium	D-Tl	<0.20	<0.20	mg/L	0.2	381956	b
Tin	D-Sn	<0.030	<0.030	mg/L	0.03	381956	b
Titanium	D-Ti	<0.010	<0.010	mg/L	0.01	381956	b
Vanadium	D-V	<0.030	<0.030	mg/L	0.03	381956	b
Zinc	D-Zn	<0.0050	<0.0050	mg/L	0.005	381956	b

Methods:
a = Turbidimetry
b = ICPOES

A Campbell Brothers Limited Company

File No. U2129

Appendix 2 - METHODOLOGY

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Sulphate in Water

This analysis is carried out using procedures adapted from APHA Method 4500-SO4 "Sulphate". Sulphate is determined using the turbidimetric method.

Recommended Holding Time:
Sample: 28 days
Reference: APHA
For more detail see ALS Environmental "Collection & Sampling Guide"

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:

Sample:	6 months
Reference:	EPA
For more detail see:	ALS "Collection & Sampling Guide"

Results contained within this report relate only to the samples as submitted.

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End of Report

A Campbell Brothers Limited Company

ALS Environmental

CHEMICAL ANALYSIS REPORT

Date:	April 13, 2004
ALS File No.	U2297 - Week 7
Report On:	Release 1516 Water Analysis
Report To:	**Canadian Environmental and** Metallurgical Inc. 1636 West 75th Avenue Vancouver, BC V6P 6G2
Attention:	**Mr. Sohan Basra**
Received:	April 7, 2004

ALS ENVIRONMENTAL
per:

Brent C. Mack, B.Sc. - Project Chemist
Leanne Harris, B.Sc. - Project Chemist

ALS CANADA LTD.
1988 Triumph Street, Vancouver, BC Canada V5L 1K5
Phone: 604-253-4188 Fax: 604-253-6700 Website: www.alsenviro.com

File No. U2297

REMARKS

Please note that the detection limits for certain Metals have been increased for some of the samples reported in the following data tables due to sample matrix interferences.

A Campbell Brothers Limited Company

File No. U2297

RESULTS OF ANALYSIS - Water

Sample ID		18978	18979	18980	18981	18982
Sample Date		04-04-06	04-04-06	04-04-06	04-04-06	04-04-06
Sample Time		08:00	08:00	08:00	08:00	08:00
ALS ID		*1*	*2*	*3*	*4*	*5*
Dissolved Metals						
Aluminum	D-Al	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony	D-Sb	<0.20	<0.30	<0.20	<0.20	<0.20
Arsenic	D-As	<0.20	<0.20	<0.20	<0.20	<0.20
Barium	D-Ba	<0.010	0.013	0.044	0.025	<0.010
Beryllium	D-Be	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bismuth	D-Bi	<0.20	<0.20	<0.20	<0.20	<0.20
Boron	D-B	<0.10	<0.10	<0.10	1.35	<0.10
Cadmium	D-Cd	<0.010	<0.20	<0.010	<0.010	<0.010
Calcium	D-Ca	5.47	1.39	12.0	24.7	9.42
Chromium	D-Cr	<0.010	<0.10	<0.010	<0.010	<0.010
Cobalt	D-Co	<0.010	5.46	<0.010	<0.010	<0.010
Copper	D-Cu	<0.010	0.585	<0.010	0.018	<0.010
Iron	D-Fe	<0.030	197	<0.030	<0.030	<0.030
Lead	D-Pb	<0.050	<0.050	<0.050	<0.050	<0.050
Lithium	D-Li	0.010	<0.010	<0.010	<0.010	<0.010
Magnesium	D-Mg	3.47	5.22	14.0	37.2	2.48
Manganese	D-Mn	0.0098	6.81	<0.0050	0.0228	0.0057
Molybdenum	D-Mo	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	D-Ni	<0.050	287	<0.050	0.093	<0.050
Phosphorus	D-P	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	D-K	3.9	<2.0	12.9	23.4	5.3
Selenium	D-Se	<0.20	<0.20	<0.20	<0.20	<0.20
Silicon	D-Si	2.28	2.27	4.27	2.34	2.51
Silver	D-Ag	<0.010	<0.010	<0.010	<0.010	<0.010
Sodium	D-Na	6.4	<2.0	6.2	13.0	6.9
Strontium	D-Sr	0.100	0.0118	0.0503	0.0975	0.0828
Thallium	D-Tl	<0.20	<0.20	<0.20	<0.20	<0.20
Tin	D-Sn	<0.030	<0.040	<0.030	<0.030	<0.030
Titanium	D-Ti	<0.010	<0.010	<0.010	<0.010	<0.010
Vanadium	D-V	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	D-Zn	0.0067	<0.30	0.0096	0.0096	0.0067

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U2297

Appendix 1 - QUALITY CONTROL - Replicates

Water		18980	18980
		04-04-06 08:00	QC # 382109
Dissolved Metals			
Aluminum	D-Al	<0.20	<0.20
Antimony	D-Sb	<0.20	<0.20
Arsenic	D-As	<0.20	<0.20
Barium	D-Ba	0.044	0.044
Beryllium	D-Be	<0.0050	<0.0050
Bismuth	D-Bi	<0.20	<0.20
Boron	D-B	<0.10	<0.10
Cadmium	D-Cd	<0.010	<0.010
Calcium	D-Ca	12.0	11.9
Chromium	D-Cr	<0.010	<0.010
Cobalt	D-Co	<0.010	<0.010
Copper	D-Cu	<0.010	<0.010
Iron	D-Fe	<0.030	<0.030
Lead	D-Pb	<0.050	<0.050
Lithium	D-Li	<0.010	<0.010
Magnesium	D-Mg	14.0	14.0
Manganese	D-Mn	<0.0050	<0.0050
Molybdenum	D-Mo	<0.030	<0.030
Nickel	D-Ni	<0.050	<0.050
Phosphorus	D-P	<0.30	<0.30
Potassium	D-K	12.9	14.2
Selenium	D-Se	<0.20	<0.20
Silicon	D-Si	4.27	4.24
Silver	D-Ag	<0.010	<0.010
Sodium	D-Na	6.2	6.2
Strontium	D-Sr	0.0503	0.0512
Thallium	D-Tl	<0.20	<0.20
Tin	D-Sn	<0.030	<0.030
Titanium	D-Ti	<0.010	<0.010
Vanadium	D-V	<0.030	<0.030
Zinc	D-Zn	0.0096	0.0096

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

A Campbell Brothers Limited Company

File No. U2297

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
ULTRA SCIENTIFIC, ULTMIX							
Total Metals							
Bismuth	T-Bi	1.00	1.00	mg/L	0.1	382404	a
Lithium	T-Li	0.199	0.200	mg/L	0.01	382404	a
Phosphorus	T-P	1.94	2.00	mg/L	0.3	382404	a
Silicon	T-Si	1.02	1.00	mg/L	0.05	382404	a
Tin	T-Sn	0.995	1.00	mg/L	0.03	382404	a
Titanium	T-Ti	0.194	0.200	mg/L	0.01	382404	a
APG Trace Metals, 31652-31653							
Total Metals							
Aluminum	T-Al	1.00	1.00	mg/L	0.2	382405	a
Antimony	T-Sb	0.28	0.28	mg/L	0.2	382405	a
Arsenic	T-As	0.49	0.49	mg/L	0.2	382405	a
Barium	T-Ba	0.524	0.525	mg/L	0.01	382405	a
Beryllium	T-Be	0.397	0.397	mg/L	0.005	382405	a
Boron	T-B	0.34	0.28	mg/L	0.1	382405	a
Cadmium	T-Cd	0.354	0.353	mg/L	0.01	382405	a
Chromium	T-Cr	0.168	0.167	mg/L	0.01	382405	a
Cobalt	T-Co	0.241	0.240	mg/L	0.01	382405	a
Copper	T-Cu	0.390	0.391	mg/L	0.01	382405	a
Iron	T-Fe	1.01	1.01	mg/L	0.03	382405	a
Lead	T-Pb	0.892	0.857	mg/L	0.05	382405	a
Manganese	T-Mn	2.28	2.26	mg/L	0.005	382405	a
Molybdenum	T-Mo	0.101	0.097	mg/L	0.03	382405	a
Nickel	T-Ni	0.602	0.611	mg/L	0.05	382405	a
Selenium	T-Se	0.21	<0.20	mg/L	0.2	382405	a
Silver	T-Ag	0.212	0.210	mg/L	0.01	382405	a
Strontium	T-Sr	0.103	0.104	mg/L	0.005	382405	a
Thallium	T-Tl	0.41	0.38	mg/L	0.2	382405	a
Titanium	T-Ti	0.194	0.192	mg/L	0.01	382405	a
Vanadium	T-V	1.49	1.50	mg/L	0.03	382405	a
Zinc	T-Zn	0.121	0.121	mg/L	0.005	382405	a

Methods:
a = ICPOES

A Campbell Brothers Limited Company

File No. U2297

Appendix 1 - QUALITY CONTROL - Reference Materials

Water

		Result	Target	Units	DL	ALSQC#	Method
APG Minerals, 32993-32994							
Total Metals							
Calcium	T-Ca	16.2	15.6	mg/L	0.05	382403	a
Magnesium	T-Mg	5.87	5.85	mg/L	0.1	382403	a
Potassium	T-K	33.5	33.1	mg/L	2	382403	a
Sodium	T-Na	40.3	39.1	mg/L	2	382403	a
APG Trace Metals, 35299-35300							
Total Metals							
Aluminum	T-Al	<0.20	<0.20	mg/L	0.2	382402	a
Antimony	T-Sb	<0.20	<0.20	mg/L	0.2	382402	a
Arsenic	T-As	<0.20	<0.20	mg/L	0.2	382402	a
Barium	T-Ba	0.344	0.338	mg/L	0.01	382402	a
Beryllium	T-Be	0.0764	0.0751	mg/L	0.005	382402	a
Boron	T-B	0.23	0.23	mg/L	0.1	382402	a
Cadmium	T-Cd	0.085	0.088	mg/L	0.01	382402	a
Chromium	T-Cr	0.217	0.218	mg/L	0.01	382402	a
Cobalt	T-Co	0.284	0.280	mg/L	0.01	382402	a
Copper	T-Cu	0.291	0.287	mg/L	0.01	382402	a
Iron	T-Fe	0.372	0.368	mg/L	0.03	382402	a
Lead	T-Pb	0.258	0.264	mg/L	0.05	382402	a
Manganese	T-Mn	0.488	0.479	mg/L	0.005	382402	a
Molybdenum	T-Mo	0.154	0.149	mg/L	0.03	382402	a
Nickel	T-Ni	0.080	0.078	mg/L	0.05	382402	a
Selenium	T-Se	<0.20	<0.20	mg/L	0.2	382402	a
Silver	T-Ag	0.065	0.063	mg/L	0.01	382402	a
Strontium	T-Sr	0.366	0.367	mg/L	0.005	382402	a
Thallium	T-Tl	<0.20	<0.20	mg/L	0.2	382402	a
Tin	T-Sn	0.857	0.890	mg/L	0.03	382402	a
Titanium	T-Ti	0.092	0.093	mg/L	0.01	382402	a
Vanadium	T-V	0.100	0.097	mg/L	0.03	382402	a
Zinc	T-Zn	0.148	0.148	mg/L	0.005	382402	a

Methods:
a = ICPOES

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Appendix 1 - QUALITY CONTROL - Blanks

Water

		Result	Target	Units	DL	ALSQC#	Method
Dissolved Metals							
Aluminum	D-Al	<0.20	<0.20	mg/L	0.2	382576	a
Antimony	D-Sb	<0.20	<0.20	mg/L	0.2	382576	a
Arsenic	D-As	<0.20	<0.20	mg/L	0.2	382576	a
Barium	D-Ba	<0.010	<0.010	mg/L	0.01	382576	a
Beryllium	D-Be	<0.0050	<0.0050	mg/L	0.005	382576	a
Bismuth	D-Bi	<0.20	<0.20	mg/L	0.2	382576	a
Boron	D-B	<0.10	<0.10	mg/L	0.1	382576	a
Cadmium	D-Cd	<0.010	<0.010	mg/L	0.01	382576	a
Calcium	D-Ca	<0.050	<0.050	mg/L	0.05	382576	a
Chromium	D-Cr	<0.010	<0.010	mg/L	0.01	382576	a
Cobalt	D-Co	<0.010	<0.010	mg/L	0.01	382576	a
Copper	D-Cu	<0.010	<0.010	mg/L	0.01	382576	a
Iron	D-Fe	<0.030	<0.030	mg/L	0.03	382576	a
Lead	D-Pb	<0.050	<0.050	mg/L	0.05	382576	a
Lithium	D-Li	<0.010	<0.010	mg/L	0.01	382576	a
Magnesium	D-Mg	<0.10	<0.10	mg/L	0.1	382576	a
Manganese	D-Mn	<0.0050	<0.0050	mg/L	0.005	382576	a
Molybdenum	D-Mo	<0.030	<0.030	mg/L	0.03	382576	a
Nickel	D-Ni	<0.050	<0.050	mg/L	0.05	382576	a
Phosphorus	D-P	<0.30	<0.30	mg/L	0.3	382576	a
Potassium	D-K	<2.0	<2.0	mg/L	2	382576	a
Selenium	D-Se	<0.20	<0.20	mg/L	0.2	382576	a
Silicon	D-Si	<0.050	<0.050	mg/L	0.05	382576	a
Silver	D-Ag	<0.010	<0.010	mg/L	0.01	382576	a
Sodium	D-Na	<2.0	<2.0	mg/L	2	382576	a
Strontium	D-Sr	<0.0050	<0.0050	mg/L	0.005	382576	a
Thallium	D-Tl	<0.20	<0.20	mg/L	0.2	382576	a
Tin	D-Sn	<0.030	<0.030	mg/L	0.03	382576	a
Titanium	D-Ti	<0.010	<0.010	mg/L	0.01	382576	a
Vanadium	D-V	<0.030	<0.030	mg/L	0.03	382576	a
Zinc	D-Zn	<0.0050	<0.0050	mg/L	0.005	382576	a

Methods:
a = ICPOES

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File No. U2297

Appendix 2 - METHODOLOGY

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Metals in Water

This analysis is carried out using procedures adapted from "StandardMethods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using eitherhotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:

Sample:	6 months
Reference:	EPA
For more detail see:	ALS "Collection & Sampling Guide"

Results contained within this report relate only to the samples as submitted.

This Chemical Analysis Report shall only be reproduced in full, except with thewritten approval of ALS Environmental.

End of Report

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APPENDIX E

LESLIE INVESTMENTS INC. RESEARCH AND CONSULTING MINERALOGY REPORTS

ENVIRONMENTAL MINERALOGY OF SAMPLES FROM THE EAGLE DEPOSIT, MICHIGAN – PART 1

Prepared for: **Geochimica, Inc.**
Ojai, California

April, 2004

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EXECUTIVE SUMMARY

Five samples from the Eagle Ni-Cu deposit in Michigan, which are the first-received of 15 to be examined, were investigated by optical microscopy and other methods to determine the environmentally relevant mineralogy. The examined samples consist of footwall and hanging-wall siltstones, massive and semi-massive sulfides, and unmineralized peridotite. Except for the peridotite, all of the samples were indicated in previous acid–base accounting to be potentially acid-producing, and the principal acid-generating source in the two sulfide-rich samples would be the oxidation of their abundant pyrrhotite. The sample of peridotite, which is the rock type that hosts the potential ore, is low in sulfides and contains a small amount of calcite; however, the rock contains a major amount of olivine + serpentine, and these two minerals would account for the bulk of the high neutralization potential indicated by the acid–base tests. The hanging-wall and footwall siltstones contain an appreciable amount of sulfides (~1%), almost all of which occurs as disseminated pyrrhotite. The siltstones consist mainly of quartz, muscovite, albite, and chlorite, an assemblage that inadequately explains the measured amounts of neutralization potential, which are 11–14 kg $CaCO_3$ equivalent per tonne of material. However, the hanging-wall siltstone contains dolomite within spotted alteration that is probably a thermal metamorphic effect related to peridotite intrusion, and the additional presence of liberated dolomite grains suggests that fracture-controlled dolomite was likely incorporated within the core interval that was utilized for the static-test bulk sample. Such fracture control is evident in the core of the footwall siltstone, whose mineralogical reference sample contains fracture-fill calcite, but both dolomite and calcite were observed in the microscopy section. The presence of carbonates provides an explanation for the higher-than-expected values of neutralization potential for both siltstones. Energy-dispersion analyses indicate that the Fe contents of the calcite, and of the dolomite from both siltstones, are low, and both minerals are near their end-members in composition.

INTRODUCTION

Five samples from the Eagle Ni–Cu project in Michigan were received by LRC on February 18, 2004. The Eagle deposit is a potential orebody whose resource has been reported to be five million tonnes grading 3.6% Ni and 3% Cu, with accompanying credits in Pt and Au (*The Northern Miner*, April 2–8, 2004). The deposit is currently under examination by Kennecott Canada Exploration, and the work undertaken for this report is part of broader studies being conducted by Geochimica Inc., with the latter the reporting authority for the work performed by LRC. The five samples are the initial batch of a group of 15 that is to be examined mineralogically, with the focus on the potential waste rocks and on environmental aspects rather than petrography. Nonetheless, the textures and textural relationships are readily evident in the various photomicrographs embodied in this report; moreover, an extensive petrographic description by B. Jago of Lakefield Research (2002) is available for 16 drill-core samples from the deposit.

The five samples received by LRC, each about 150 g, had been crushed, and the material consisted both of fragments (chips) and fines. The largest chips were up to 2 × 2 cm wide and about 2 mm thick. As well, for each sample a corresponding piece of core, typically about 6 cm long, was provided. The core had been sawn along its length in two cuts at right angles to one another, but with both parallel to the elongation. Each of the resulting two flat faces was therefore about 6 cm long and 3 to 3½ cm wide, and the sample represented a quarter section of the original core. Viewed on end, therefore, the two right-angle cut faces and the arcuate exterior of the core have the geometry of the surface of a quarter of a pie. The sample numbers and lithology are summarized in Table 1.

Table 1. Sample numbers and related data*

Number	Lithology	S, wt%	NP
VR71100A	siltstone, hanging wall	1.06	14
VR71120A	massive sulfide	36.1	–4
VR71213A	peridotite	0.2	42
VR71325A	net-texture sulfides in peridotite	12.85	41
VR71499A	siltstone, footwall	1.23	11

*Data provided by Kennecott Canada Exploration; NP = neutralization potential

METHODS

The cores were retained intact for reference purposes; the crushed samples are portions of the material used in the static and kinetic tests, and these portions were therefore deemed to be the more appropriate for the mineralogical study. To obtain samples for the X-ray diffraction and optical studies, the complete contents of each of the submitted crushed samples were individually emptied onto a clean sheet of paper, and the resulting cone was vertically quartered. Minor modifications of this procedure for specific samples are given in the descriptions in the next section.

To obtain good representation in the sections for optical microscopy, the selected split was further crushed with a hammer to reduce the size of the largest chips, thereby minimizing the risk of have a few large chips dominating the representation in a section. This crushed material was then split, with the two halves bagged separately, one for X-ray diffractometry and the other for the optical section. After completion of this 'coarse crush', one of the bags of each sample was randomly chosen to be the X-ray material. That material was further crushed with a hammer, and the pulp was immersed in acetone and ground by hand using a mortar and pestle. Although such a grind yields a fineness suitable for standard X-ray diffractometry, for Rietveld refinements a final mechanical grind is used to reduce the particle size to <10 μm. Details of the procedures related to the Rietveld refinements, which were done by M. Raudsepp and E. Pani of the University of British Columbia, are given in Appendix 1.

The polished thin sections were prepared by Vancouver Petrographics Ltd as standard 26 × 46 mm glass slides. Water was used as the lubricant in the preparation procedure. The sections were received by LRC on March 4, 2004.

Although the Sampling and Analysis Plan for the Eagle project indicates that all 15 of the mineralogy samples are to be examined by X-ray diffractometry (XRD) and Rietveld refinements, some flexibility is also indicated in the plan. Thus, for the initial five samples it was decided, following the preliminary optical examination, that X-ray data would not be obtained for the massive sulfide sample and that, in its place, reconnaissance scanning electron microscopy (SEM) and qualitative energy-dispersion analyses (EDS) would be used to identify some of the carbonate-mineral grains that had been observed by optical microscopy. The SEM–EDS examinations were done with a Philips XL-30 instrument housed in the Department of

Earth and Ocean Sciences at the University of British Columbia.

SAMPLE DESCRIPTIONS AND RESULTS

In standard petrographic descriptions, the alteration products of the initially crystallized minerals are commonly referred to as 'secondary' minerals. A typical example is the serpentinization of olivine, wherein olivine is the primary magmatic mineral and is subsequently altered to (replaced by) 'secondary' serpentine during a more hydrous event that may be part of the crystallization continuum or related to a later episode. Confusion may arise because it is also common to refer to minerals formed by weathering, including supergene products, as 'secondary' minerals even though the alteration conditions and processes may be quite different from those of the first example, serpentinization. In the present study, no minerals attributable to weathering processes have been observed; all of the minerals, including serpentine, are therefore regarded as being part of the primary assemblage. In environmental mineralogy, 'secondary' minerals are those that form by weathering, most commonly oxidation, after the rock has been anthropogenically exposed or displaced from its geological setting.

Sample VR71100A

The sample is of hangingwall siltstone. The core shows that good bedding is present, with the downside half of the core dark, slightly greenish gray and massive and in sharp but undisturbed contact with the black upper half. Sub-millimetric sulfides are disseminated throughout the core but are much more abundant in the greenish gray lower half. Megascopic aggregation of the sulfides is absent; only two loosely clustered concentrations, each <2 mm across, are present, and no fracture-controlled sulfides are evident.

The as-received sample for the mineralogical studies is coarsely crushed, with some chips up to the aforementioned maximum size. The material is dark gray, fine-grained, and many of the chips have a conchoidal fracture. In addition to barely visible disseminated sulfides, a minute amount of sulfides was visible along 'fractures', up to ~1 mm in width and 15 mm in length; however, bedding is not clearly evident in the chips, and it was not certain whether the sulfides were fracture-controlled or were concentrations along sedimentary planes whose exposure merely simulated the appearance of fracture fill. The assumption was that a good indication of

overall sulfide content would be obtainable from the bulk-sample chemical analysis of wt% S, coupled with the sulfide mineralogy; therefore, to decrease the risk that the sulfide 'veinlets' might not be included in the polished thin section, 12 of the relevant chips were hand-picked and added to the otherwise random split that was subsequently gently, coarsely crushed to provide material for the optical and XRD studies.

The polished thin section contains about 25 chips, with the largest ones ranging from 5 × 7 mm to 1 × 2 mm. The megascopic color of the chips varies from brownish gray to black, and in many of them disseminated 'pin-point' sulfides are visible. One of the intermediate-size chips consists largely of sulfides.

Optical microscopy with reflected light showed that some chips, including the largest one in the section, are devoid of sulfide minerals even though at least a few disseminated grains are present in most chips. The megascopic sulfide-rich chip is shown in Figure 1, and a smaller but equally sulfide-rich chip is shown in Figure 2. These, which are the only two of their type in the section, consist of extremely fine-grained pyrite, locally accompanied by minute amounts of intimately associated marcasite. Otherwise, however, the remainder of the sulfides, i.e., the disseminated grains in all other chips, consist largely of pyrrhotite; chalcopyrite is erratically distributed and sparse, and in one chip the principal sulfide is sphalerite (Fig. 2). Relative to the microscopy observations, the chemical value of 1.06 wt% S (Table 1) seems to be high but of an appropriate order of magnitude. Much of the pyrrhotite occurs as extremely fine-grained blebs that are not readily observable at the optical magnifications typically used to estimate sulfide abundances. Even taking into account the erratic presence of the pyritiferous chips, however, the quantity of pyrite determined by the Rietveld analysis is too high (Table 2).

The fine-grained character of the siltstone is apparent in transmitted light, but quartz, muscovite, and chlorite are identifiable, and the Rietveld analysis indicates that plagioclase (albite) is abundant and that a small amount of kaolinite is present (Table 2). The siltstone could be characterized as texturally uniform except that "spotted alteration" is abundant in some chips and absent in others (Fig. 3). The spotted alteration is interpreted to be a thermal metamorphic effect and is of interest because the spots have been the loci of deposition of some of the sparse carbonates that were observed in the siltstone. The spots consist predominantly of concentrations of chlorite, but some spots consist largely of quartz (Fig. 1) and others largely of K-feldspar. A

Table 2. Quantitative mineralogy of siltstone VR71100A*

wt. %				
	quartz	28.0	kaolinite	2.2
	plagioclase	12.6	pyrite	3.9
	muscovite	37.8	pyrrhotite	3.0
	chlorite	12.5		

*Quantitative values for all samples are values normalized to 100 wt%

peculiarity of the chloritic spots is that they are not apparent in plain transmitted light but are observable with the polarizers crossed because of their low birefringence, and are most evident in reflected light (Fig. 3). A feature that attracts the eye to the spots in reflected light is that many are surrounded by a narrow rim of rutile, which has a high reflectance and a pronounced internal reflection (Fig. 4).

The NP of the siltstone sample was determined to be 14 (all NP values referred to herein are in kg $CaCO_3$ equivalent per tonne of material), which is too high for the mineral assemblage reported in Table 2. However, the presence of a small amount of dolomite in the siltstone accounts for the higher-than-expected NP value. One chip in the section contains an elongate particle of dolomite, about 150 × 500 μm, that may be fracture-controlled but whose irregular margins suggest otherwise (Fig. 5). Several much small liberated grains were also observed, and several minute grains of dolomite are associated with the spotted alteration, particularly but not exclusively those in which the chief mineral within the spots is K-feldspar or quartz (Figs. l, 4, 5). EDS spectra of the dolomite, including the elongate particle in Figure 5 and the porphyroblast-type particles in Figure 6, are consistent in their similarity; Fe and Mn are barely detectable and vary only slightly from grain to grain. A representative spectrum is shown in Figure 7. No calcite was detected, and neither the core nor a sample of pulverized material was observed to effervesce upon the addition of a calcite-reactive weak HCl solution.

Following the completion of the preceding study, the as-received sample was searched specifically for fracture-controlled carbonates. The seven selected chips were treated with alizarin solution and then with 15% HNO_3. No calcite was detected, but all reacted appropriately for the presence of dolomite. A sulfide mineral, thought to be pyrite, also occurs sparingly in fractures.

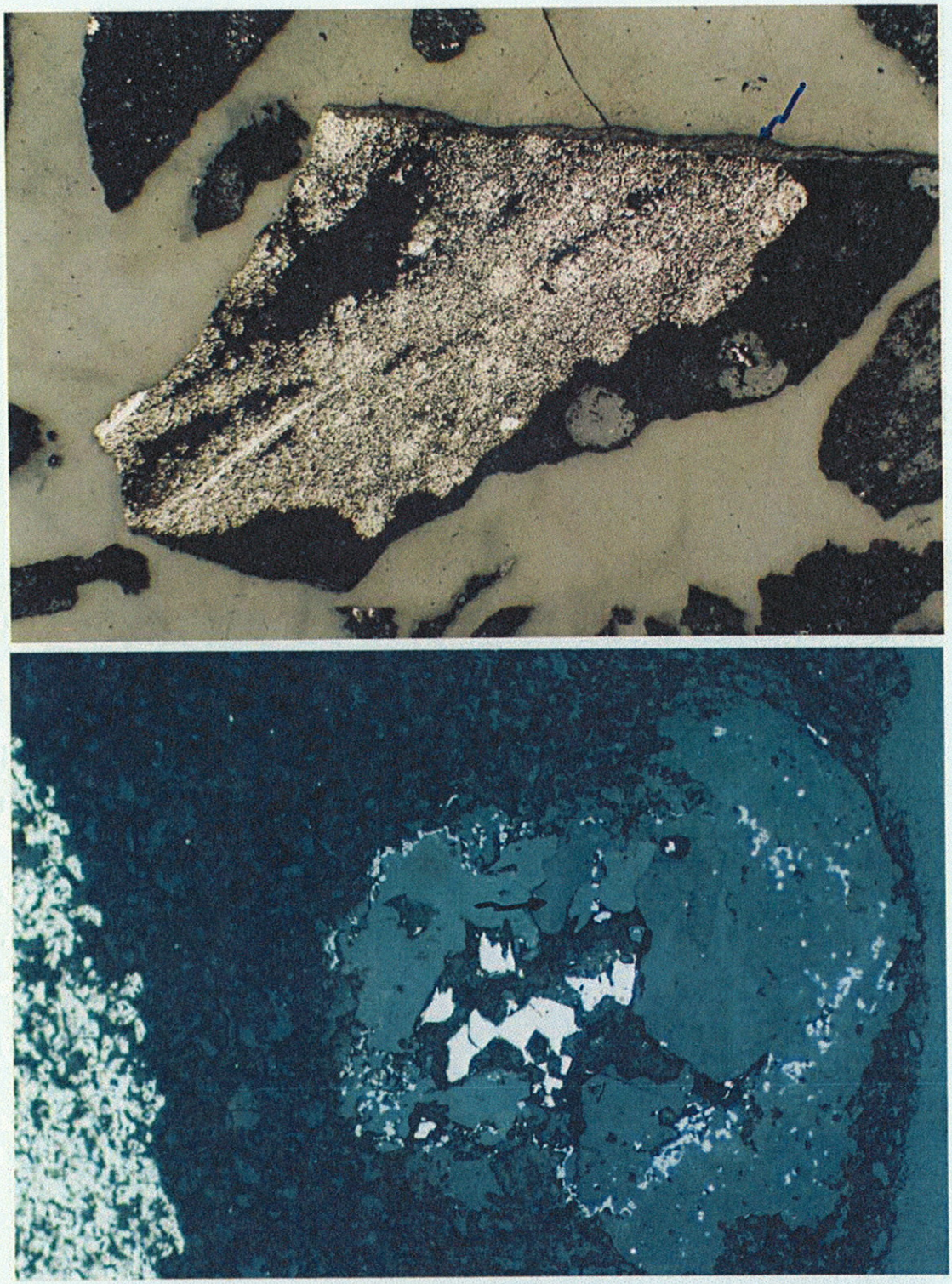


Figure 1. Siltstone VR71100A in plain reflected light. The upper photo (width of field 5.6 mm) shows the most sulfide-rich chip in the polished thin section. The sulfide is fine-grained pyrite (as is evident along the left margin of the lower photo). Below and right of center are two circular bodies ('spots') consisting mainly of quartz, and along the top of the chip is an almost horizontal, crosscutting veinlet of chlorite (arrow). The lower photo, width of field 0.625 mm, is of the 'spot' on the right in the upper photo. The slightly pinkish white mineral at the core is pyrrhotite; most of the outer mass consists of quartz with blebs of rutile, but a few grains of dolomite are present (e.g., at arrow).

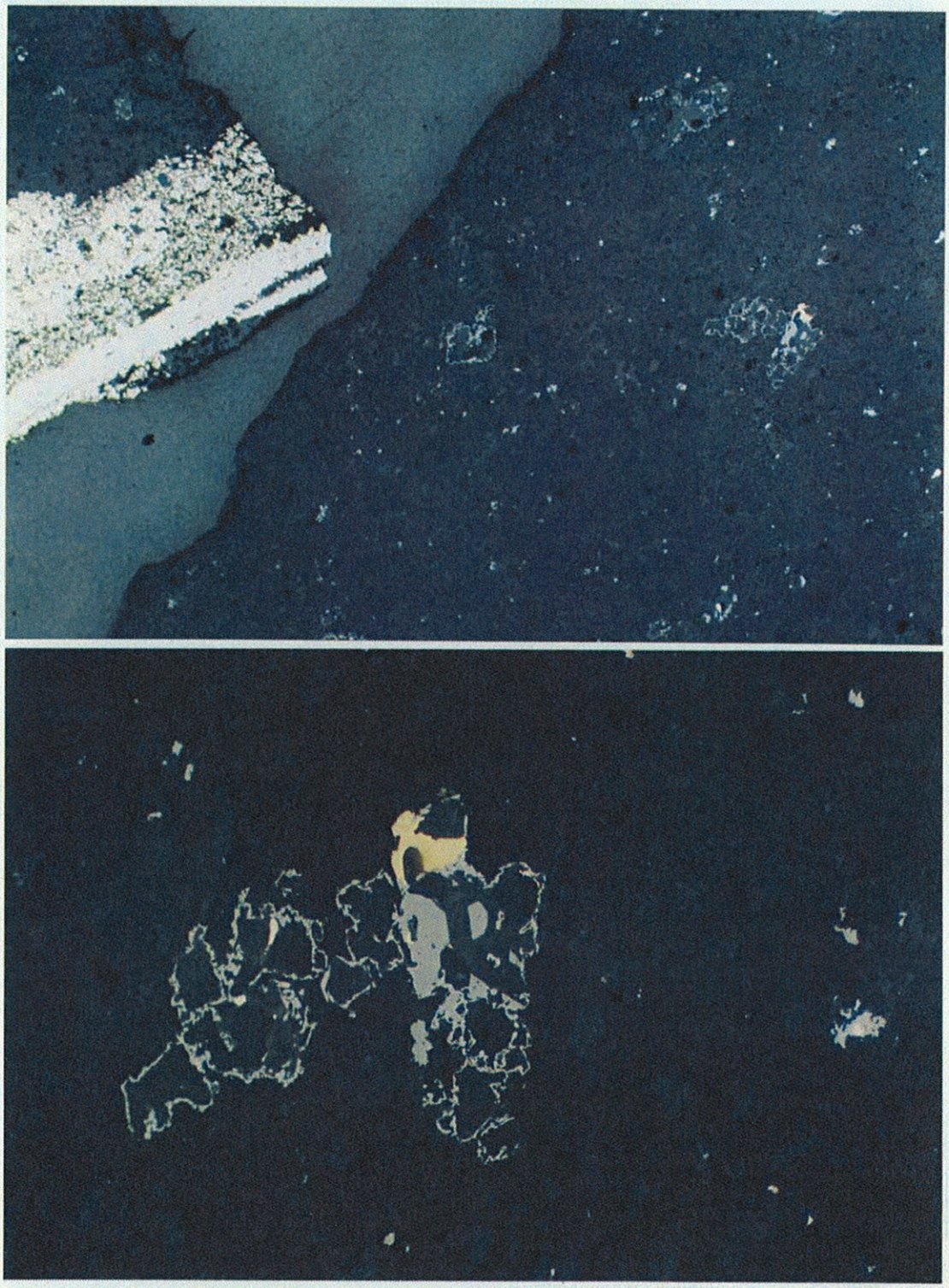


Figure 2. Siltstone VR71100A in plain reflected light, width of field 2.6 mm, showing on the left the only other pyritiferous chip in the section. In the much larger chip to the right of the pyrite, chloritic spots are outlined by a gray mineral, which typically is rutile but in this chip is sphalerite. The lower photo is an enlargement (width of field 0.625 mm) of the area at mid-height on the far right of the upper photo, showing yellow chalcopyrite and grayish rims of sphalerite. EDS spectra indicate that the sphalerite contains a minor amount of Fe.

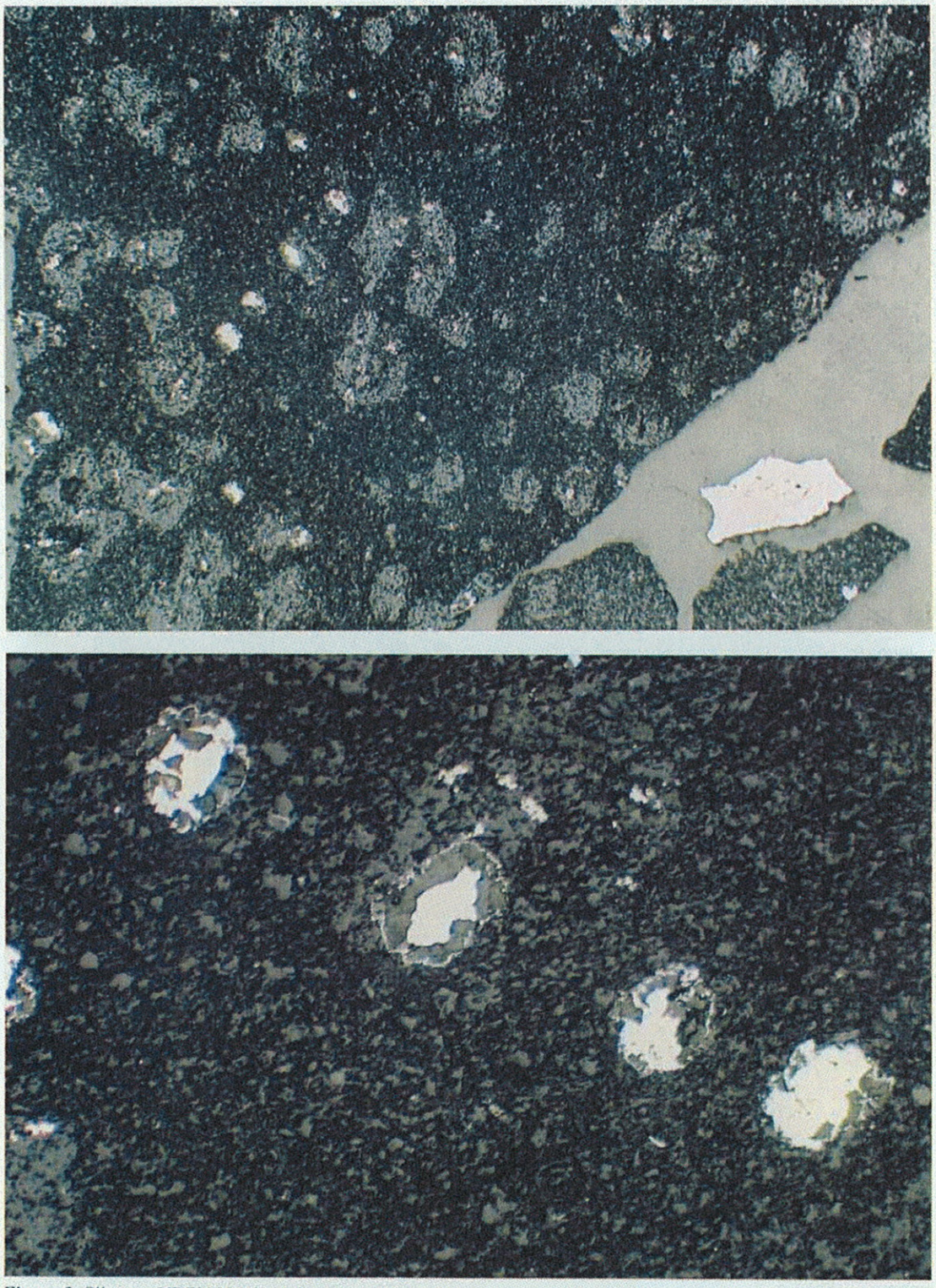


Figure 3. Siltstone VR71100A in plain reflected light. Upper photo, width of field 2.6 mm, shows the extensive spotted alteration, here mainly chloritic, that is present in some chips. The whitish grain at the bottom right is pyrrhotite whose large size is not in conformity with the siltstone assemblage. The lower photo is an enlargement (width of field 0.625 mm) of the train of pyrrhotite grains to the left of center and trending northeasterly in the upper photo. Pyrrhotite (white) at the cores of spots is surrounded by chlorite (dark) which in turn has a narrow rim of rutile (grayish white).

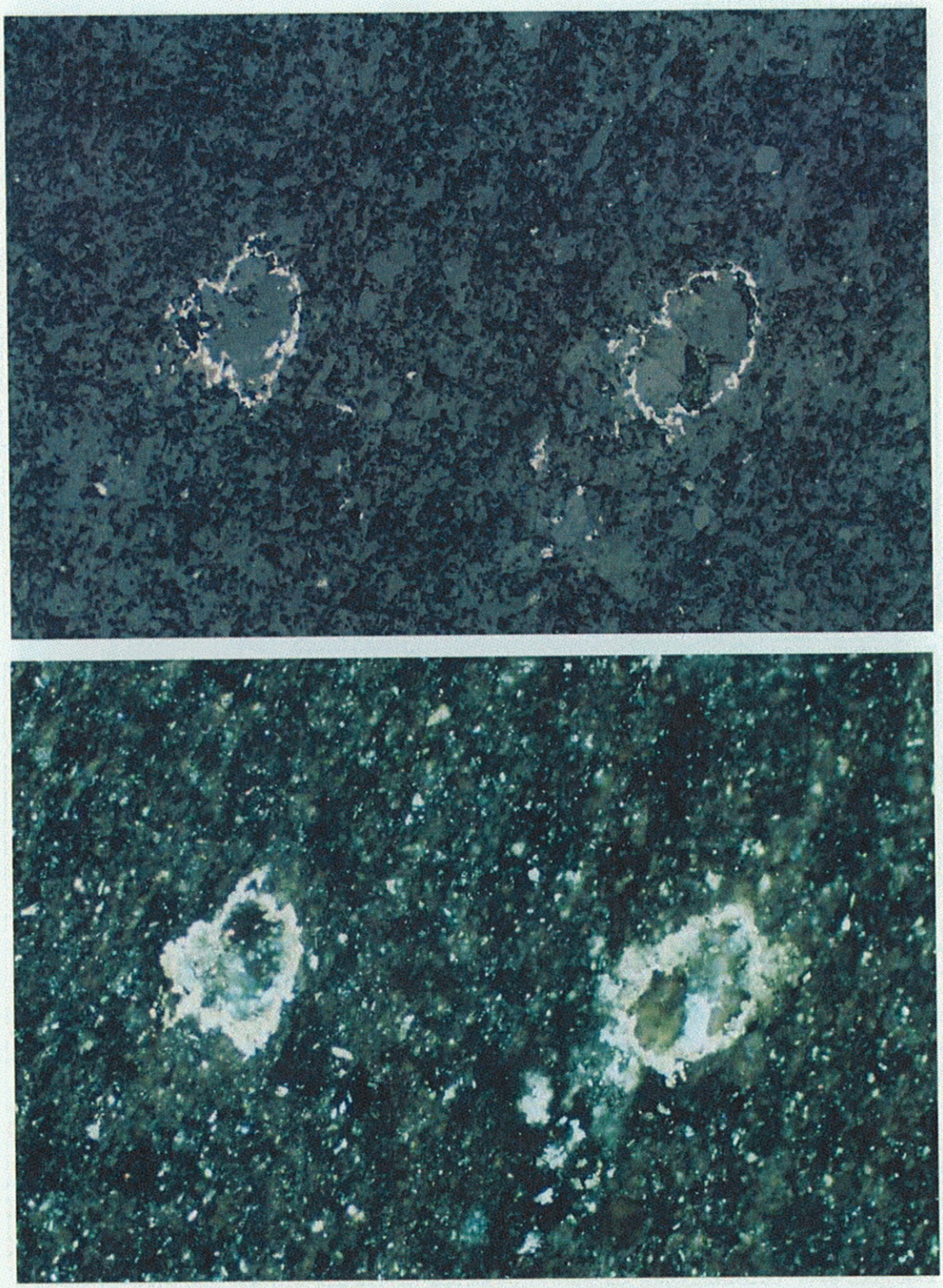


Figure 4. Siltstone VR71100A in plain reflected light (top) and the same field with polarizers almost crossed and internal reflection (width of field 0.625 mm). The core mineral in this case is K-feldspar, accompanied by minor chlorite, and the bright outer rim of rutile has distinct internal reflection.

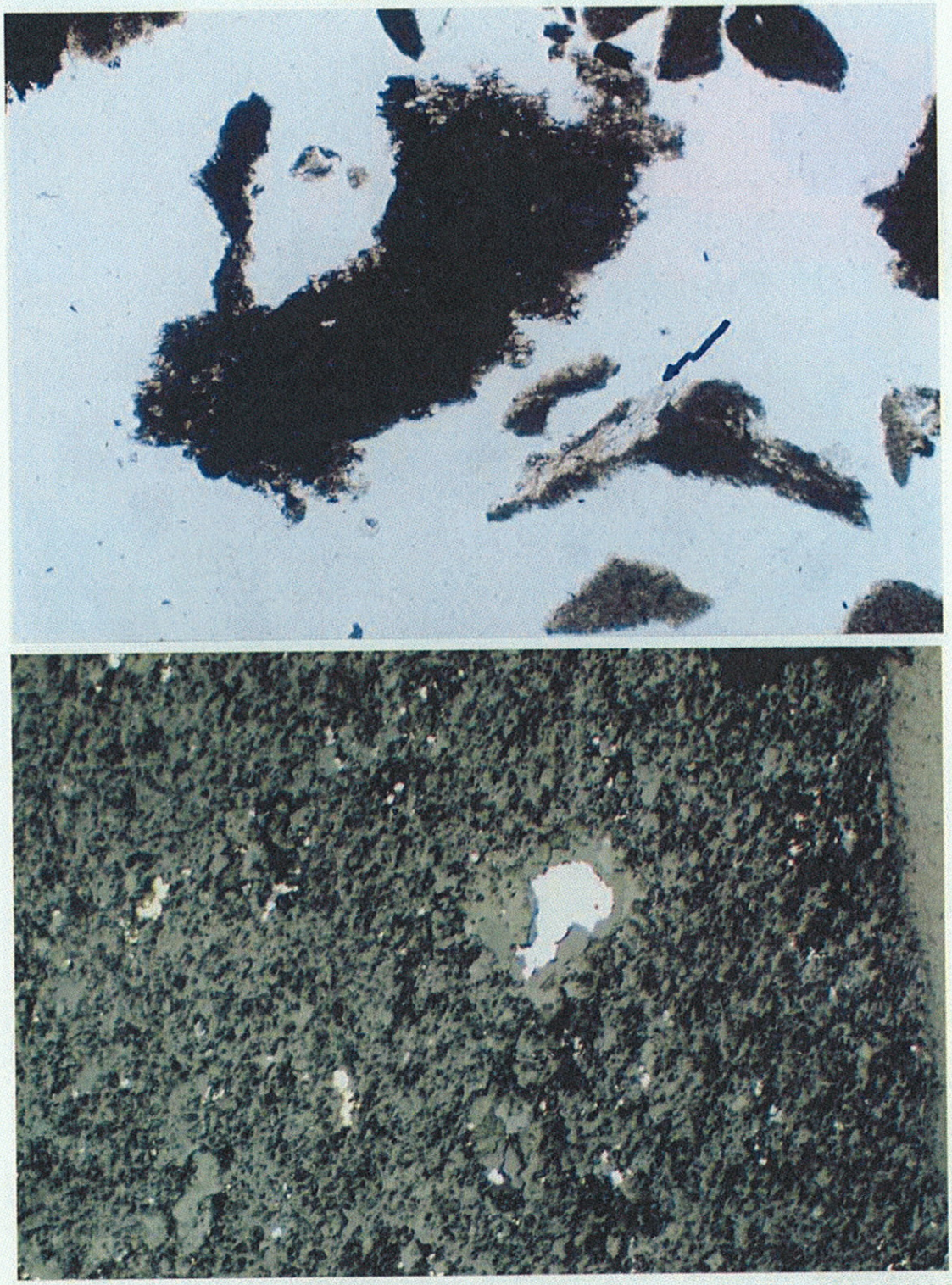


Figure 5. Dolomite occurrences in siltstone VR71100A. The upper photo in plain transmitted light, width of field 2.6 mm, shows an elongate clot or possible veinlet of dolomite (colorless feature at arrow). The lower photo, in plain reflected light, width of field 1.3 mm, shows a 'spot' in which the pyrrhotite core (white) is in direct contact with a dolomite rim, which in turn is partly surrounded by chlorite.

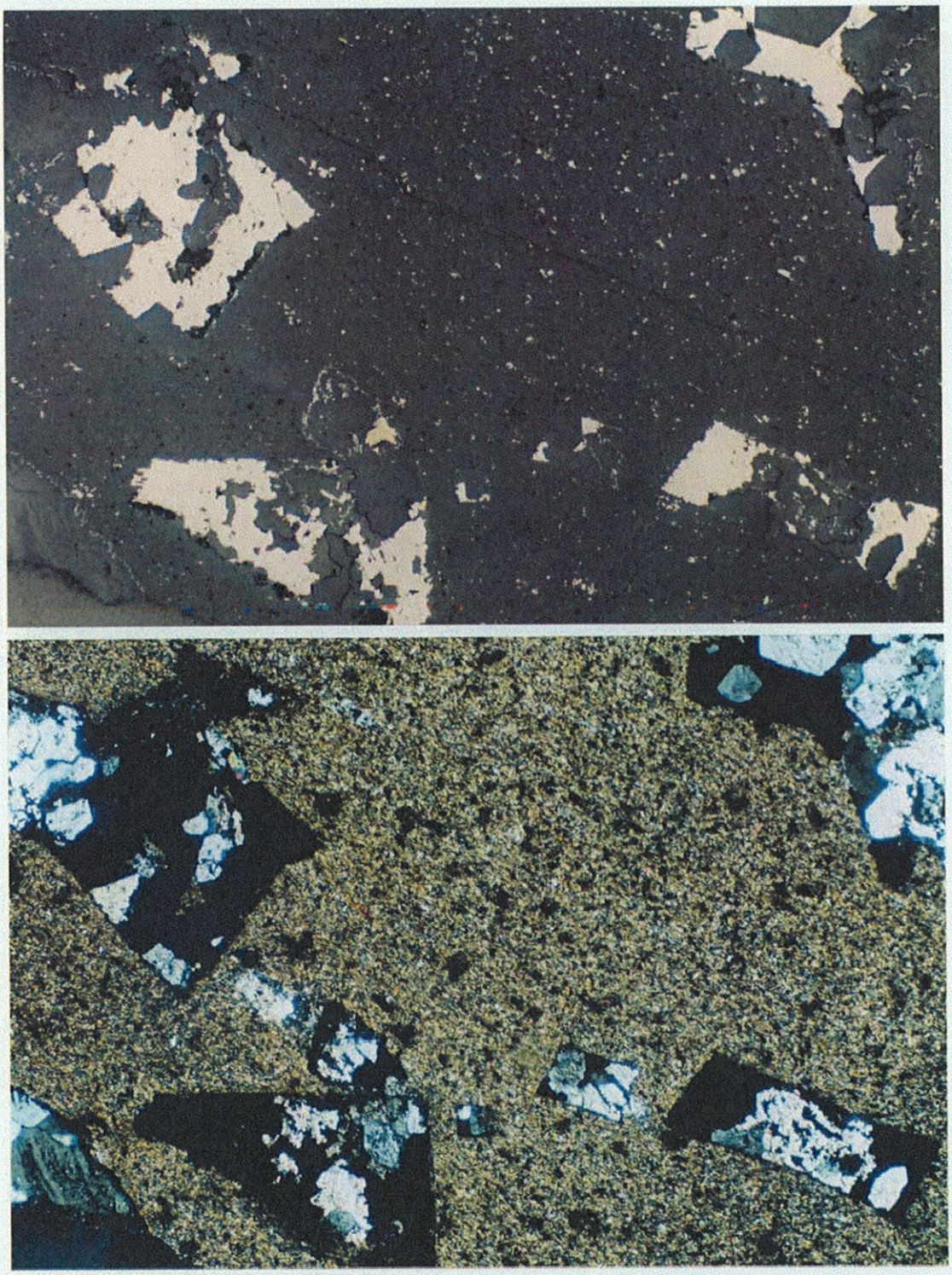


Figure 6. Porphyroblast-type development in siltstone VR71100A, width of field 2.6 mm. The upper photo in plain reflected light shows abundant pinkish white pyrrhotite accompanied by smaller, yellow grains of chalcopyrite. The lower photo is of the same field in transmitted light with crossed polarizers. The well-formed, coarse-grained, pseudomorphs of porphyroblasts consist of pyrrhotite (opaque), quartz, K-feldspar, and dolomite. The irregular, whitish mineral making up the bulk of the non-opaque portion of the rectangular porphyroblast pseudomorph at the bottom right corner is dolomite.

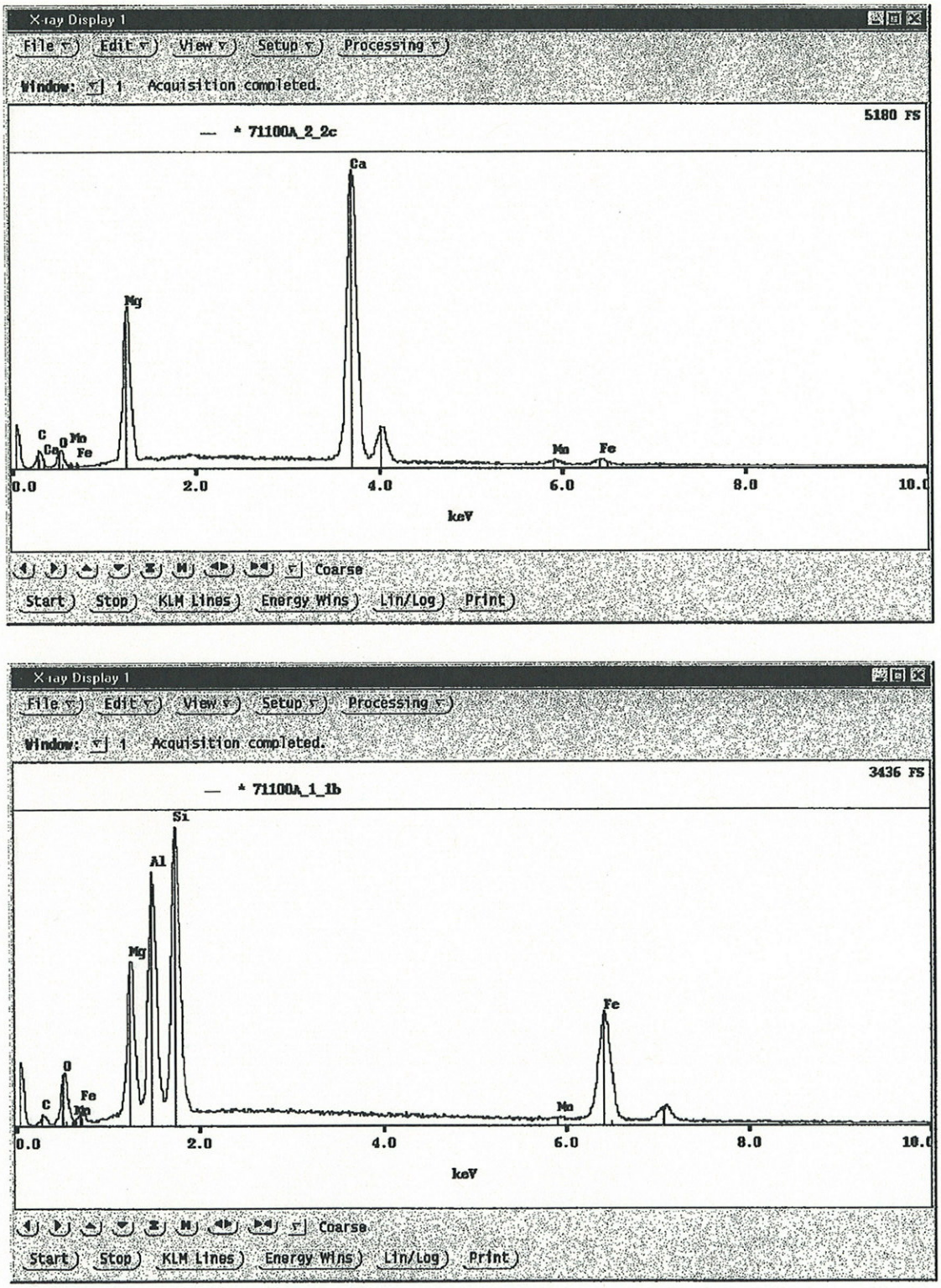


Figure 7. EDS spectra, siltstone VR71100A. The upper spectrum is typical for dolomite in the sample. The lower spectrum shows the typically Fe-rich character of the chlorite.

Sample VR71120A

Sample VR71120 consists of massive sulfides. The core is pyrrhotite-rich, strongly magnetic, and the exterior shows abundant chalcopyrite, including a largely monomineralic patch about 2 cm across. The cut faces also show abundant, large irregular concentrations of chalcopyrite, and on the cut faces the chalcopyrite is elongate to sinuous, with a poorly developed elongation along the core length. The segregation of the chalcopyrite into relatively large patches, in contrast to dissemination, seems to be a characteristic feature.

A random split of the crushed sample, including the fines, was taken for the mineralogical study. The largest chip in the polished thin section is about 20 × 5 × 5 mm, but most of the larger ones are approximately 4 to 5 mm in diameter. Microscopic examination revealed the assemblage to consist of massive sulfides wherein pyrrhotite, pentlandite, and chalcopyrite are accompanied by a much smaller amount (~5%) of magnetite, and the four minerals make up at least 99% of the mineral assemblage. The striking feature is the high sulfide-mineral content, which is at least as great as that of some sulfide concentrates. The bulk of the sulfides occurs as large anhedral grains with uncomplicated contacts (Fig. 8). A volumetrically minute proportion of the pentlandite is present as flame-like intergrowths in pyrrhotite, but not in chalcopyrite, and a small amount of chalcopyrite is present as oriented, rod or lath-like intergrowths with pyrrhotite (Fig. 8). Most of the magnetite is present as anhedral, rarely subhedral, grains that are included within chalcopyrite or at its grain boundaries, but the association is not exclusive and is only less common in pentlandite and pyrrhotite. Magnetite also occurs as narrow veinlets that cut all three sulfides.

The relative abundances in the section are pyrrhotite > chalcopyrite > pentlandite > magnetite, with pyrrhotite making up about half the total sulfide content. Minute amounts of cubanite and violarite were detected by Jago (2002) in some of the Eagle sulfide-rich samples, but the minerals were not observed in the VR71120A section. Extensive microprobe analyses of pyrrhotite in three head samples (Lane 2002) gave means of (wt%) 0.66 Ni and 0.01 Co (n = 100), 0.36 Ni and 0.00 Co (n = 100), and 0.58 Ni and 0.01 Co (n = 99).

From the perspective of reconnaissance environmental mineralogy, little can be added to the brief description given above. The content of potential NP contributors is negligible, and the application of HCl to a portion of the powdered sample did not yield any effervescence.

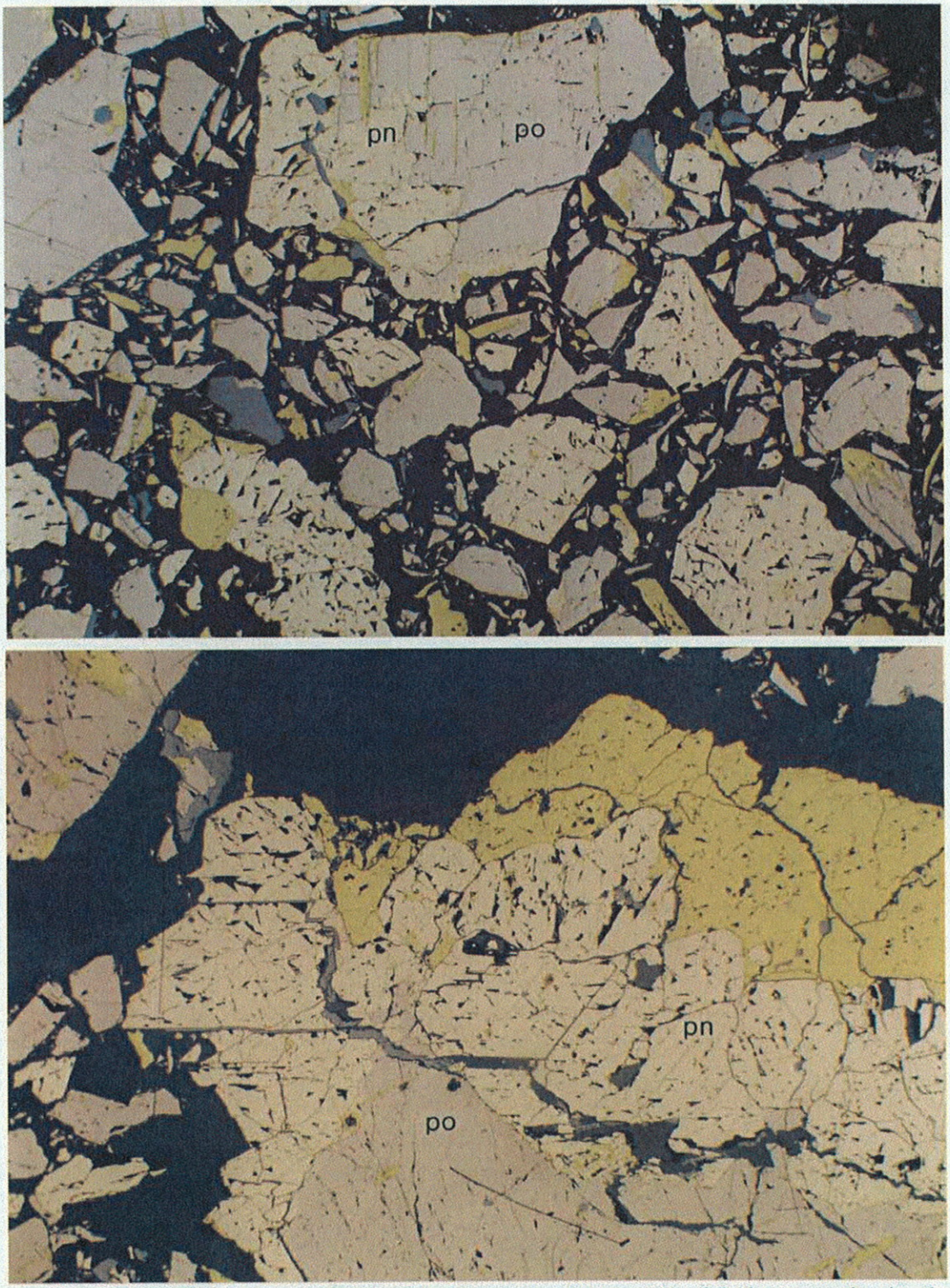


Figure 8. Massive sulfide sample VR71120A in plain reflected light, width of field 5.1 mm, showing the sulfide-rich character of the sample. The yellow mineral is chalcopyrite, the smooth, slightly pinkish mineral is pyrrhotite (**po**), which in the largest particle in the upper photo contains vertically aligned laths of chalcopyrite, and the whitest, characteristically pitted mineral is pentlandite (**pn**). The gray mineral is magnetite, which occurs as anhedral grains and veinlets.

Sample VR71213A

The sample is of peridotite, which in the core is massive and uniformly coarse-grained. The as-received crushed sample contained only a small proportion, estimated to be <10%, of fines. The sample was split in half, and because the size of the larger chips was such that only two or three could be accommodated in a polished thin section, one of the halves was further crushed and the resulting minus 5 mm fraction was used for the mineralogy study.

Megascopic examination of the polished thin section did not indicate the presence of sulfides; although numerous high-reflectance disseminated opaque grains of up to half a millimeter across were observed, these were of a steel-grey color and subsequently were determined to be magnetite and ilmenite. Sulfide grains observed microscopically proved to be mainly of pyrrhotite, the largest about 100 μm across. Pentlandite occurs as isolated anhedral grains, but most are attached to pyrrhotite or intergrown with it; flames of pentlandite within pyrrhotite were observed but are rare. Chalcopyrite is present in only trace amounts, hence pyrrhotite >> pentlandite >> chalcopyrite. The sulfide content was estimated to be ~0.1%, with pyrrhotite accounting for >90% of the total.

Transmitted-light microscopy revealed that olivine and clinopyroxene are the principal silicate minerals. Even though much of the olivine has been altered to serpentine, the residual olivine still optically exceeds the abundance of clinopyroxene. Accessory orthopyroxene is present, but the amount is insufficient to be quantified in the Rietveld mineralogy (Table 3). Comparison of the qualitative optical impressions and the quantitative Rietveld data gave some unexpected differences, most notably in the high proportion of magnetite and chlorite detected by the X-ray data. Almost all, if not all, of the large opaque grains in the section are ilmenite rather than magnetite; much smaller grains of primary magnetite are common but would account for no more than about 2% magnetite. However, alteration of olivine has released solid-solution Fe that formed abundant blebs and veinlet-like trains of magnetite in serpentine (Figs. 9, 10), which is the predominant form of magnetite in the section.

Table 3. Quantitative mineralogy of peridotite VR7123A

wt%				
	olivine	18.4	amphibole	4.0
	clinopyroxene	13.9	talc	10.8
	magnetite	8.4	lizardite	9.2
	plagioclase	10.6	chlorite	20.6
	biotite	4.0		

Chlorite occurs abundantly as an alteration of biotite, but also replaced olivine and, to a much lesser extent, pyroxene (Figs. 10, 11). Talc occurs typically at the periphery of mesh-texture, serpentinized olivine. The serpentine was identified by XRD as lizardite, all of which is extremely fine-grained, polycrystalline, and non-fibrous. The serpentine species that has the well-known commercially utilized fibrous habit is clinochrysotile rather than lizardite, but no fibrous veinlets, even on a microscopic scale, were observed.

The measured NP of VR71213 is 42, which even in the presence of olivine and serpentine, is too high unless carbonates are present. In a HCl test of the powdered bulk sample, several pinpoint areas gave the strong and instantaneous effervescence characteristic of calcite. Several calcite-bearing areas were identified optically, the most notable a large homogeneous grain about 100 × 250 to 300 μm, which may have been even larger prior to crushing of the sample (Fig. 12). More typical, however, are minute, polycrystalline aggregates of the type shown in Figure 13. Tests with alizarin solution indicated that all of the carbonate occurrences are calcite, and EDS spectra indicate that the mineral is near the end-member in composition.

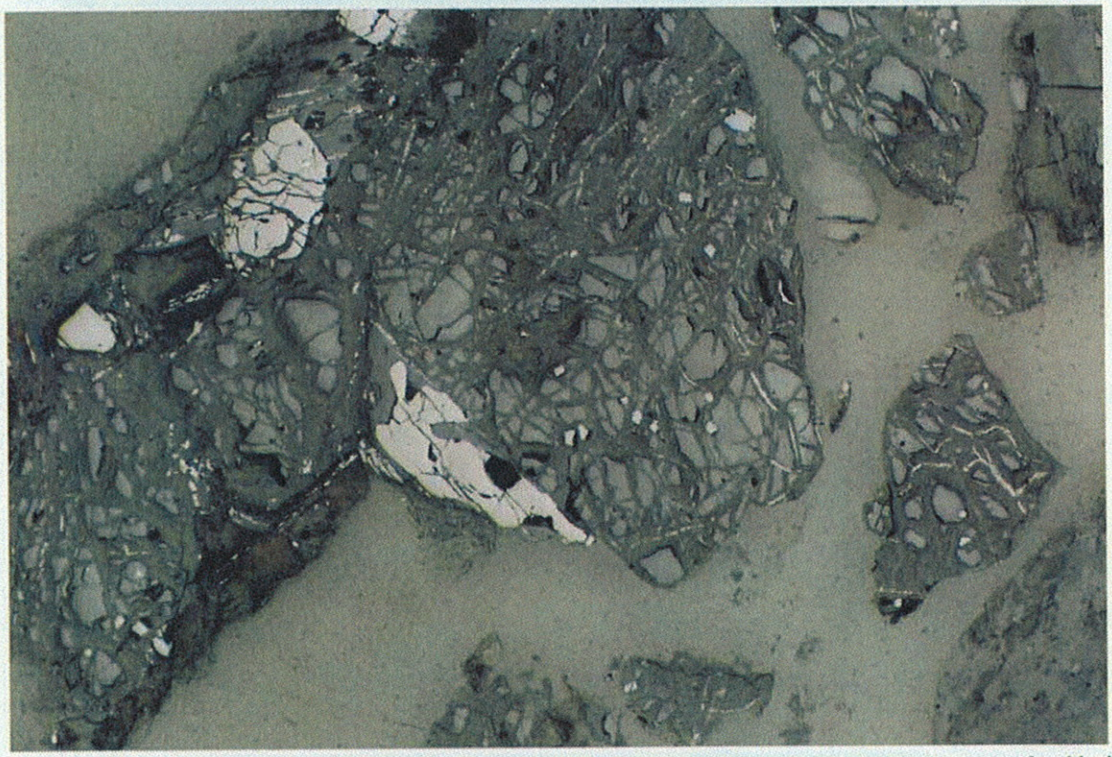


Figure 9. Peridotite VR71213A in plain reflected light, width of field 2.6 mm, showing the typical texture of residual 'islands' of largely replaced olivine. The large, pale gray, high-reflectance grains are ilmenite, and between the olivine islands are thread-like trains of magnetite that formed by alteration of the olivine. Immediately to the right of the large ilmenite grain below center is a group of similarly whitish, small anhedral grains of primary, non-alteration magnetite.

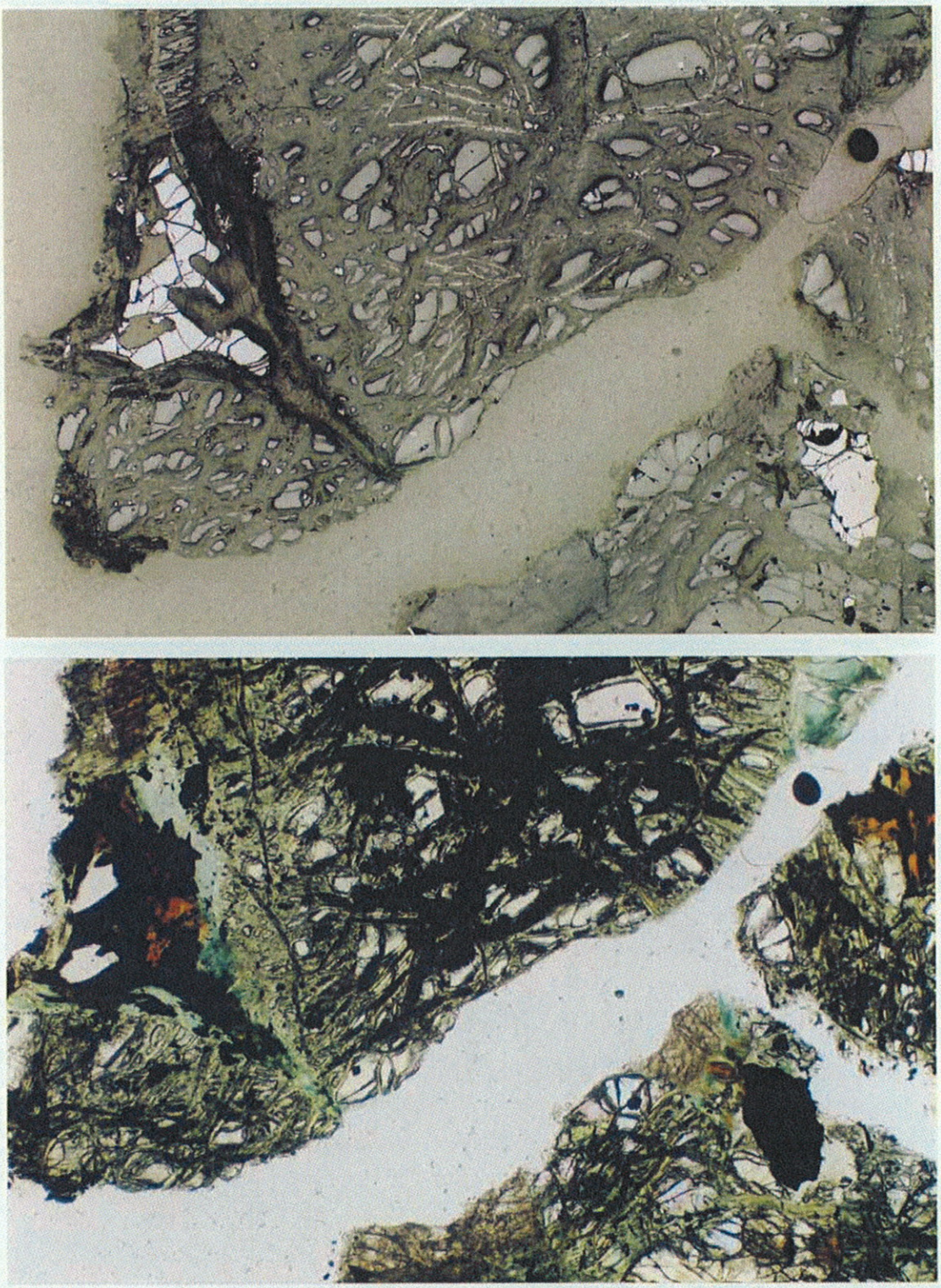


Figure 10. Peridotite VR71213A in plain reflected light (top) and the corresponding field in plain transmitted light (bottom), width of field 2.6 mm. The large, high-reflectance grains are ilmenite, and amidst the residual islands of olivine is thread-like magnetite. In the lower photo, the residual olivine is colorless, the brown mineral is biotite, and the green mineral is chlorite.

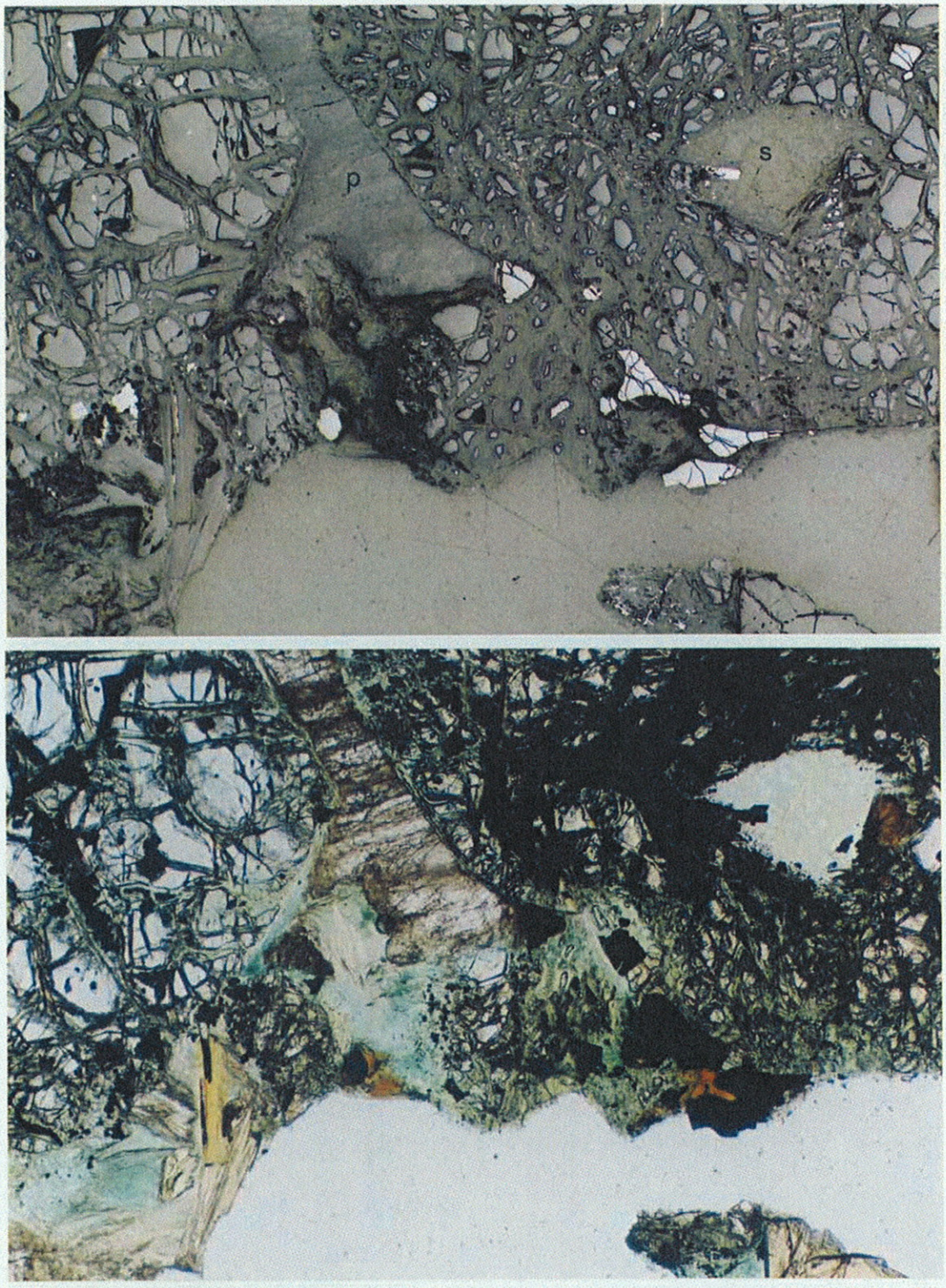


Figure 11. Peridotite VR71213A in plain reflected light (top) and the corresponding field in plain transmitted light (bottom) and with polarizers crossed (next page), width of field 2.6 mm. The high-reflectance grains are ilmenite, and between the residual islands of olivine is plagioclase (**p**). Within the pocket of serpentine (**s**) is a small, white, tabular grain that consists of pyrrhotite rimmed by pentlandite. In the lower photo, biotite is brown, chlorite is green, and the serpentine is colorless.

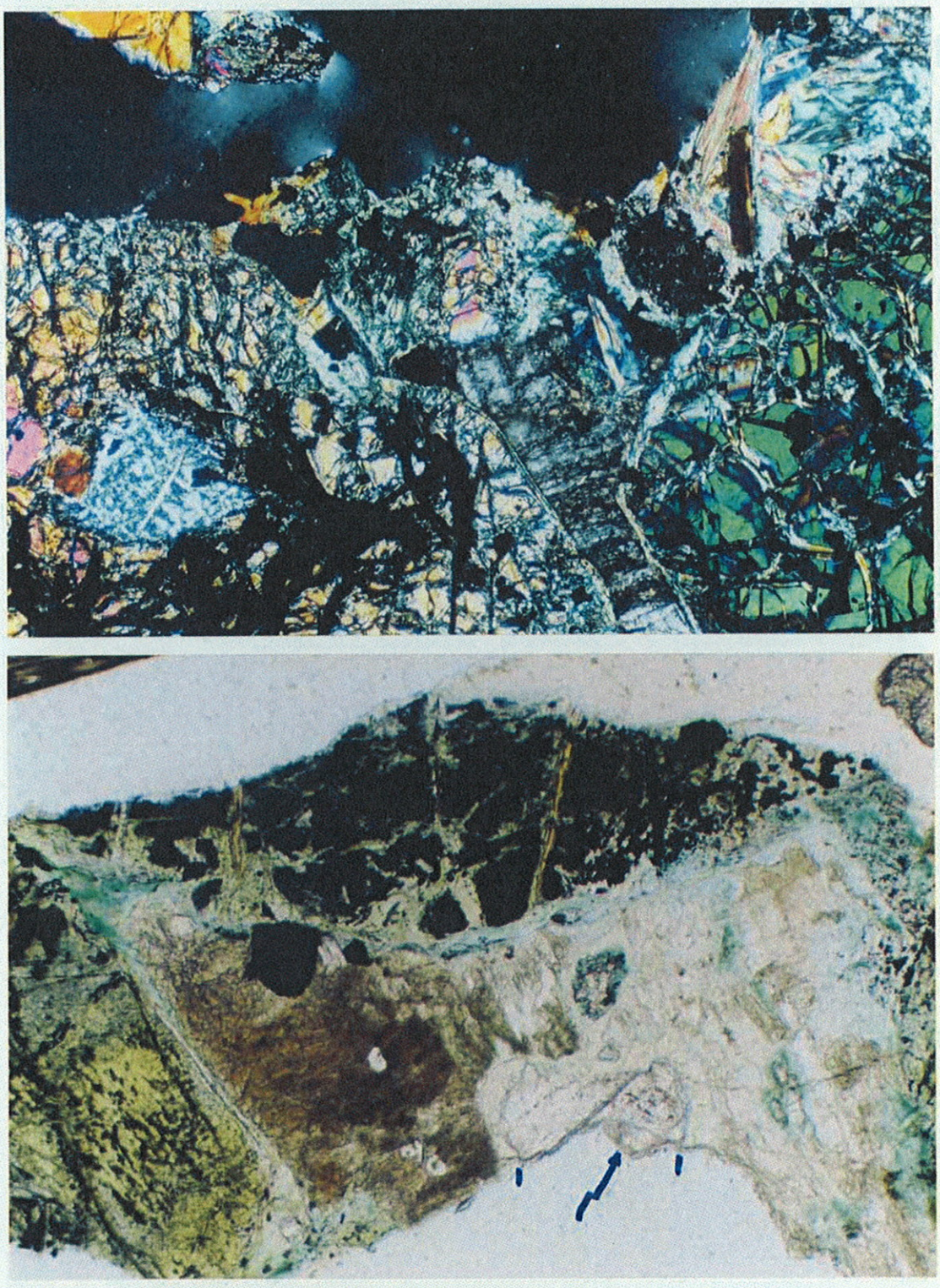


Figure 12. Peridotite VR71213A. Upper photo is the continuation of Figure 11, but with polarizers crossed. The lower photo, in plain transmitted light, width of field 1.25 mm, shows a large grain of calcite, 250 to 300 μm long (at arrow, with margins indicated), within chlorite and serpentine.

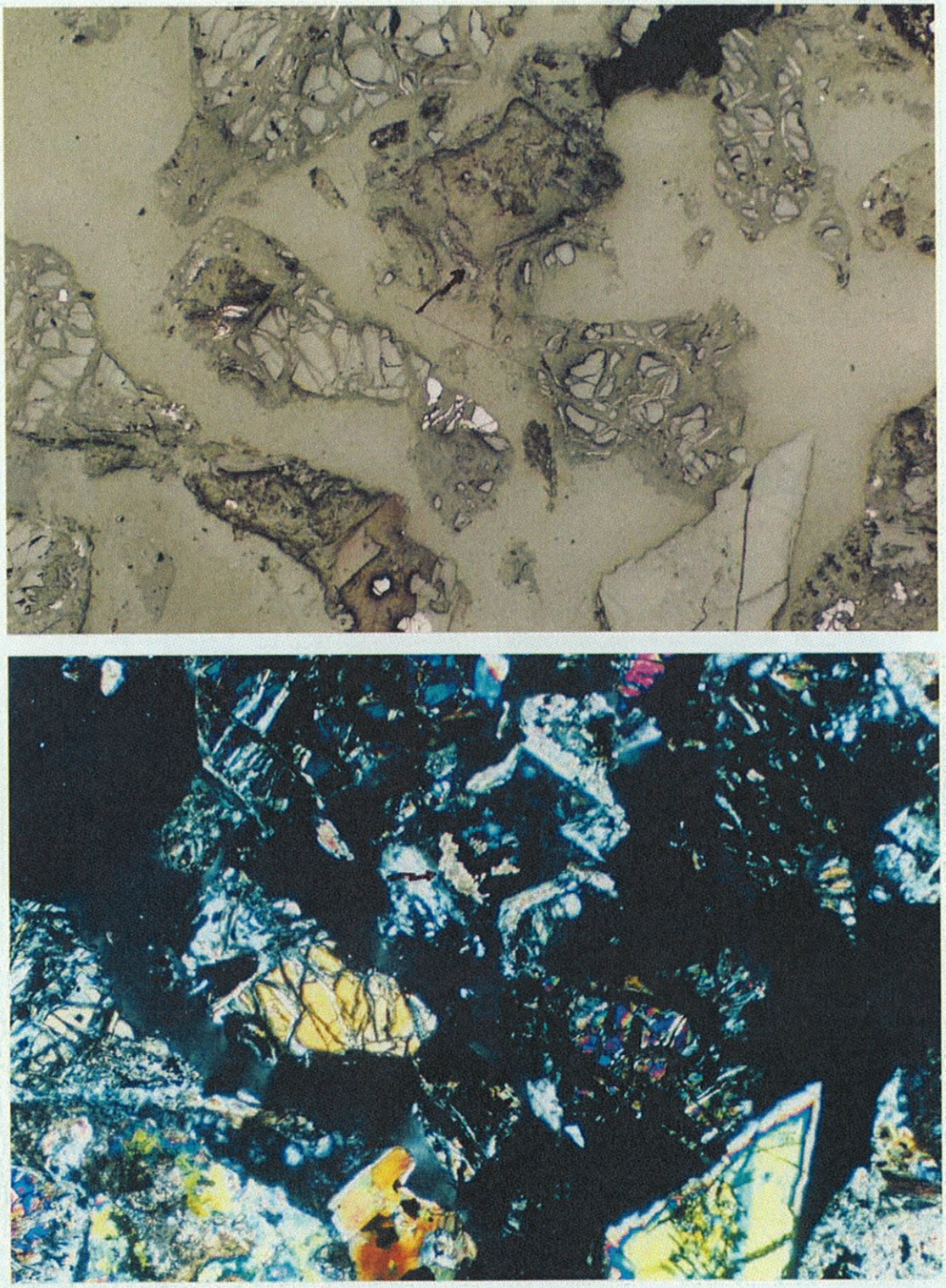


Figure 13. Peridotite VR71213A in plain reflected light (top), and the same area in transmitted light with polarizers crossed, width of field 2.6 mm. The arrow near the center in both photos points to the typical habit of occurrences of calcite, which is as fine-grained, irregular aggregates within serpentine (here, mainly black and enclosed within a narrow rim of talc).

Sample VR71325A

The sample is reported to be of net-texture sulfides in peridotite (Table 1). The core is similar in appearance to that of peridotite VR71213A except that a major amount of pyrrhotite-rich sulfides is evenly distributed throughout the network sample. The sulfides are of millimetric size, of irregular outline, and commonly form rims or partial rims on the original coarse-grained mafic minerals, thus resulting in the network arrangement. For the mineralogical study, the original crushed sample was split in half, and one of the halves was gently crushed only to reduce the size of the largest chips. This re-crushed fraction was then split, and one of the halves, including the fines, was used for the mineralogical study.

Transmitted-light microscopy revealed some significant differences from the peridotite, most notably in the decrease in residual 'island' or mesh-type olivine, and in the commensurate large increase in the amount of serpentine (Figs. 14, 15). Other minerals, such as plagioclase, biotite that has been partly altered to chlorite, and brownish amphibole replacement of clinopyroxene, are present in accessory amounts but are of insufficient abundance to have been detected in the Rietveld analysis. The result is a much simpler and 'cleaner' mineralogy that, in transmitted light, lacks the optically complex intergrowths and turbidity observed in the peridotite. In that regard, a notable difference is the absence of quantifiable chlorite and talc (Table 4), which are major minerals in the examined sample of peridotite.

The sulfide mineralogy is like that of the massive sulfides insofar as pyrrhotite, pentlandite, and chalcopyrite are the represented species. The pyrrhotite differs in that, in contrast to its characteristically smooth, uniform appearance in the massive sulfides, in the network sample almost all of the grains are fractured; nonetheless, the fractures are relatively widely spaced and broad, and the distinction from the denser and more complex pattern in pentlandite is still readily apparent. That the fractures in the pyrrhotite are not polishing or handling artifacts is confirmed by the presence of serpentine as the infill. The pyrrhotite lacks the rod-shaped intergrowths with chalcopyrite (as in Fig. 8), and whereas flame-like intergrowths of pentlandite in pyrrhotite have been observed, especially at the grain boundaries of pyrrhotite, such intergrowths are uncommon. Unlike the massive peridotite? sulfide sample, wherein the large, megascopically visible oxide mineral is ilmenite, in the network-texture sample the oxide mineral is magnetite. The major part of the very high magnetite content (12 wt%, Table 4) is attributable to the thread-like occurrences of serpentine that has been derived by the alteration

Table 4. Quantitative mineralogy of network-sulfide sample VR71213A

wt%	olivine	6.2	pyrrhotite	37.4
	lizardite	27.0	pentlandite	8.8
	clinopyroxene	5.2	chalcopyrite	3.4
	magnetite	12.0		

of olivine.

The measured NP of the network-sulfide sample is 41 (Table 1), which is regarded here as to high because, in the absence of carbonate minerals, nearly all of the NP would have to be derivable from olivine and lizardite; thus, because of the high proportion of sulfides and magnetite in the sample (assuming them for NP purposes to be inert), the magnitude of the NP values assignable to each of olivine and lizardite would have to be at least 100. A test with HCl on a portion of the powdered sample did not yield visible effervescence, and other than an uncertain trace of carbonate alteration within a grain of plagioclase, carbonates were not observed microscopically. It is important to note that the statement that the measured NP value is 'too high' does not imply that the sample was incorrectly processed or erroneously measured; several explanations can be offered as to how such values can be achieved while adhering to the Sobek test protocol. However, the topic is probably immaterial because the rock is most likely to be processed as ore.

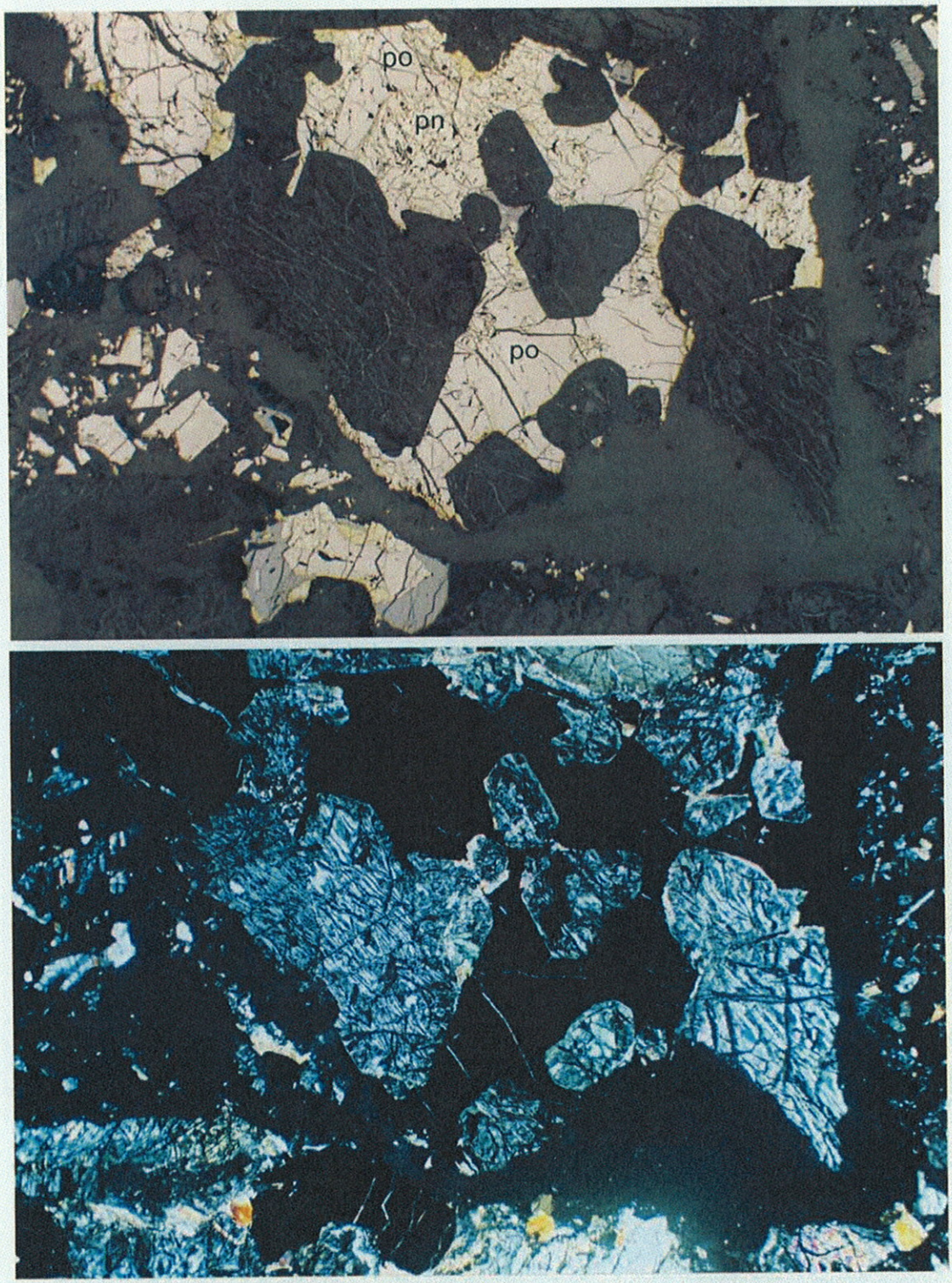


Figure 14. Sample VR7325A (network-texture sulfides) in plain reflected light (top) and the same field in transmitted light with polarizers crossed (bottom), width of field 5.1 mm. The upper photo shows the well-defined crystal outlines of former olivine grains, now consisting of serpentine with abundant threads of magnetite, and the inter-crystal occurrence of the sulfides: chalcopyrite (yellow), coarsely fractured pyrrhotite (smooth surface, **po**), and the more densely fractured pentlandite (**pn**). The gray mineral at the bottom is magnetite. The lower photo shows the pseudomorphism of olivine by the almost monomineralic serpentine.

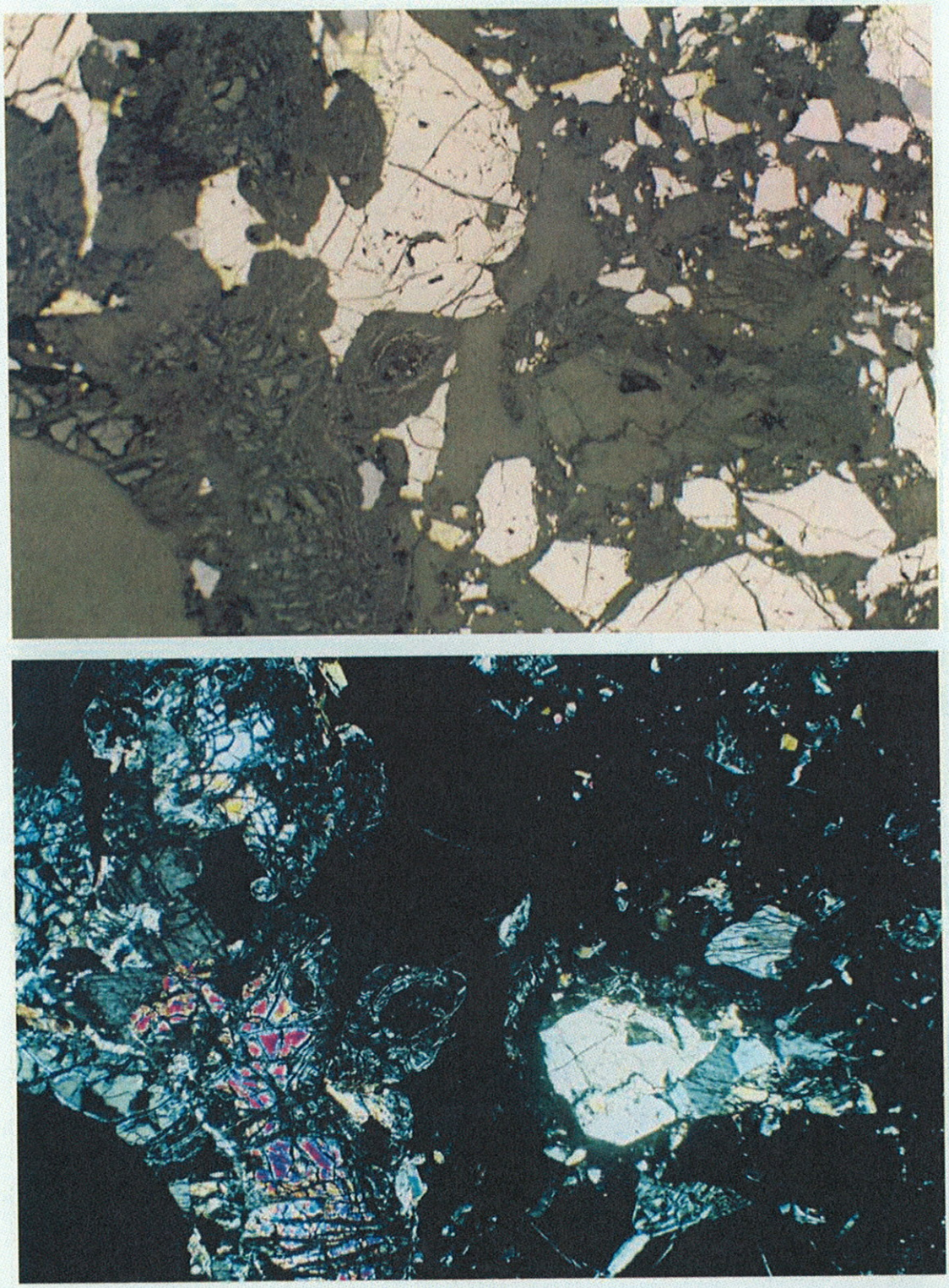


Figure 15. Sample VR7325A (network-texture sulfides) in plain reflected light (top) and the same field in transmitted light with polarizers crossed (bottom), width of field 5.1 mm. The main sulfides are pyrrhotite and chalcopyrite. The lower photo shows residual islands of olivine (violet) on the left, and clinopyroxene on the right.

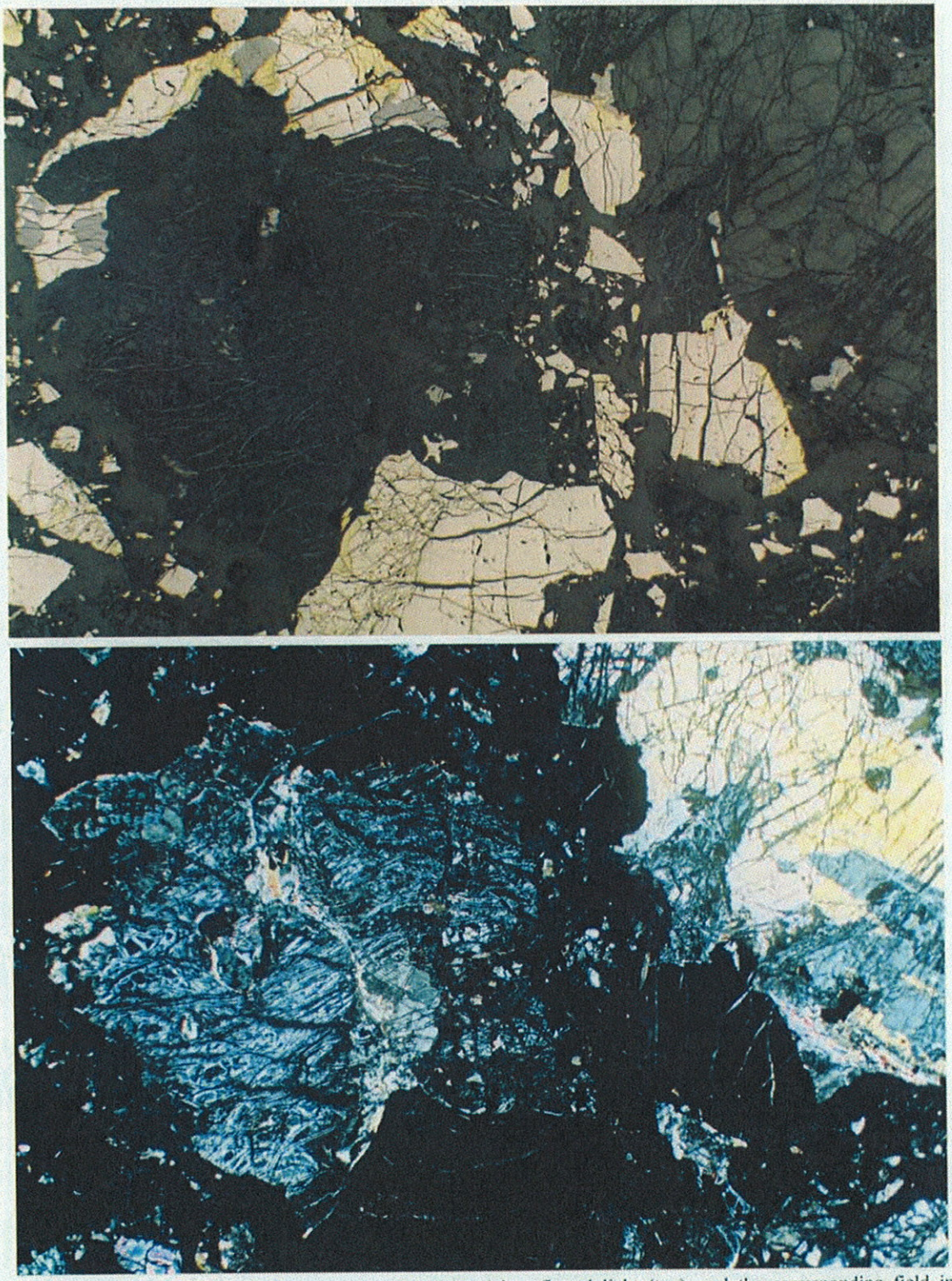


Figure 16. Sample VR7325A (net-texture sulfides) in plain reflected light (top), and the corresponding field in transmitted light and polarizers crossed, width of field 5.1 mm. At the top left (upper photo) are pyrrhotite, chalcopyrite, and magnetite; at the bottom is a large particle of pyrrhotite with attached (on its left) pentlandite (and chalcopyrite). The fracture fill in the pyrrhotite is serpentine. In the lower photo, the area on the left is serpentine, within which (below and left of the photo center) is an aggregate of grayish, twinned plagioclase. At the upper right, the large yellowish particle is clinopyroxene.

Sample VR71499A

The sample is designated as footwall siltstone (Table 1). The core is black and massive, with evenly disseminated sub-millimetric sulfides (~1%). Only two spots of aggregation of the sulfides are evident, and in those the sulfides are loosely clustered in areas of about 2 mm in diameter rather than compactly aggregated. One end of the core has a broken, sharply irregular surface, but the other end is a smoothly planar fracture surface at a low angle to the core length. Residual fracture-fill material, <1 mm in thickness, partly coats the surface. The material effervesces strongly in HCl, and a test with alizarin solution confirmed that calcite is the principal mineral.

For the mineralogical study, the crushed sample was split in half, and one of the halves was gently crushed to reduce the size of the largest chips. Half of the resulting product, including the fines, was used for the mineralogy. Prior to the optical examination, a HCl test of a small portion of the sample gave a vigorous effervescence at one spot and a slow effervescence at two others, thus indicating that calcite is present, that the carbonates are unevenly distributed, and that possibly more than one type of carbonate mineral is present.

Most of the chips in the polished thin section are gray, but a few are black, and the minute grains of disseminated sulfides visible in the core are also megascopically visible in the chips. The optical microscopy revealed that the rock is fine-grained and similar to the hanging-wall siltstone, including the presence of chloritic spotted alteration (Figs. 17, 18). Rutile rims are present but are less conspicuous than in the hanging-wall siltstone. The Rietveld-determined quantitative mineralogy of the two siltstones (Table 5) shows a remarkable similarity in the abundances of the non-sulfide minerals. A few anomalously coarse-grained non-siltstone particles, among which are olivine, pyroxene, and peridotite, are present but quantitatively are no more than a trace amount of the total assemblage.

Table 5. Comparison of the quantitative mineralogy of the hanging-wall (VR71100A) and footwall (VR71499A) siltstones

		VR71100A	VR71499A		VR71100A	VR71499A
wt%	quartz	28.0	26.9	kaolinite	2.2	2.4
	plagioclase	12.6	12.3	pyrite	3.9	–
	muscovite	37.8	41.4	pyrrhotite	3.0	3.6
	chlorite	12.5	13.3			

Reflected-light microscopy showed that nearly all of the sulfide consists of pyrrhotite, which is present as minute disseminated grains and as concentrations at the rims and within the cores of the chloritic spots. One chip, however, consists of fine-grained pyrite with associated calcite, and is likely a fragment of fracture fill (Fig. 19). The chemically determined content of 1.2 wt% S (Table 1) is in accord with the optical estimate of sulfide abundance.

The NP of the sample is 11 (Table 1), the bulk of which would have been derived from chlorite and carbonates. A rough, order-of-magnitude approximation of the carbonate-mineral content in the optical section is 0.3–0.4 vol.%. The suspicion, although highly tenuous, that two carbonate minerals might be present proved to be correct; both calcite and dolomite are present. EDS spectra of the calcite indicate that it is close to the end-member in composition, and spectra of the dolomite are almost identical to the spectrum shown in Figure 7, i.e., also close to end-member in composition.

Although veinlet calcite is thought to be recognizable (Figs. 17, 19), nearly all of the carbonate grains are liberated. One dolomite grain is 350 × 500 μm; the relatively coarse size and liberation suggest that both dolomite and calcite occur as veinlets in the footwall siltstone.

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Lane, G. (2002) Mineralogical determination of pentlandite and chalcopyrite distribution in three head samples and a bulk rougher tail. Unpublished private report by Lakefield Research for Kennecott Inc.

Mandarino, J.A. and Back, M.E. (2004) Fleischer's Glossary of Mineral Species 2004. Mineralogical Record, Tucson, Arizona.

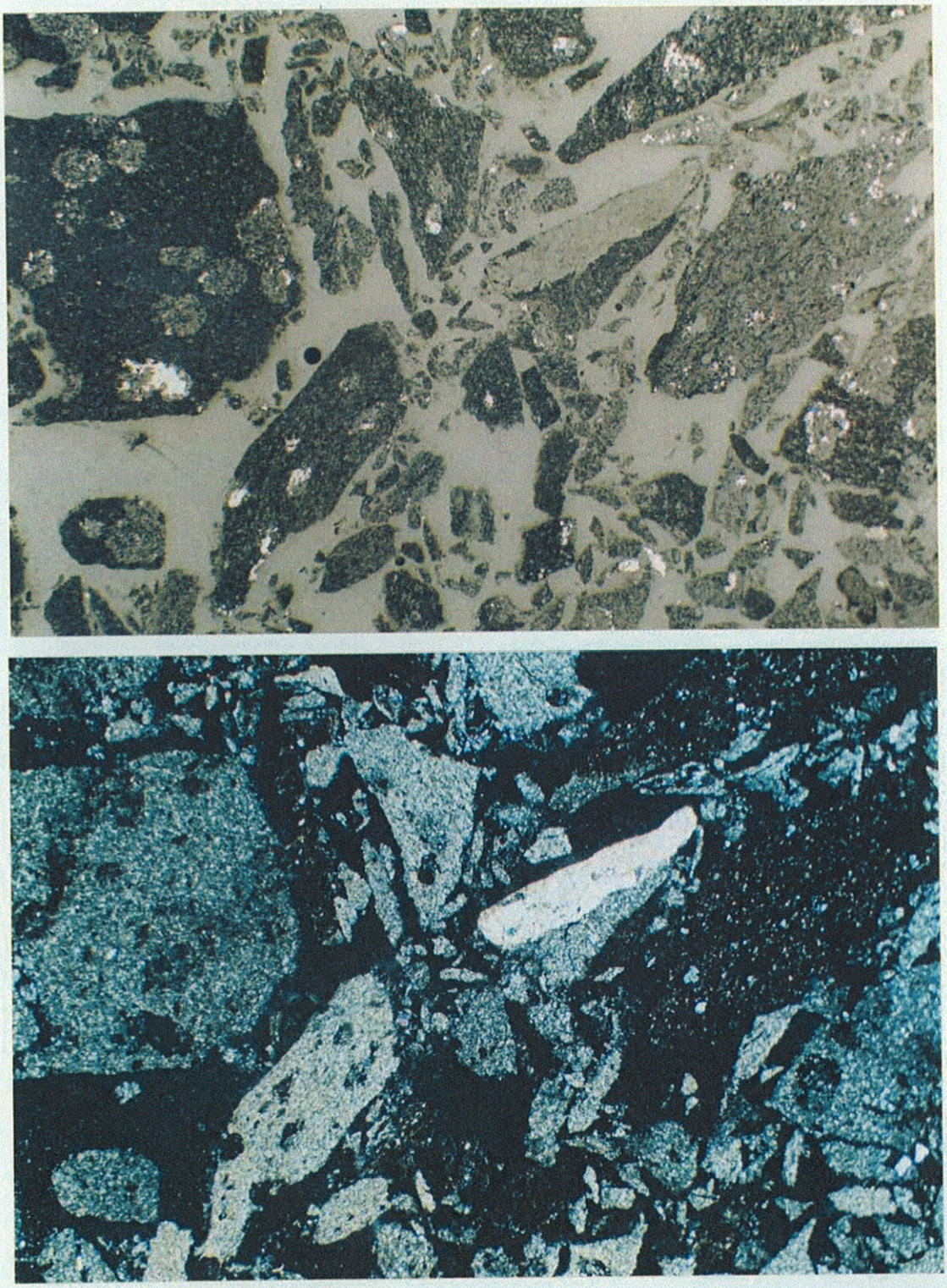


Figure 17. Footwall siltstone VR71499A in plain reflected light (top), and the same area in transmitted light with polarizers crossed (bottom), width of field 5.1 mm, showing the spotted character and fine grain size. White grains in the upper photo are pyrrhotite, and to the right of center is a calcite veinlet that is conspicuous in the lower photo as the whitish, elongate particle pointing to the top right corner.

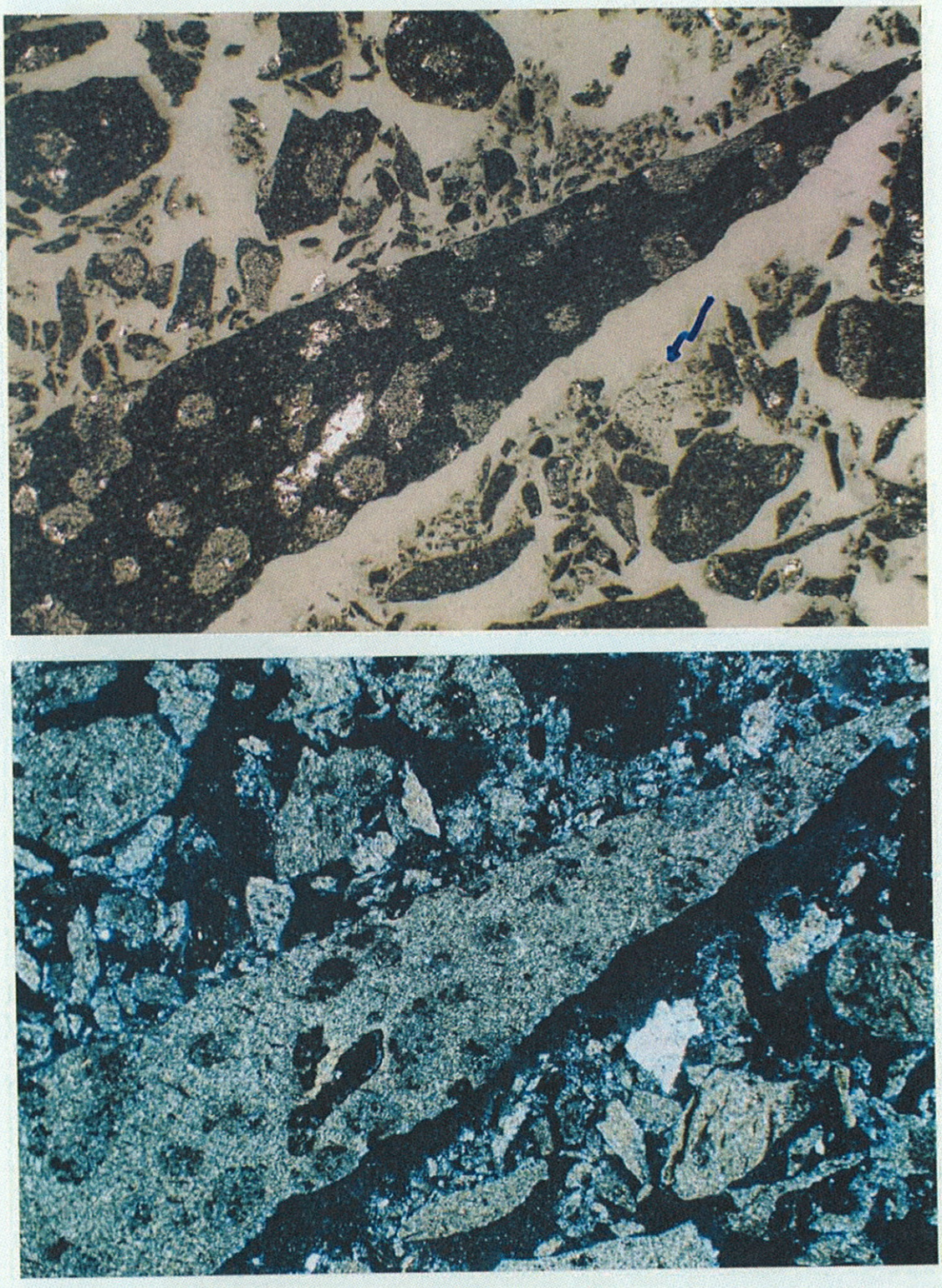


Figure 18. Footwall siltstone VR71499A in plain reflected light (top) and in transmitted light with crossed polarizers (bottom), width of field 5.1 mm. The features are as in Figure 17, but the arrow points to a large particle that is dolomite rather than calcite.

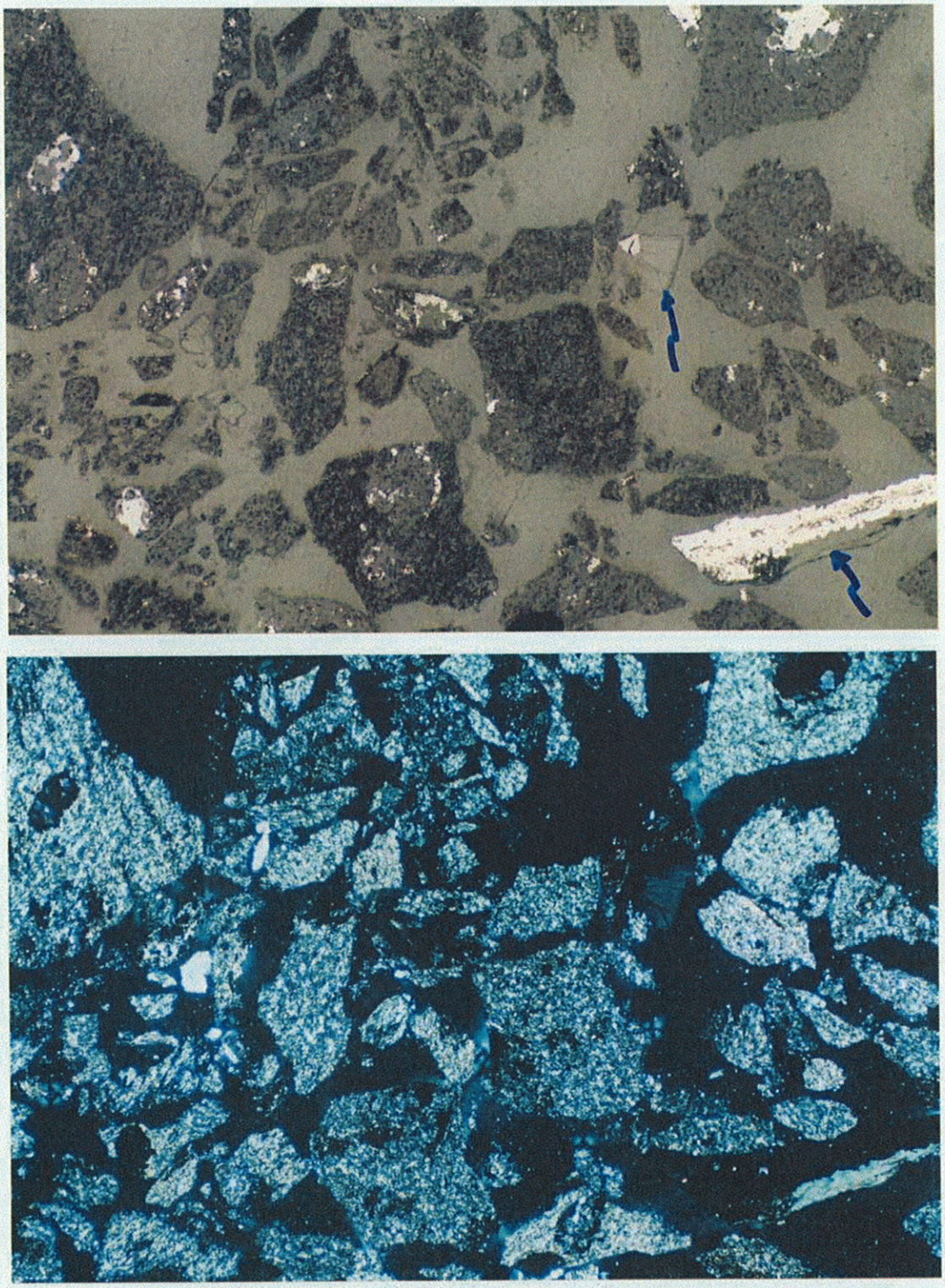


Figure 19. Footwall siltstone VR71499A in plain reflected light (top) and in transmitted light with polarizers crossed (bottom), width of field 2.6 mm. The white mineral is pyrrhotite, except that the elongate particle at the bottom right corner is pyrite with associated calcite (at arrow). The other arrow points to a grain of olivine.

APPENDIX 1

QUANTITATIVE PHASE ANALYSIS OF FOUR POWDER SAMPLES USING THE RIETVELD METHOD AND X-RAY POWDER DIFFRACTION DATA.

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March 31, 2004

EXPERIMENTAL METHOD

The four samples "VR71325A", "VR71100A", "VR71499A" and "VR71213" were ground into fine powder to the optimum grain-size range for X-ray analysis (<10μm) by grinding under ethanol in a vibratory McCrone Micronising Mill for 7 minutes. Step-scan X-ray powder-diffraction data were collected over a range 3-70°2θ with CuKα radiation on a standard Siemens (Bruker) D5000 Bragg-Brentano diffractometer equipped with a diffracted-beam graphite monochromator crystal, 2 mm (1°) divergence and antiscatter slits, 0.6 mm receiving slit and incident-beam Soller slit. The long fine-focus Cu X-ray tube was operated at 40 kV and 40 mA, using a take-off angle of 6°.

RESULTS AND DISCUSSION

The X-ray diffractograms were analyzed using the International Centre for Diffraction Database PDF-4 using Search-Match software by Siemens (Bruker). X-ray powder-diffraction data were refined with Rietveld Topas 2.1 (Bruker AXS). The results of quantitative phase analysis by Rietveld refinement are given in Table 1. These amounts represent the relative amounts of crystalline phases normalized to 100%. Rietveld refinement plots for the samples are shown in Figures 1 - 4.

Table 1. Results of quantitative phase analysis (wt.%)					
	Ideal Formula	VR71100A	VR71213	VR71325A	VR71499A
Quartz	SiO_2	28.0			26.9
Plagioclase	$NaAlSi_3O_8 - CaAl_2Si_2O_8$	12.6	10.6		12.3
Muscovite	$KAl_2AlSi_3O_{10}(OH)_2$	37.8			41.4
Biotite	$K(Mg,Fe^{2+})_3AlSi_3O_{10}(OH)_2$		4.0		
Chlorite	$(Mg,Fe^{2+})_5Al(Si_3Al)O_{10}(OH)_8$	12.5	20.6		13.3
Talc	$Mg_3Si_4O_{10}(OH)_2$		10.8		
Tremolite	$\square Ca_2Mg_5Si_8O_{22}(OH)_2$		4.0		
Kaolinite	$Al_2Si_2O_5(OH)_4$	2.2			2.4
Lizardite	$Mg_3Si_2O_5(OH)_4$		9.2	27.0	
Augite	$(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_2O_6$		13.9	5.2	
Pyrite	FeS_2	3.9			
Chalcopyrite	$CuFeS_2$			3.4	
Pyrrhotite	$Fe_{1-x}S$	3.0		37.4	3.6
Magnetite	$Fe^{2+}Fe_2^{3+}O4$		8.4	12.0	
Forsterite	Mg_2SiO_4		18.4	6.2	
Pentlandite	$(Fe,Ni)_9S_8$			8.8	
Total		100.0	100.0	100.0	100.0

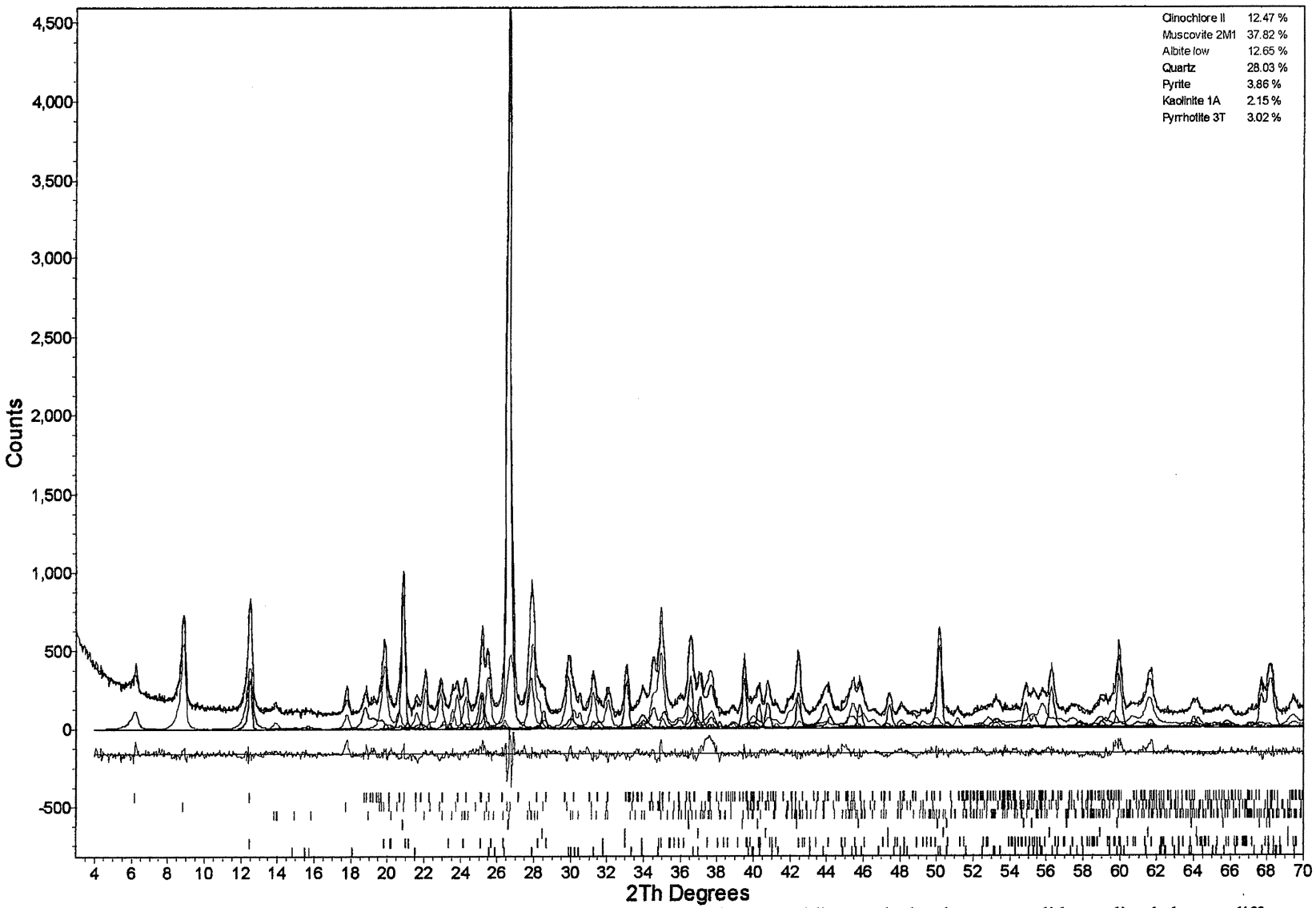


Figure 1. Rietveld refinement plot for **VR71100** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

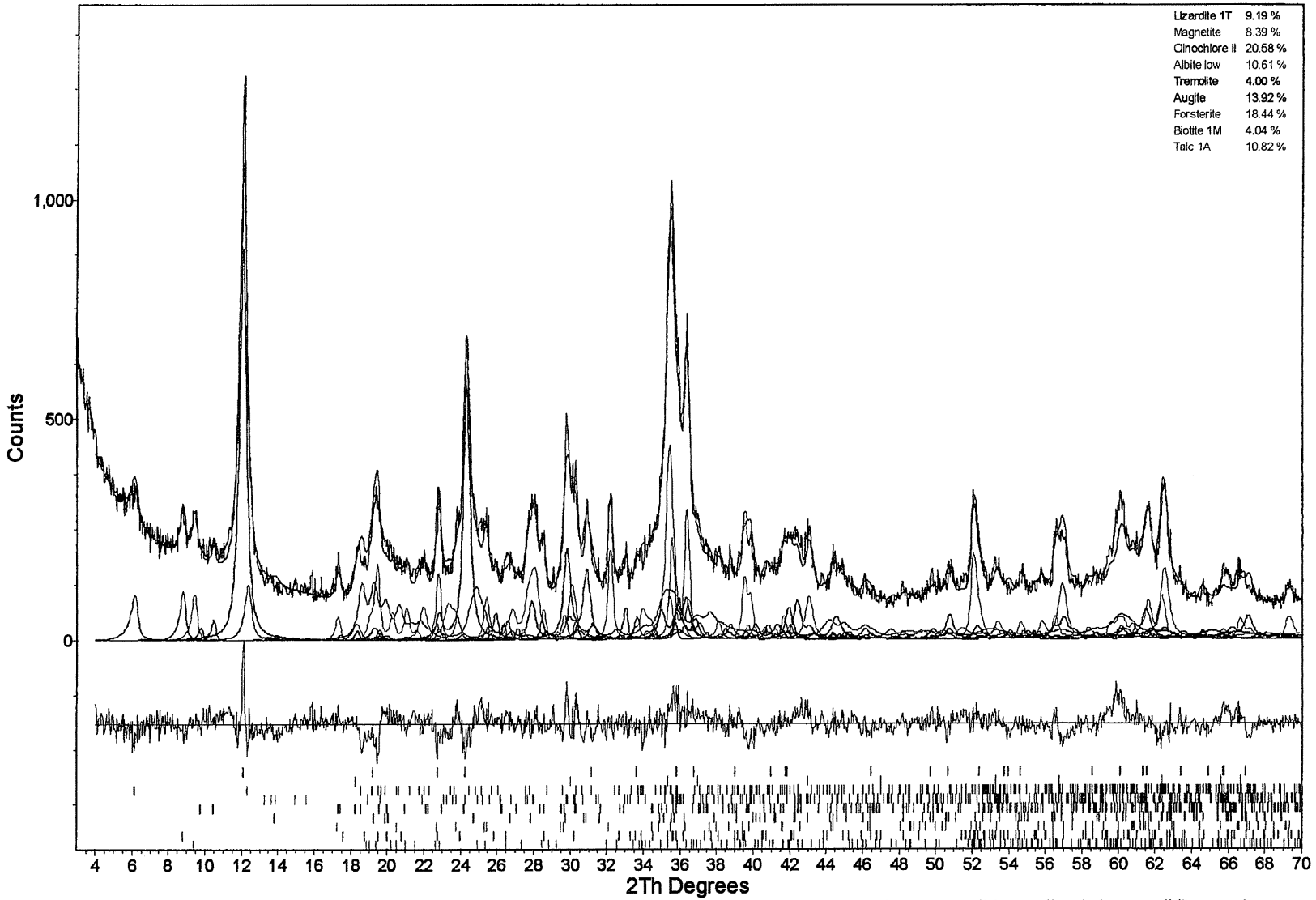


Figure 2. Rietveld refinement plot for **VR71213** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

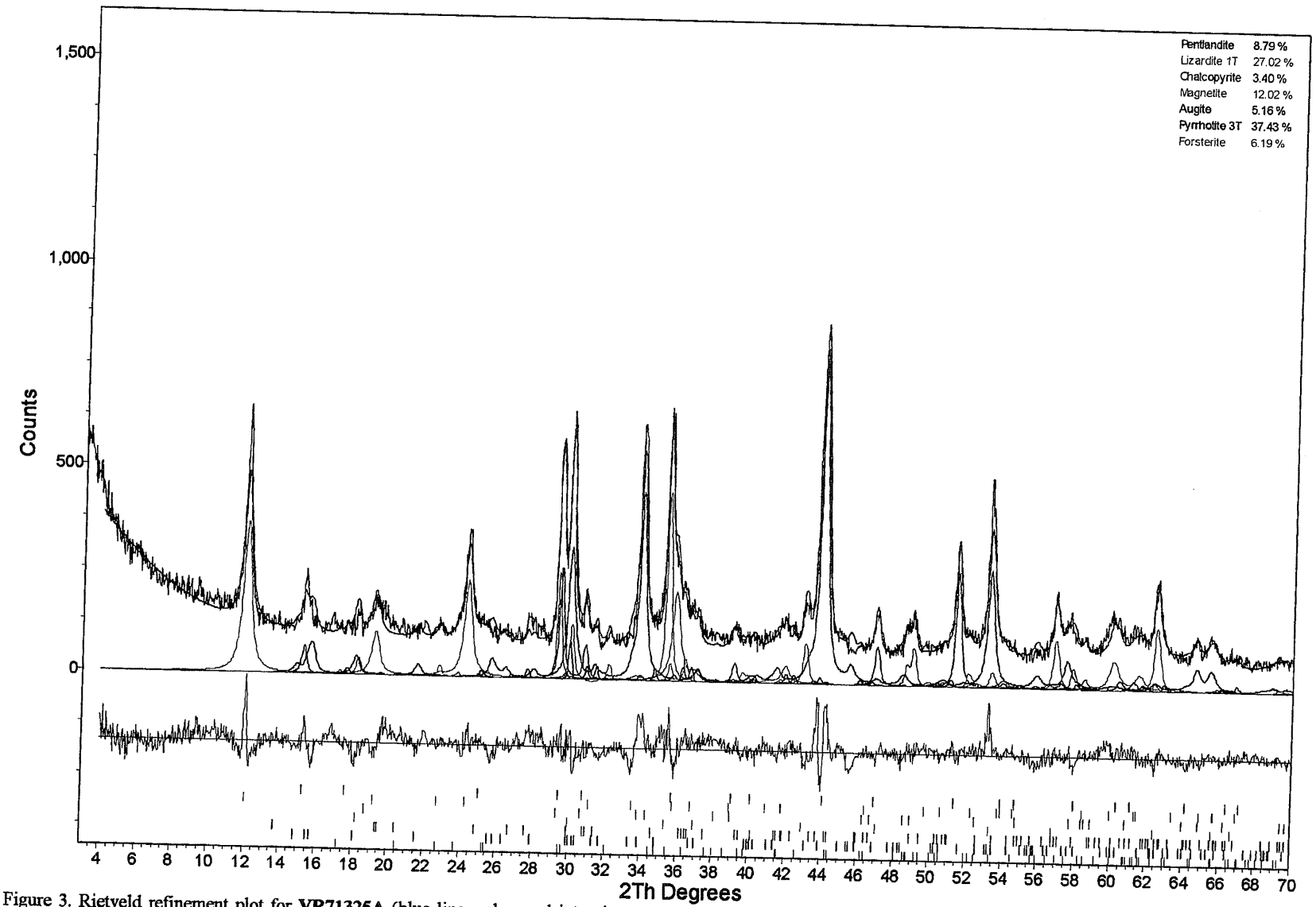


Figure 3. Rietveld refinement plot for **VR71325A** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

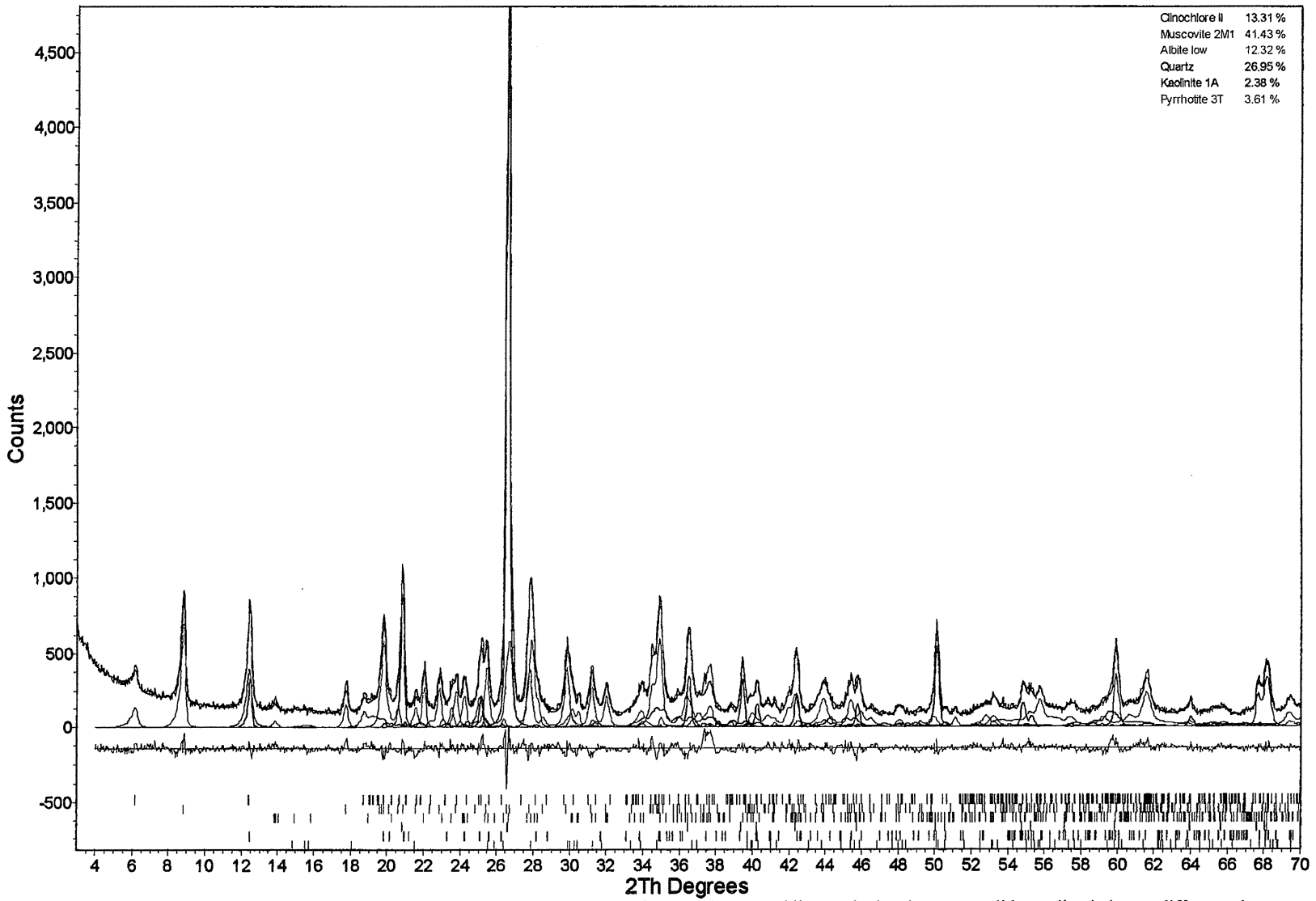


Figure 4. Rietveld refinement plot for sample **VR71499A** (bluc linc - obscrved intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

APPENDIX 2

Nomenclature and ideal formulas* of minerals referred to in the text and Appendix 1

albite	$NaAlSi_3O_8$; sodic plagioclase; forms a series with anorthite $CaAl_2Si_2O_8$, within which the division is at formula Na:Ca = 1:1
amphibole	group name; $AB_2C_5T_8O_{22}X_2$ wherein *A* is K or Ca, *B* is typically Ca, Mg, Fe^{2+}, Mn, *C* is generally Al, *T* is Si, and *X* is OH, Cl, F
augite	clinopyroxene group, $(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_2O_6$
biotite	general name for dark mica; most commonly phlogopite $K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$
calcite	$CaCO_3$
chalcopyrite	$CuFeS_2$
chlorite	group name; most commonly clinochlore $(Mg,Fe^{2+})_5Al(Si_3Al)O_{10}(OH)_8$
clinopyroxene	general term for monoclinic pyroxenes; most commonly augite $(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_2O_6$ or diopside
cubanite	$CuFe_2S_3$
diopside	pyroxene group; monoclinic, $CaMgSi_2O_6$
dolomite	$CaMg(CO_3)_2$
feldspar	general term that includes the albite–anorthite series and K-dominant members
forsterite	olivine group; Mg_2SiO_4
ilmenite	$Fe^{2+}TiO_3$
kaolinite	clay mineral, $Al_2Si_2O_5(OH)_4$
K-feldspar	$KAlSi_3O_8$, feldspar group; generally the species microcline, less commonly orthoclase
lizardite	serpentine group, $Mg_3Si_2O_5(OH)_4$

magnetite	$Fe^{2+}Fe^{3+}{}_2O_4$
marcasite	FeS_2, the orthorhombic polymorph of pyrite
mica	group name that includes muscovite, phlogopite, and biotite
muscovite	mica group; $KAl_2AlSi_3O_{10}(OH)_2$
olivine	group name, most commonly the Mg member forsterite
orthopyroxene	orthorhombic members of the pyroxene group, as distinct from the clinopyroxenes; typically enstatite $Mg_2Si_2O_6$
pentlandite	$(Fe,Ni)_9S_8$
plagioclase	group name for the feldspar series $NaAlSi_3O_8$ (albite) – $CaAl_2Si_2O_8$ (anorthite)
pyrite	FeS_2
pyroxene	group name; includes clinopyroxenes and orthopyroxenes
pyrrhotite	$Fe_{1-x}S$
quartz	SiO_2
rutile	TiO_2
serpentine	group name; most commonly lizardite or clinochrysotile, both $Mg_3Si_2O_5(OH)_4$
sphalerite	ZnS, most commonly (Zn,Fe)S
talc	$Mg_3Si_4O_{10}(OH)_2$
tremolite	$Ca_2Mg_5Si_8O_{22}(OH)_2$; amphibole group; forms a series with actinolite $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$
violarite	$FeNi_2S_4$, cubic

*Ideal formulas from Mandarino and Back (2004)

ENVIRONMENTAL MINERALOGY OF SAMPLES FROM THE EAGLE DEPOSIT, MICHIGAN – PART 2

Prepared for: **Geochimica, Inc.**
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EXECUTIVE SUMMARY

The environmental mineralogy of ten samples from the Eagle Ni–Cu deposit in Michigan was examined as a follow-up to the investigation of five sample for which the results were reported in Part 1. The rocks examined vary from massive sulfides to peridotite and pyroxenite, hornfels, and hanging-wall and footwall siltstone. The most significant change from the Part 1 study is the recognition that fracture-controlled carbonates, both calcite and dolomite, are appreciable local contributors of NP to the bulk-sample values of the siltstone and hornfels. The peridotite and pyroxenite also contain small amounts of carbonate minerals, but most of the measured NP in peridotite is attributable to the presence of olivine and serpentine. Non-opaque minerals are almost absent in the two samples of massive sulfides that have been examined; the only non-opaque mineral identified is siderite, the presence of which was not detected in any of the other samples. Energy-dispersion spectra indicate that calcite in the Eagle samples is close to the end-member in composition, and that the dolomite typically contains only small amounts of Fe and Mn. Quantitative electron-microprobe analyses, keyed to peak heights in the energy-dispersion spectra, indicate that the maximum MnO and FeO contents of veinlet dolomite are about 2.1 and 4.5 wt%, respectively, and the maxima for calcite are <3 wt% MnO and <1% FeO.

INTRODUCTION

In Part 1 of this study the environmental mineralogy of the first five of 15 samples from the Eagle Ni–Cu deposit in Michigan was described (LRC 2004). The remaining ten samples, received on April 13, 2004, are described in this report. As in the initial study, both crushed material and intact, sawn reference cores were submitted to LRC, and the crushed material was used for the optical part of the mineralogical investigation. The only difference in procedures was that the initial equal split of the crushed material was done by Canadian Environmental & Metallurgical Inc., which thereupon ground to minus 200 mesh one of the halves of each sample. Nine of the ten as-received ground samples were submitted directly by LRC to M. Raudsepp of the University of British Columbia for Rietveld analysis; the tenth sample was withheld because it consisted of massive sulfides for which bulk-sample X-ray examination and quantitative mineralogy were deemed to be of limited benefit. The sample numbers and related data are given in Table 1.

Table 1. Samples received and related data

Sample	Lithology	wt% S	NP	wt% C_{total}
VR90425A	hanging-wall siltstone	0.77	8.8	<0.05
VR91625A	footwall siltstone	1.39	12.3	0.11
VR91620A	hanging-wall sandstone	0.31	5.6	<0.05
VR71109A	hornfels	0.7	25.3	0.25
VR91306A	hornfels, mineralized	2.72	20.6	0.11
VR71275A	pyroxenite	0.99	24.6	<0.05
VR91267A	peridotite	0.89	22.2	0.05
VR71373A	mineralized peridotite	2.44	34.4	0.06
VR90181A	massive sulfide	32.4	0.9	<0.05
VR90125A	semi-massive sulfide	8.13	23.9	0.05

DESCRIPTIONS AND RESULTS

Sample VR90425A

The core, like those described in Part 1, had been twice cut along the length such that the sawn surfaces are at right angles and the sample therefore represents a quarter of the original core. The rock, which is hanging-wall siltstone, is black, massive, and lacks recognizable

bedding. The two ends are planar and at a low angle to the core length, but the planes are not at the same angles and are only sub-parallel. One of the ends is smooth and has a sandy color when viewed under a binocular microscope, but no surficial deposits are evident. The other end of the core is rougher, and tests with acid and alizarin solution showed that a small area on the rough surface is calcite-bearing, but carbonates were not detected elsewhere on the core.

At mid height along the core length one of the cut surfaces has a 1-mm pyritic veinlet that parallels the planar ends, but the veinlet seems to have ramified and does not continue to the second cut surface. Part of the second surface instead has several barely visible, sub-millimetric sulfide veinlets that are highly irregular and, although chaotic, seem to be predominantly both in the direction of core elongation and at a steep angle to it.

The polished thin section consists of as-received crushed material that was split and crushed further to obtain a good representation in the section. The section contains at least 50 millimetric chips, the largest ~2 × 4 mm, and abundant sub-millimetric fines. All chips in the section are pale brownish. Disseminated sulfides are megascopically visible, but all are sub-millimetric; the sulfide content was estimated to be about 0.5%

The section as viewed in transmitted light has a uniform 'pelletal' or 'globular' texture (Fig. 1). Locally coarser grained areas within the section reveal the presence of quartz, chlorite, muscovite, and albite; the assemblage and combination of fine grain size are similar to those of the siltstone described in Part 1. The overall particle sizes are 25 μm or less, and the minerals within the globules are slightly coarser grained and less turbid than the surrounding material, thus suggesting that the textural feature is related to weak recrystallization; the lack of planar or oriented development, in turn, suggests a relationship to thermal rather than to dynamic metamorphism.

Two of the chips in the section contain narrow chlorite veinlets in which lath elongation is perpendicular to the wallrock. The wider veinlet is only about 75 μm in width, and neither of the veinlets has associated carbonate minerals. A few pockets of monomineralic chlorite in which lath lengths are up to 50 μm were also observed, and these appear to be uncomplicated segregations with the host rock. Only one carbonate grain, 30 μm across and liberated, was observed. Although calcite was detected on the fractured surface of the core, alizarin staining of the mineral in the optical section indicated that grain to be of dolomite rather than calcite.

Reflected-light examination revealed that, aside from the pervasive globular texture

evident in transmitted light, a spotted texture is also present. As was described in Part 1 for the siltstone, the spots are conspicuous in reflected light because many have a narrow rim of high-reflectance rutile. In the VR90425A siltstone, the spots are less abundant than observed previously, and their distribution seems to be random and spatially independent of the globular texture. Other than a trace of chalcopyrite, all of the sulfide in the section consists of pyrite, the largest particle of which is a polycrystalline aggregate almost 300 μm across (Fig. 2). More typical than such aggregates are disseminated fine grains, but many of the chips are sulfide-barren or contain no more than a bleb or two of pyrite (Fig. 2). The coarsest grains in the section are compact, homogeneous, and liberated; there does not seem to be a gradation in size between the liberated and the much smaller within-host disseminated grains, and the inference is that the liberated grains are from fracture fill. No veinlets of the relatively coarse pyrite were observed in the optical section, but pyrite of appropriate size occurs on fracture surfaces of the core, and a few veinlets in which the pyrite is only a few micrometers wide but forms a braided veinlet pattern were observed in the microscopy section.

The quantitative mineralogy, as determined by Rietveld refinement of the X-ray data for the sample, is given in Table 2. The sulfide content was estimated optically to be about 0.5%, which on the usual pyrite:wt% S correlation of 1:1 suggests a sulfur content of 0.5 wt%. The bulk-sample chemically determined value is 0.77 wt% S, but the difference is not considered to be disputatious. The measured NP is low (8.8), a portion of which is thought to be attributable to fracture-fill carbonates.

Table 2. Quantitative mineralogy of hanging-wall siltstone VR90425A

wt%	quartz	27.9	albite	8.8
	muscovite	43.0	chlorite	9.9
	K-feldspar	8.5	pyrite	1.9

Mineral quantities are normalized to 100 wt% here and in all subsequent tables.

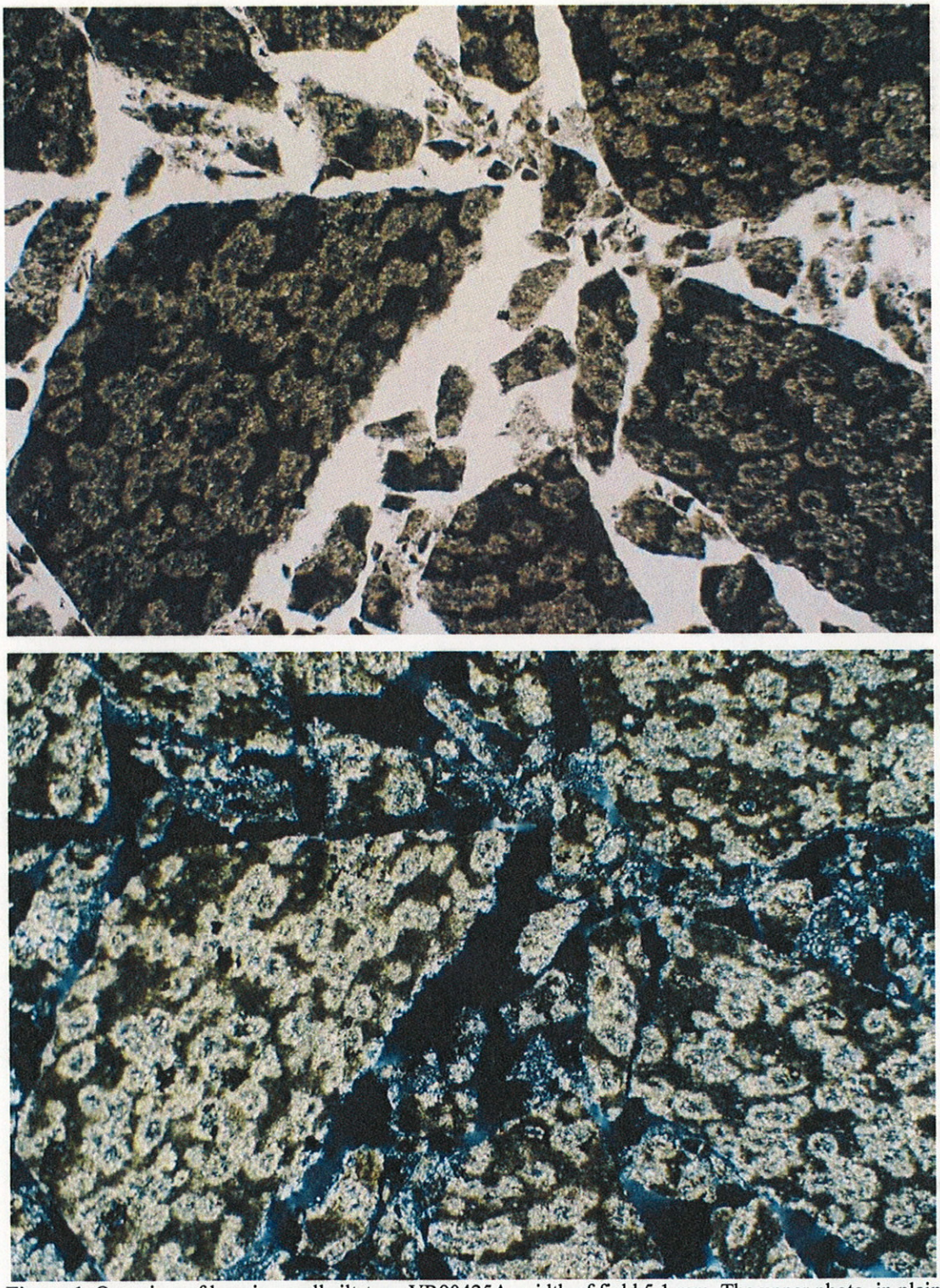


Figure 1. Overview of hanging-wall siltstone VR90425A, width of field 5.1 mm. The upper photo, in plain transmitted light, shows the characteristic pelletal or globular texture and the almost opaque nature of the inter-globule rock. The lower photo of the same area, taken with polarizers almost crossed, shows the typical fine-grained character of the siltstone, and the slightly coarser grain size of the globules (the bluish color is from mounting medium. See also Figure 2 of the same area.

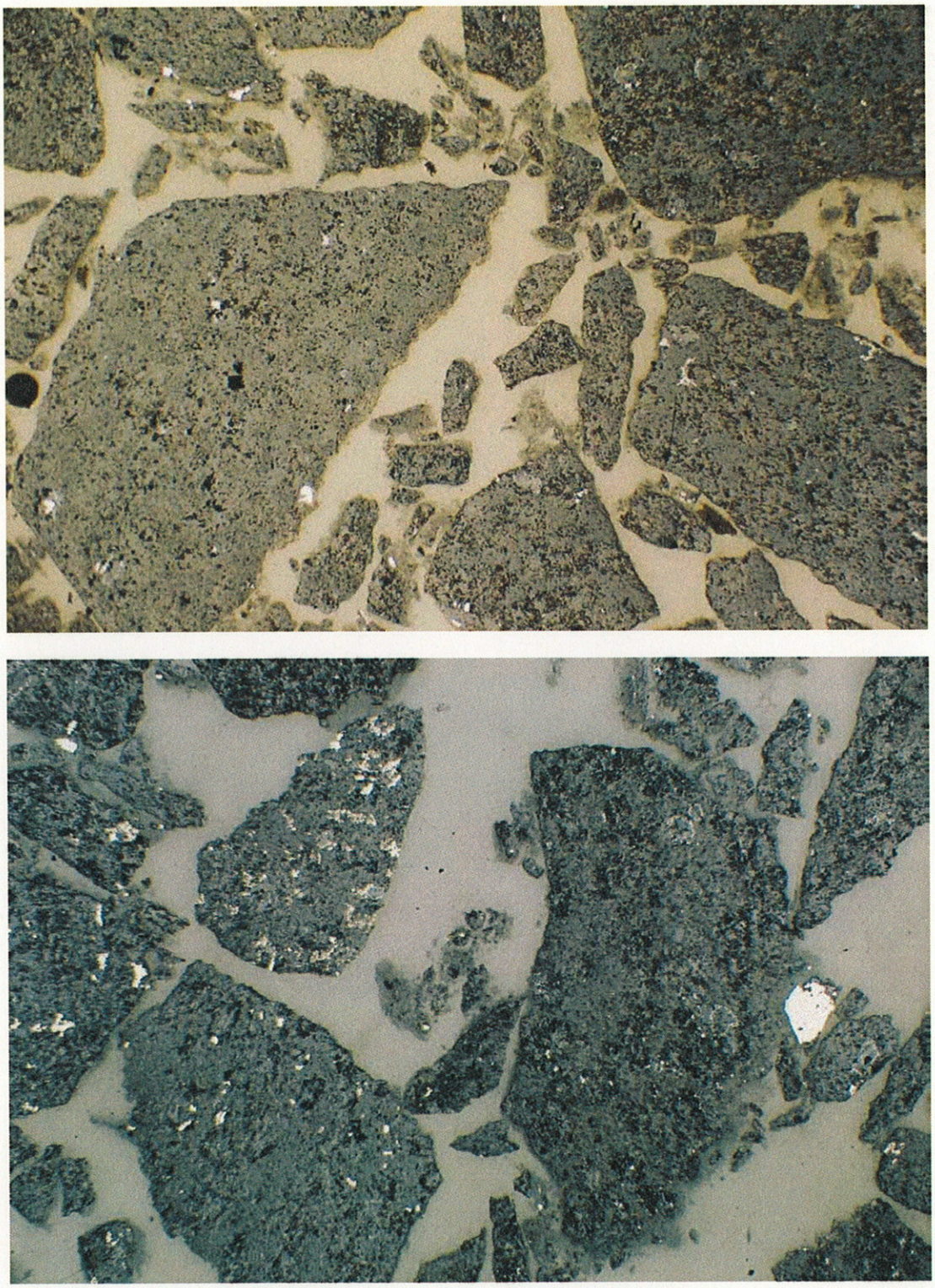


Figure 2. The upper photo is of the same field as Figure 1, but here in plain reflected light. The disseminated white grains in the various chips are illustrative of the typical fine-grained character and distribution of pyrite in the section, as is also evident in the lower photo of another area, at the same magnification. The largest grain of pyrite in the section is at the far right (white).

Sample VR91625A

The sample is of footwall siltstone that is dark grey, massive, and lacks visible bedding. As in the preceding siltstone core, the broken ends of the quartered core are planar and sub-parallel at a low angle to the core length. The planar surfaces are clean breaks that exposed fresh, undisturbed rock. Throughout the core is evenly disseminated pyrite or pyrrhotite, the grains of which are neither aggregated nor aligned. The sulfides are sub-millimetric but the grains are numerous; a value of ~1% sulfides was chosen as an indication of the magnitude of their abundance.

In the crushed sample the pronounced conchoidal fracture that is characteristic of the hanging-wall (VR90425A) siltstone is less evident, and fragments (chips) are commonly tabular rather than equant. No fracture-fill surfaces were observed in the as-received sample, which was split and further crushed to obtain the material for the polished thin section.

The optical section contains >50 chips, with almost all <2 mm across. Two distinct populations of chips are megascopically evident: about 10 15% of the chips are black and opaque, and the remainder of the chips is translucent and brownish gray. Sub-millimetric sulfide grains are disseminated throughout the section in roughly triple the abundance of that in the preceding sample of hanging-wall siltstone.

Microscopic examination revealed that the black, opaque chips have a high carbonaceous content but are otherwise similar to the non-opaque majority (Fig. 3). The results from the quantitative determination of mineralogy indicate that the major-mineral assemblages in the examined samples of siltstones, be they from the hanging wall or footwall, do not vary appreciably with regard to environmental mineralogy (Tables 2 and 3, and Part 1), although in terms of metamorphic systematics there is an indication that K-feldspar may have crystallized at the expense of muscovite within the thermal aureole.

In one of the chips in the optical section, grain sizes of many of the clasts are 30 50 μm across, which is a size coarser than that of the typical siltstone. The coarser grained chip contains carbonate-mineral clasts, but not a carbonate cement, and such clasts make up 5 10% of the chip. A second chip, only a bit coarser in grain size, is similarly but slightly less calcareous. Aside from the two calcareous chips, carbonate minerals with other habits are present. Several relatively coarse liberated grains, up to 100 μm across but of a polycrystalline character that is distinct from the optically uniform or coarser liberated grains, occur within the siltstone host

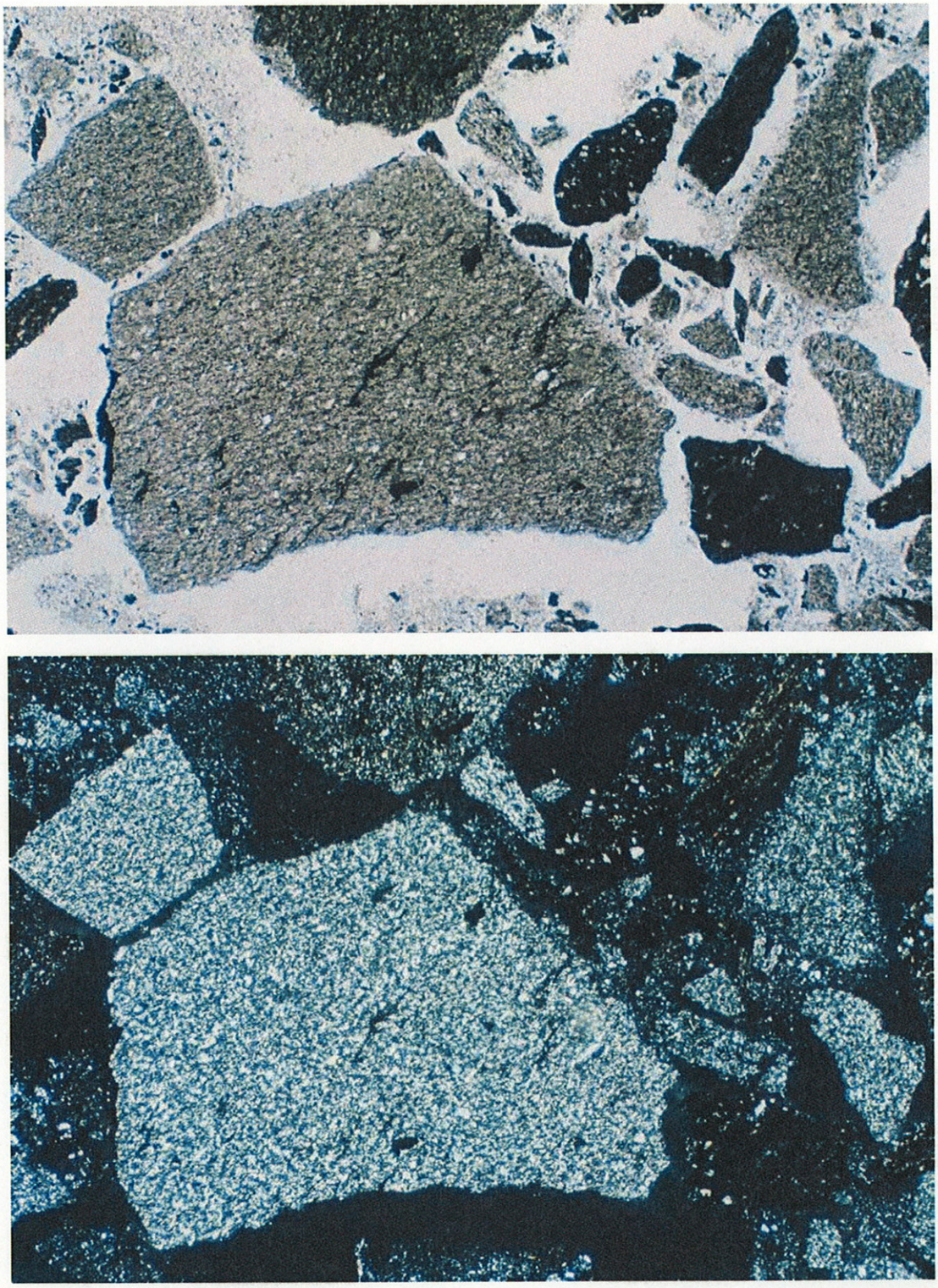


Figure 3. Footwall siltstone VR91625A in plain transmitted light (top), and the same field with polarizers crossed (bottom), width of field 5.1 mm. The upper photo shows the fine-grained character and the two distinct populations of chips (opaque and translucent). Figure 4 is the same area in reflected light.

Table 3. Quantitative mineralogy of footwall siltstone VR91625A

wt%	quartz	29.4	chlorite	13.4
	muscovite	37.5	calcite	0.6
	albite	15.4	pyrrhotite	3.1
			rutile	0.6

(Fig. 4). As well, disseminated carbonate grains of a size like those of siltstone quartz were observed; although difficult to identify because of their small size, the carbonate grains of this type seem to be sparse.

In contrast to the fine-grained pyrite in hanging-wall siltstone VR90425A (Fig. 2), the sulfides in the sample of footwall siltstone are predominantly of pyrrhotite in relatively coarse grains, typically 100 to 300 μm across. Some chips also contain disseminated fine grains, most of which are ≤15 μm. Many of the large pyrrhotite grains have narrow, peripheral concentrations of rutile that are too discontinuous to be called rims (Fig. 5). Traces of pentlandite occur as flames within pyrrhotite, which also contains trace amounts of pyrite and chalcopyrite as inclusions. Extremely fine-grained, polycrystalline, inclusion-riddled marcasite, some with associated pyrite and some with pyrrhotite, has also been observed but is quantitatively insignificant. Sulfide abundances in the more strongly carbonaceous chips do not seem to differ from those of the other chips.

The overall sulfide content of the optical section was estimated to be between 1 and 2%, and probably closer to the higher value. The carbonate-mineral content, even with the presence of the two calcareous chips (Fig. 6), was estimated to be <1 %, and most likely ~0.5%. Areas tested with alizarin solution indicate that the liberated grains of carbonate and the aggregates within the siltstone are calcite; the calcareous chips are also calcite-bearing, but it is uncertain whether all of the carbonate grains are calcite. The higher carbonate-mineral content relative to that in hanging-wall siltstone VR90425A (the preceding sample) accounts for the higher NP value (12.8 versus 8.8).

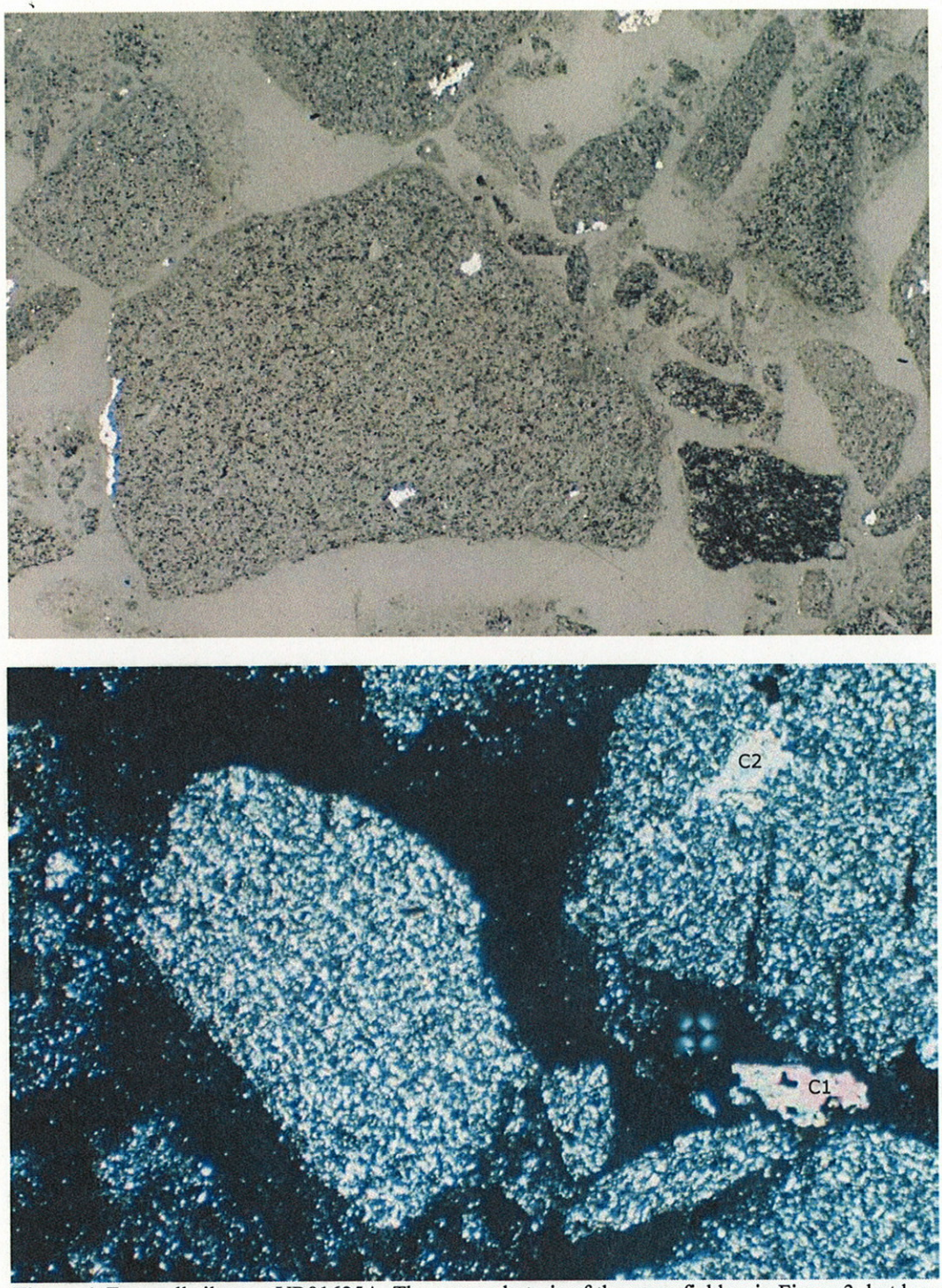


Figure 4. Footwall siltstone VR91625A. The upper photo is of the same field as in Figure 3, but here in reflected light. The white grains are pyrrhotite, and on the far left is a pyrrhotite-bearing veinlet whose continuation at the upper end is marked by grains of chalcopyrite rather than of pyrrhotite. The lower photo, in transmitted light with polarizers crossed, width of field 5.1 mm, shows the different carbonate types: **C1** at the lower right is the liberated type, **C2** consists of within-matrix, irregular aggregates, and **C3** consists of sparse fine-grained, disseminated grains (not distinguishable in the photo) within the siltstone.

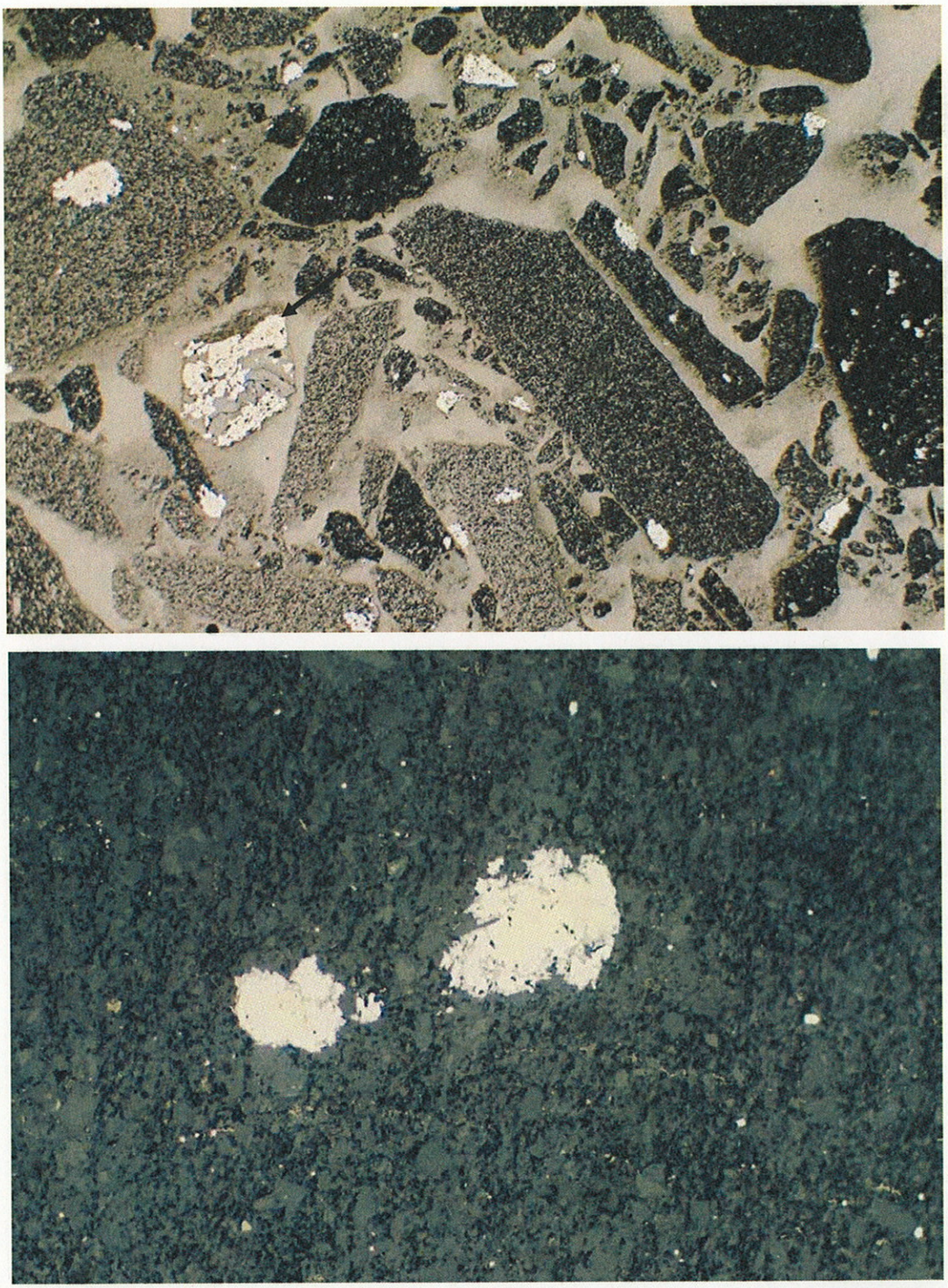


Figure 5. Siltstone VR91625A in plain reflected light. The upper photo (width of field 5.1 mm) shows the general nature of the siltstone (black chips are more carbonaceous) and the distribution of pyrrhotite (white). The arrow points to a chip that is part of a veinlet. At the arrow head is a zone of pyrrhotite, and the remainder of the white is marcasite; the associated light gray minerals are calcite and quartz. The lower photo (width of field 0.625 mm) shows pyrrhotite with peripheral rutile.

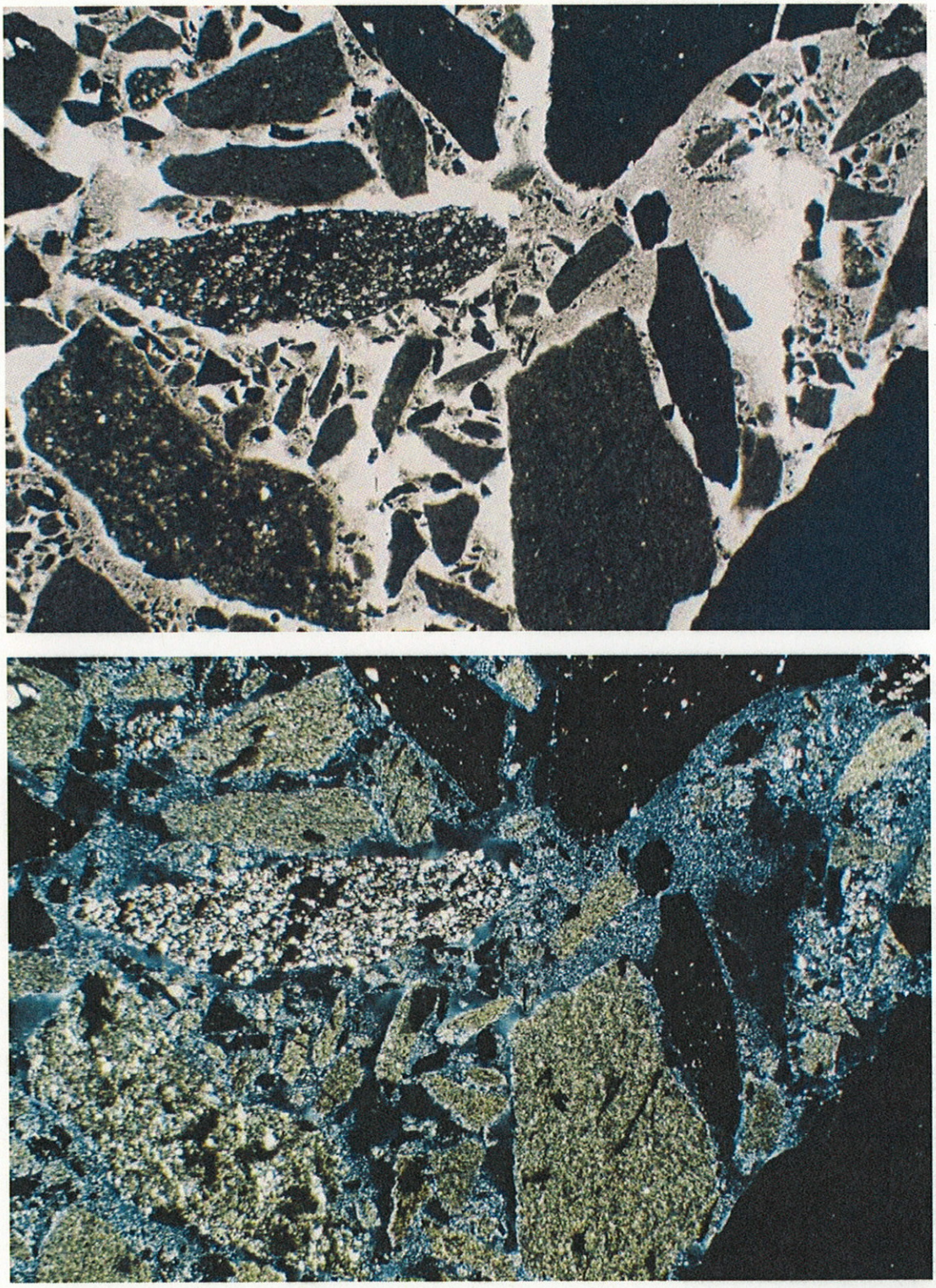


Figure 6. Siltstone VR91625A in plain transmitted light (top) and the same field with crossed polarizers (bottom), width of field 5.1 mm. The elongate chip at mid-height, left, is one of the coarser grained, calcareous chips.

Sample VR91620A

The sample is of dark gray hanging-wall sandstone. The core ends are planar at about 45 60° to the core length and are sub-parallel; one end is greenish white and is sulfide- and probably muscovite-rich, whereas the other end is rougher and not mineralogically distinct. No carbonates were detected with alizarin solution or acid. Disseminated, sub-millimetric sulfides are sparingly visible on the sawn surfaces. In the sample of crushed material, no fracture-fill pieces were observed. The sample was split and further crushed for the polished thin section.

The optical section contains numerous chips, with about 20 of the largest ones in the 2 to 3 mm range. No carbonaceous chips are present; all are grayish and translucent. Megascopic sub-millimetric sulfides are sparse, with the abundance estimated to be <0.5%.

Microscopic examination showed that a few siltstone chips are present, but the others are coarser grained, less turbid, and have quartz grain sizes of 50 100 μm (Fig. 7). Albite is common, and muscovite and chlorite occur as shreds within the phyllosilicate-dominant matrix. The quantitative mineralogy is given in Table 4. Carbonate minerals are present only in trace amounts. Five grains, ranging from about 25 to 60 μm across, were observed in the sandstone, wherein they occur as clasts. Four liberated grains, the largest ~70 × 250 μm and the smallest ~30 μm across, were observed. Tests with alizarin solution indicated that both calcite and dolomite are present.

Pervasive, finely disseminated sulfides are absent; the bulk occurs as polycrystalline particles of pyrite, most commonly 40 to 200 μm across. A few of the particles are marcasite rather than pyrite, and most of the pyrite has associated with it a subordinate amount of polycrystalline marcasite that is concentrated at the periphery or is adjacent to non-sulfide inclusions within the aggregates. A few, minute, isolated grains of chalcopyrite are present. The sulfide content of the section was estimated to be 0.1%, with pyrite > marcasite >> chalcopyrite. The low NP value (5.6; Table 1) is in accord with the expectations from the mineralogy.

Table 4. Quantitative mineralogy, VR91620A

wt%	quartz	47.0	chlorite	9.6
	muscovite	15.0	pyrite	0.5
	albite	27.5	rutile	0.5

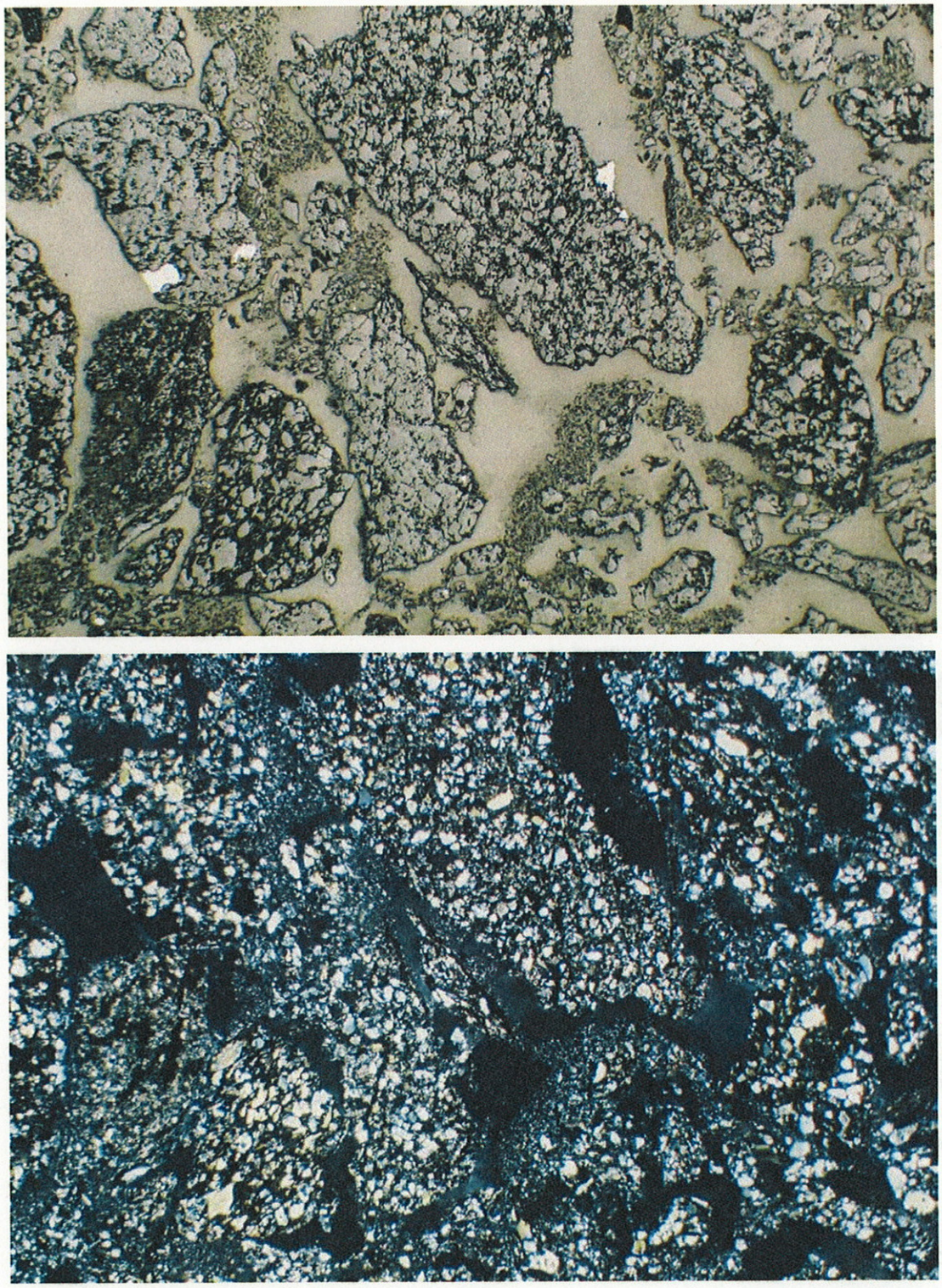


Figure 7. Sandstone VR91620A in plain reflected light (top), and the same area in transmitted light with crossed polarizers (bottom), width of field 5.1 mm, showing the typical sparingly distributed pyrite (white). The lower photo illustrates the coarser grain size relative to that of siltstone; the absence of bright colors is a reflection of the low mica content relative to that of siltstone.

Sample VR71109A

Hornfels sample VR71109A is dark gray, slightly greenish, massive and homogeneous except for a slightly lighter, elongate 'clot' about 6 mm wide and 4 cm long. No sulfides are visible. One of the core ends is planar, has a greenish sandy appearance, and is almost normal (~10°) to the core length. The other end is rougher, yellowish sandy, and is at a steep angle to the core length. No reaction with alizarin or acid was obtained from the core.

The crushed material consists of roughly equant chips with an irregular to conchoidal fracture. One chip ~5 mm in diameter is white; about half its volume was added to the material for the optical section, and the remainder was retained for separate examination. Another chip seemed to have a whitish veinlet, about 2 mm wide; only a small portion was added to the material for optical study. Subsequent examination of the two chips indicated that both the white chip and the veinlet consist of carbonates whose behavior with the test solutions suggested that each chip is a mixture of calcite and dolomite.

The section contains more than a hundred chips, of which about 3% are black and opaque and the others are slightly greenish. The largest chips are about 2 mm across and are numerous. One of the larger chips consists of pyrite, and several smaller sulfide-bearing chips are megascopically observable. The sulfide content was estimated to be of the order of 1%.

The rock, which is classified as hornfels (Table 1) is of the fine-grained siltstone type and has a mottled texture (Figs. 8, 9) that is similar to the globular texture of the siltstone illustrated in Figure 1. The black opaque chips are not texturally different and are distinguishable only because of their high carbonaceous content. Rutilated, ring-type spots are common but are not a predominant feature. One quartz–chlorite veinlet, ~30 μm wide and 1.2 mm long, occurs at the margin of a chip, and a shorter chloritic veinlet at a right angle to the long veinlet cuts the chip. Neither veinlet is carbonate-bearing.

The quantitative mineralogy is given in Table 5. The most outstanding feature in the optical section is the high content of carbonate minerals, which occur as cleavage fragments up to 1 mm across, and as fine- and coarse-grained aggregates, with the latter commonly showing well-defined zoning (Fig. 10). Carbonates either as grains or as veinlets within the hornfels were not observed; thus, the carbonates presumably represent liberated fracture-fill material, among which are likely to be some of the particles that are mentioned in the second paragraph above. Tests with alizarin solution indicated that calcite and dolomite commonly coexist on a

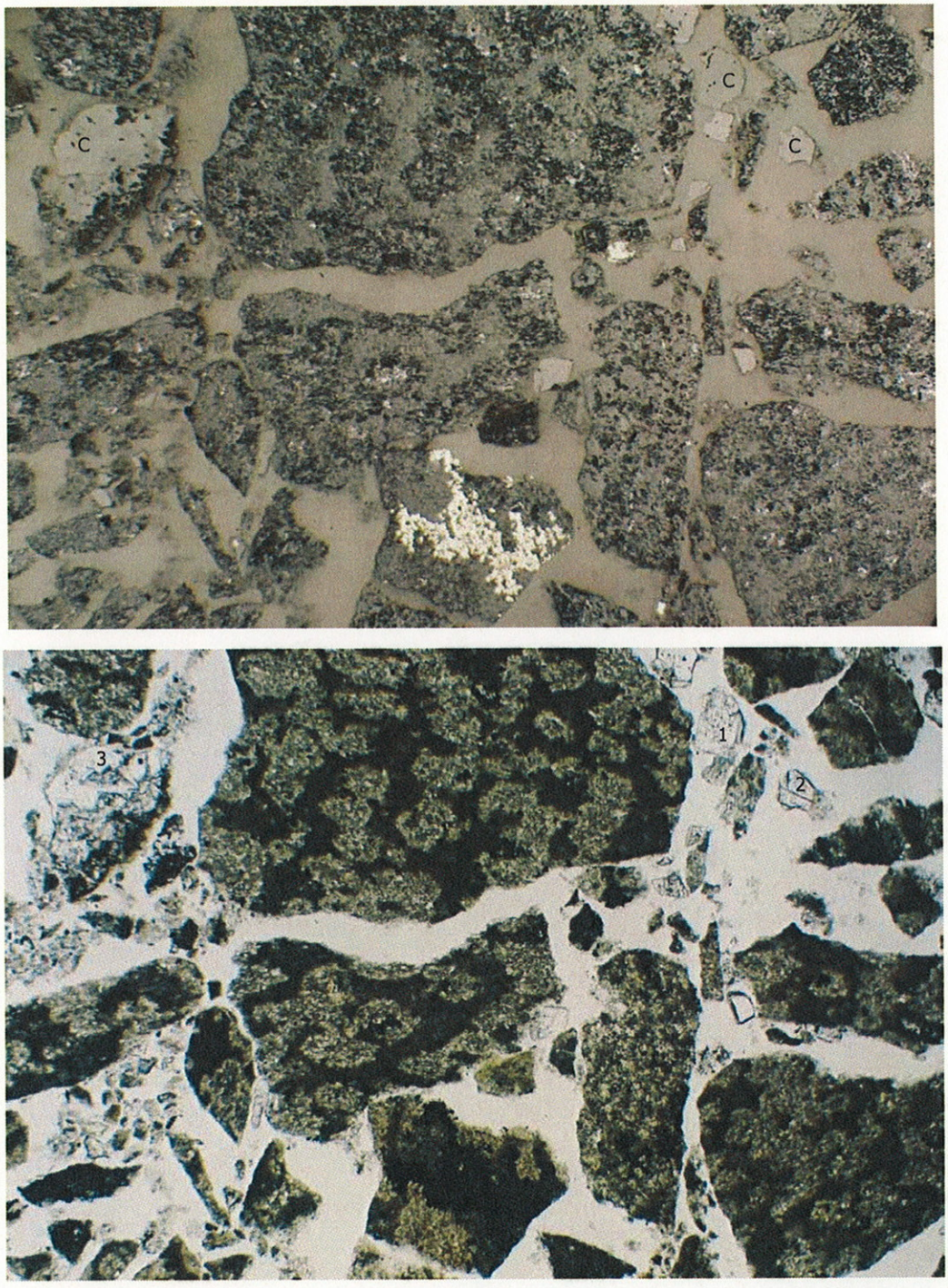


Figure 8. Hornfels VR71109A in plain reflected light (top) and in plain transmitted light (bottom), width of field 5.1 mm, showing the typical texture (see also Fig. 9). Numerous carbonate grains are present (e.g., **C** at the left and right in the upper photo), and these appear as the coarser, colorless grains (**1**, **2**, **3**) in the lower photo. The typical occurrence of fine-grained aggregations of pyrite is evident in the chip at the bottom of the upper photo. EDS spectra for the labelled grains are given in Appendix 2.

Table 5. Quantitative mineralogy of VR71109A

wt%	quartz	29.7	chlorite	10.1
	muscovite	39.6	pyrite	1.4
	K-feldspar	11.6	pyrrhotite	1.1
	albite	6.6		

microscopic scale. Age relations are variable, but dolomite more commonly is the younger mineral. The aggregates that show zoning are of dolomite; zoning was not detected in coarse grains of calcite. EDS spectra of the various labelled grains in Figures 8 and 10 are given in Appendix 2. Both the calcite and the dolomite have low Fe and Mn contents.

The sulfides are present in two dissimilar forms: (a) as fine-grained aggregates, typified by the pyrite-rich chip shown in Figure 8, and (b) as large, liberated grains of pyrite and pyrrhotite (Fig. 10). As well, several grains of chalcopyrite occur within the hornfels. Both pyrite and pyrrhotite are represented by the large, liberated grains, but the two occur independently. Pyrite is predominant. Only one minute grain of marcasite, within pyrite, was observed. The within-hornfels sulfide content was estimated to be ~0.2%, but the large size and homogeneity of the liberated grains probably doubles the sulfide content to about 0.4%. The bulk-sample value is 0.7 wt% S (Table 1). Almost all of the high NP (25.3) is attributable to calcite and dolomite.

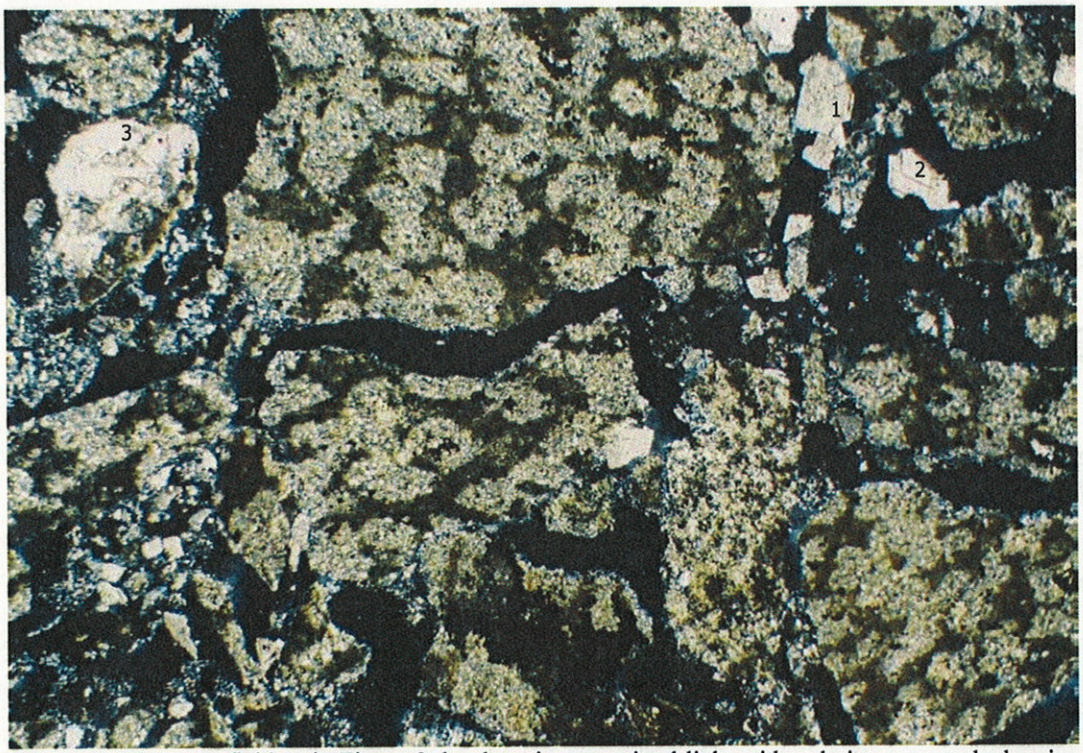


Figure 9. The same field as in Figure 8, but here in transmitted light with polarizers crossed, showing the fine-grained character of the hornfels and the much coarser grain size of the carbonate minerals.

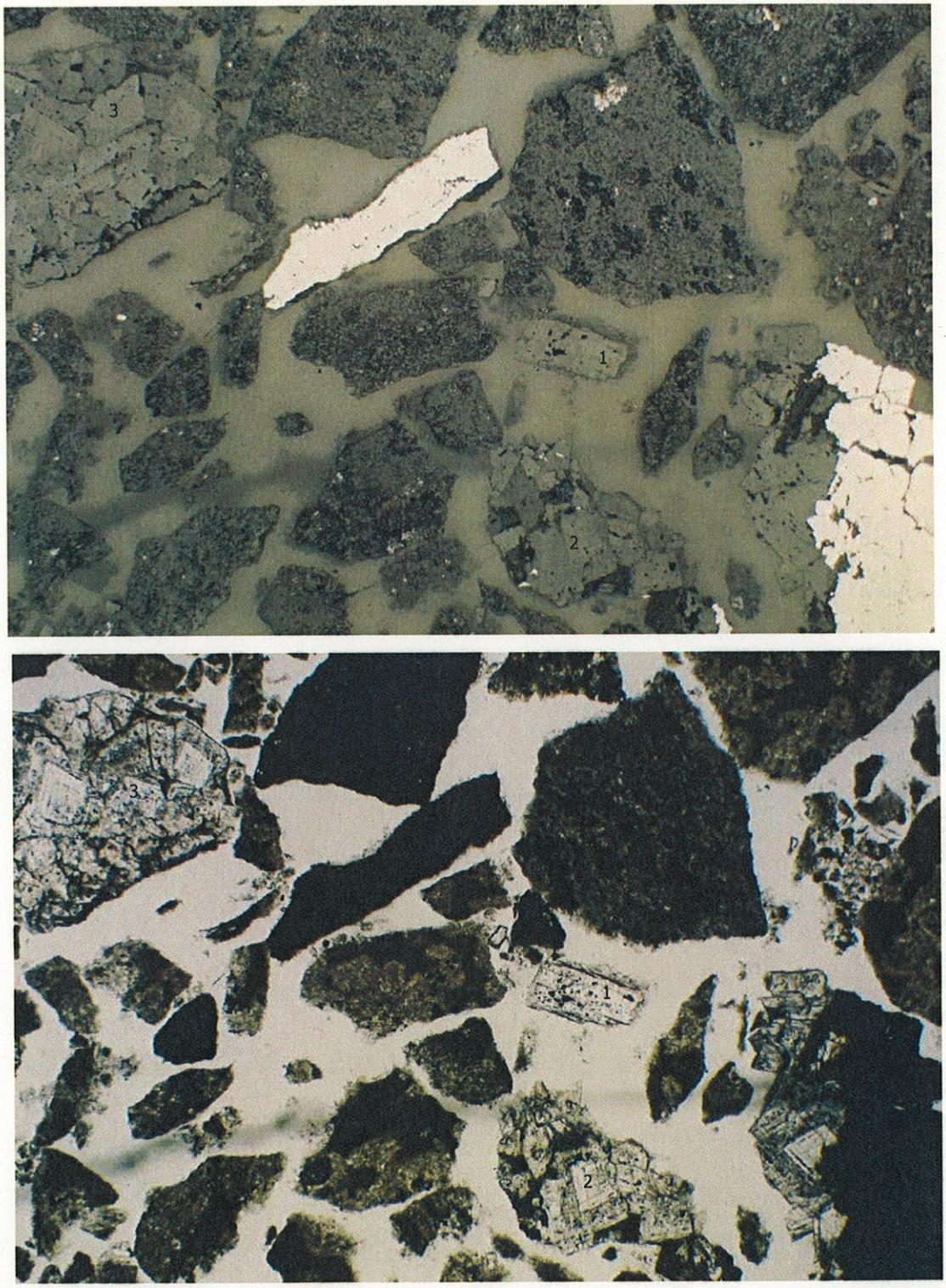


Figure 10. Hornfels VR71109A in plain reflected light (top), and the same field in plain transmitted light (bottom), width of field 5.1 mm. The upper photo shows two large particles of liberated-type pyrite, and the lower photo shows aggregates of zoned dolomite. EDS spectra for the labelled grains are given in Appendix 2.

Sample VR91306A

Sample VR91306A is of weakly mineralized hornfels. Two pieces of core were received. One is the 'standard' quartered core, about 10 cm long, which contains only traces of sub-millimetric disseminated sulfides and is similar in appearance to hornfels VR71109A. One end of the core has a rough, steeply dipping fracture surface, which appears to be chloritic and which has a small amount of associated dolomite. Within the core and about 1 cm from the fractured surface is a chloritic veinlet, about 1 mm wide, that did not give a reaction for carbonate. The opposite end of the core apparently has two intersecting fracture planes; the main one is smoothly planar and has a chloritic surface, whereas the other is rough and uncoated. Carbonates were not detected on either surface.

The hornfels is apparently irregularly mineralized, and a smaller piece of core, about 5 cm long, was provided as an example of the mineralized material. The core is highly fractured along rough, irregular surfaces, to the extent that the as-received example was no longer intact. The sample contains about 10% chalcopyrite that occurs predominantly as irregular aggregates, up to about 5 mm wide, that have an uneven distribution. Tests with alizarin solution and acid indicate that dolomite is locally present on the irregularly fractured surfaces.

The as-received crushed sample was noted to be chalcopyrite-rich, but no veinlets or obvious fractured surfaces were observed within the chips. The material selected for the optical section was therefore a random split. The resulting optical section contains >50 chips, the largest about 2 × 3 mm. Most are megascopically gray or slightly brownish, and a few consist solely of pyrite. Chalcopyrite is visible in several of the smaller chips. The overall sulfide content of the section is high and was estimated, prior to the optical examination, to be ~7%.

Transmitted-light microscopy revealed that the grain size of the rock is like that of the sandstone rather than the siltstone; grain diameters are commonly to 100 μm, many are to 150 μm, and a few are to 200 μm. Many of the grains are slightly pinkish and turbid, presumably as a result of permeation by sub-microscopic hematite. Quartz and chlorite are predominant, and the mineral affected by hematite staining is K-feldspar. Shreds of muscovite are abundant in some chips and are absent in others. A few grains of amphibole were observed, but the mineral has been extensively chloritized. Chlorite occurs predominantly as a matrix for the quartz and feldspar, but one chip of about 0.3 × 0.9 mm consists of an aggregate of radial sheaves, each ~100 μm in diameter. Several fine-grained, polycrystalline, monomineralic aggregates of chlorite

Table 6. Quantitative mineralogy of VR91306A

wt%	quartz	32.5	chlorite	18.0
	muscovite	13.4	chalcopyrite	4.1
	K-feldspar	9.4	pyrite	2.0
	albite	18.9	pyrrhotite	0.8

are present, as are several predominantly monomineralic chlorite veinlets; both have also been observed to locally contain inclusions of dolomite.

The section is carbonate-rich, with the largest grain a cleavage fragment that is ½ mm along an edge. Several others of only slightly smaller size are present (Figs. 11-13). One chip has a coarse-grained carbonate veinlet, or part of a veinlet, along one side, but otherwise all of the large carbonate grains are liberated, and no aggregates, clasts, or cementation within the quartzose portions of the hornfels were observed. There is, however, a pronounced association between chlorite and carbonates, and some of that material may have been derived from chlorite-rich aggregates within the hornfels rather than from veinlets. Despite the conspicuousness of the large carbonate grains, the overall content of carbonate minerals was estimated to be no more than 1% of the optical section. Tests with alizarin solution indicated the mineral to be dolomite, and no calcite was detected. EDS analyses of four carbonate grains confirmed that all are dolomite; spectra for the dolomite and for chlorite are given in Appendix 2. No carbonates were detectable in the quantitative mineralogical analysis (Table 6).

The sulfide content of the section is in percentage amounts and consists almost wholly of pyrite and chalcopyrite. The pyrite occurs as fine-grained aggregates within the hornfels (exemplified by the pyritiferous chip at the lower right of Fig. 13), and as coarse, homogeneous grains that are either liberated or intergrown with dolomite (Figs. 12, 13). The chalcopyrite occurs within the hornfels (Fig. 12) and as liberated grains. Although a few exceptions were noted, >99% of the chalcopyrite does not coexist as intergrowths with pyrite. Trace amounts of ilmenite, marcasite, a grain of metallic iron, and traces of sphalerite are present, with the sphalerite occurring at the periphery of chalcopyrite or as occluded blebs within the chalcopyrite. Although a small amount of pyrrhotite is reported in the quantitative analysis (Table 6), none was identified as present in the optical section; however, a few grains of pentlandite, either isolated or in contact with chalcopyrite of similar size, were observed in the section.

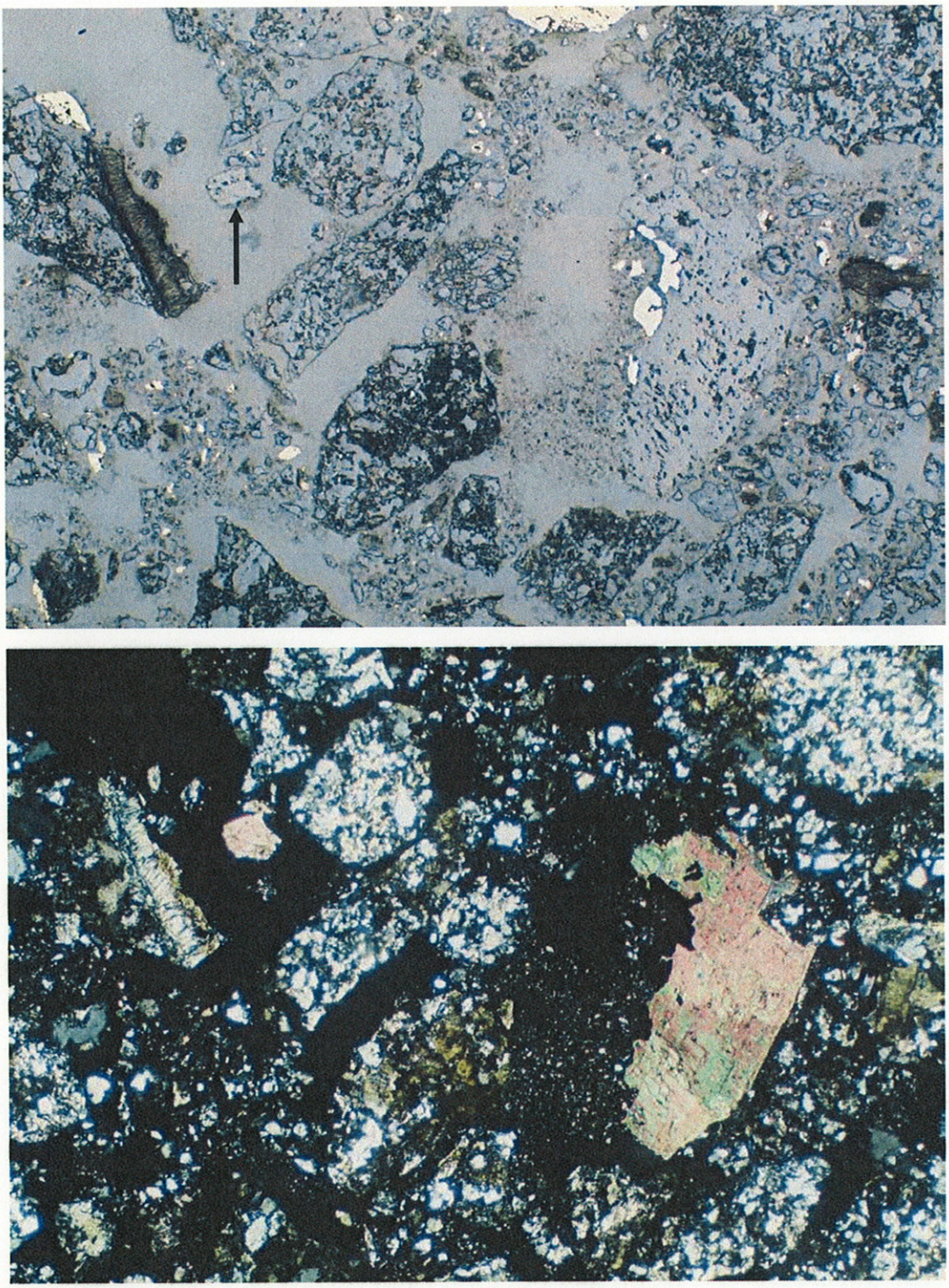


Figure 11. Hornfels VR91306A in plain reflected light (top) and in transmitted light with crossed polarizers (bottom), width of field 2.6 mm. In the upper photo, whitish grains in the left half are chalcopyrite; the arrow points to a grain of liberated dolomite, and immediately to its left is a blackish veinlet of chlorite. The large white grains to the right of center are pyrite attached to a coarse grain of dolomite whose large size is evident in the lower photo. EDS spectra for the dolomite and chlorite are given in Appendix 2.

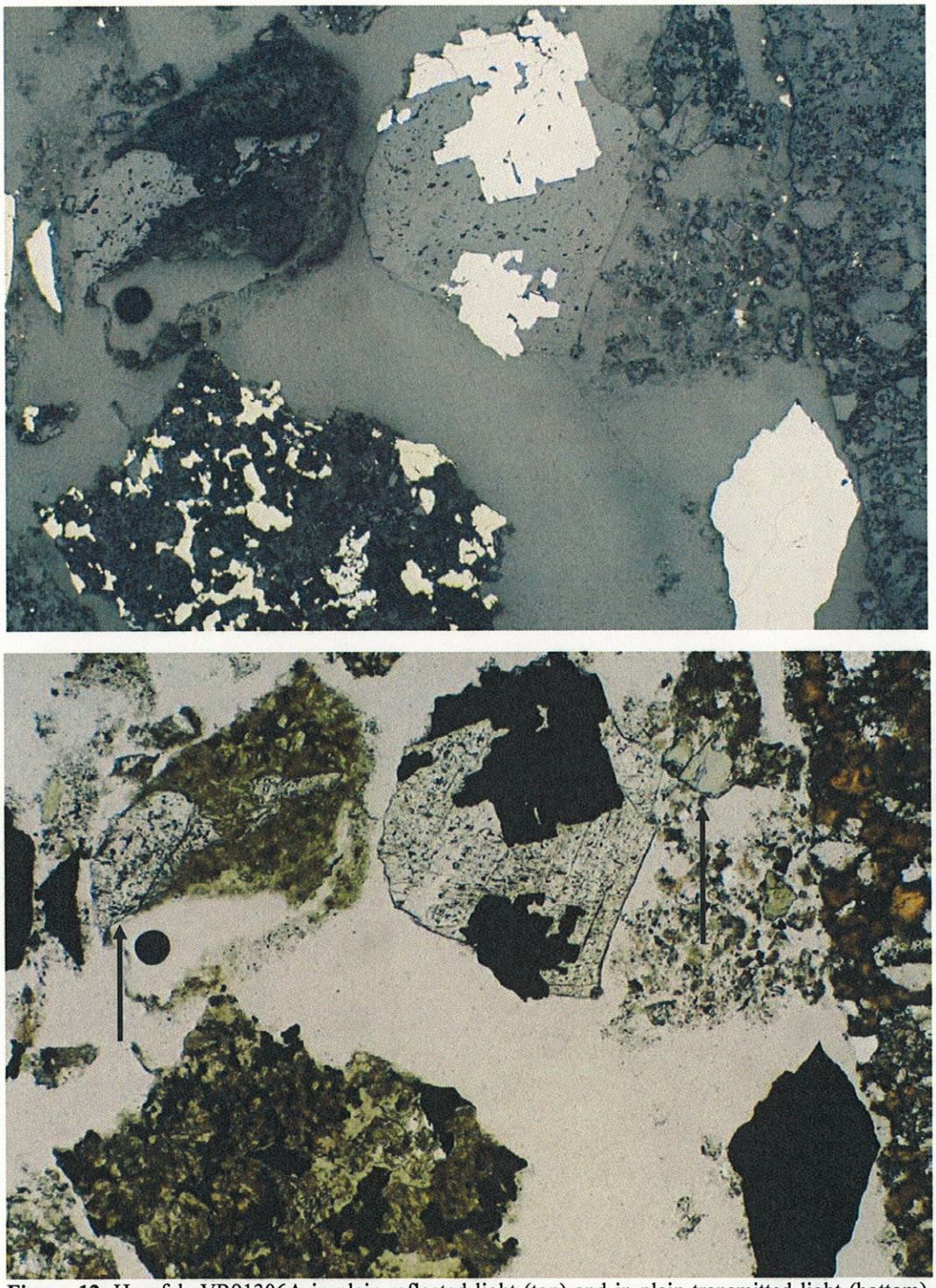


Figure 12. Hornfels VR91306A in plain reflected light (top) and in plain transmitted light (bottom), width of field 5.1 mm; the same field is shown in the upper photo of Figure 13. The sulfide in the chip at the bottom left is chalcopyrite, and the large white grains are pyrite. The pyrite above center is in dolomite; the arrow on the left points to dolomite with associated fine-grained chlorite (see Fig. 13), and the arrow on the right points to coarse-grained chlorite. The brownish, turbid color of the chip whose edge extends from the top to the bottom of the right margin of the photo is typical for this sample of hornfels.

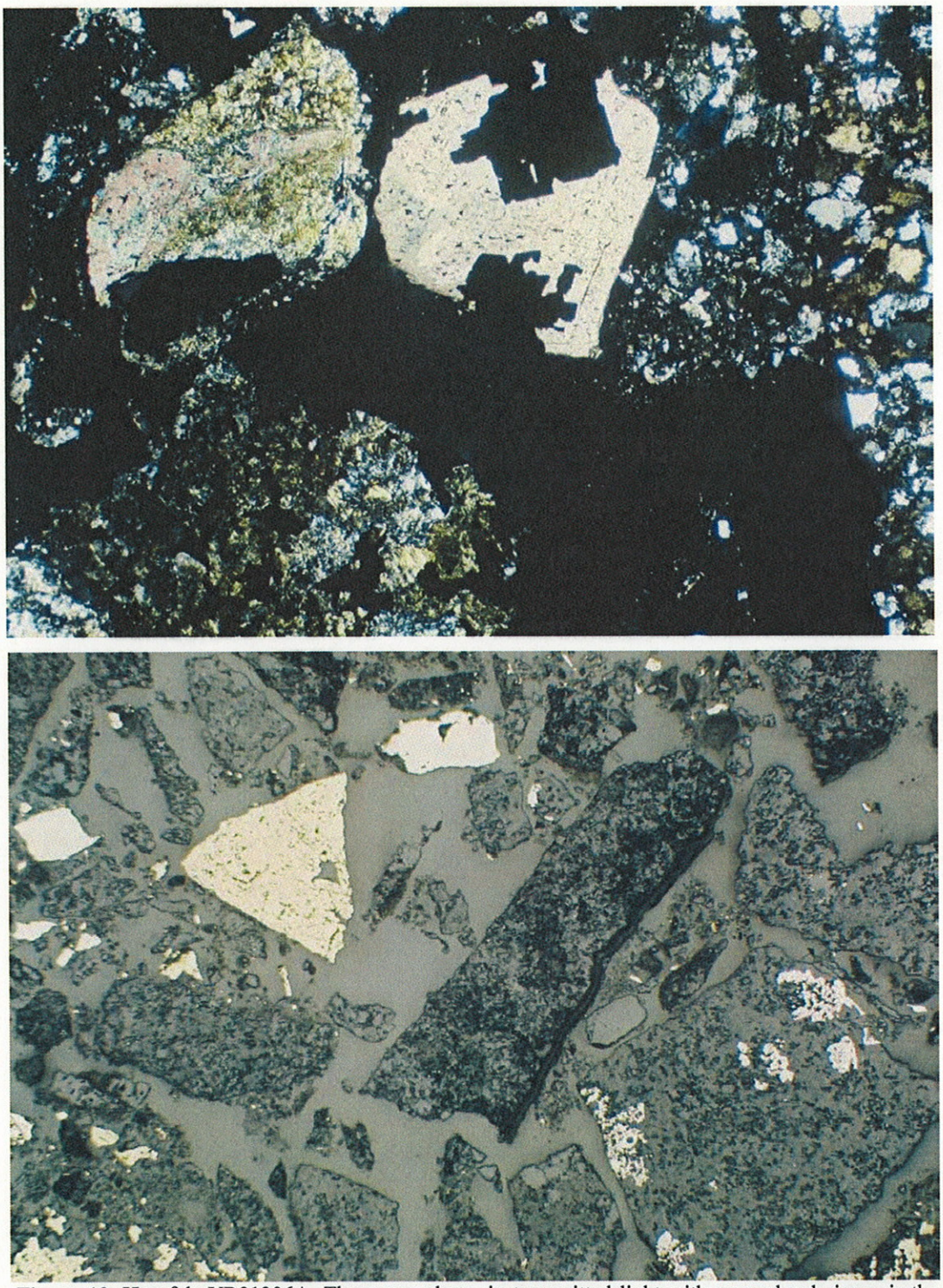


Figure 13. Hornfels VR91306A. The upper photo, in transmitted light with crossed polarizers, is the continuation of Figure 12, showing coarse-grained dolomite above center and, on the left, in association with fine-grained chlorite. The lower photo, in plain reflected light, width of field 2.6 mm, shows to the left of center a large, triangular grain of liberated chalcopyrite with adjacent white grains of liberated pyrite. The chip at the lower right shows the typical fine-grained aggregates of pyrite that occur within the hornfels.

Sample VR71275A

The core, reported to be of pyroxenite (Table 1), is slightly greenish and equigranular, with apparent grain sizes in the 1 5 mm range. One end of the core may have a poorly developed, rough fracture surface, but the other is clearly a random, non-planar break. No carbonates were detected at the core ends. Disseminated sulfides occur throughout the core length.

The chips in the crushed sample are irregular to equant and seem to be uniformly representative of the mass. A random split was taken and was further crushed for the preparation of the optical section. The section contains >100 chips, all of which are <2 mm across. Most are megascopically slightly brownish and translucent, a few are poorly translucent to opaque, and one of the larger chips in the section is of pyrite. Other than that chip, however, the sulfides are sub-millimetric and sparse, and their abundance was estimated to be 0.3%.

Microscopic examination revealed that the poorly translucent chips are of siltstone, which is texturally uniformly massive and varies from pyrrhotite-bearing to sulfide-barren (Fig. 14). The pyrrhotite occurs as anhedral grains or irregular aggregates, 30 to 300 μm across, with one of the larger or two of the smaller occurrences per chip.

The pyroxenite contains major amounts of clinopyroxene and small amounts of orthopyroxene, accompanied by minor amounts of plagioclase. The quantitative mineralogy is given in Table 7. The clinopyroxene is the coarser grained of the two pyroxenes; the largest clinopyroxene is a prismatic grain ~0.8 × 3 mm, whereas the largest orthopyroxene is about half that size. The orthopyroxene has been the more susceptible to alteration, and much of the talc in the sample occurs as fine-grained alteration rims, veinlets, and complete replacements of the orthopyroxene. Plagioclase varies from fresh to partly altered, the latter mainly network veins of a low-birefringence mineral that is probably chlorite. Brown amphibole occurs among the interstices of pyroxene aggregates, and as a replacement of the pyroxene. Accessory mica occurs

Table 7. Quantitative mineralogy of VR71275A

wt%				
	quartz	2.1	talc	43.1
	plagioclase	7.0	chlorite	6.4
	amphibole	7.6	lizardite	1.7
	clinopyroxene	28.1	pyrrhotite	0.3
	enstatite	3.5	pentlandite	0.3

as reddish brown biotite (phlogopite), and only a trace of micaceous alteration ('sericitization') of the plagioclase is present. The mica content is too low for detection in the X-ray study.

The opaque-mineral assemblage is complex. The principal non-sulfide opaque mineral is ilmenite, and only a trace amount of magnetite was observed; abundances of both, however, are too low to be detectable in the X-ray diffractogram. The sulfides consist of pyrite (including the megascopically identified chip), chalcopyrite, pyrrhotite, marcasite, pentlandite, and a trace of what is thought to be cubanite. The marcasite occurs as microcrystalline aggregates that form particles containing numerous oriented voids or inclusions (Fig. 15). Also evident in one aggregate is coarser grained pyrite whose appearance suggests possible co-crystallization with the marcasite. The fine grain size and the pervasive and numerous aligned voids are combined features that are characteristic of marcasite derived by alteration of precursor pyrrhotite. The marcasite is associated with the pyroxenite chips, and none occurs in the siltstone. The sulfide in the siltstone is pyrrhotite, whereas nearly all of the pyrrhotite in the pyroxenites has been converted to marcasite, but with pentlandite unaffected.

The estimated relative abundance of the sulfides is marcasite > chalcopyrite > pentlandite > pyrite > pyrrhotite. The megascopic estimate of 0.3% sulfides is low; the optical examination suggests a higher value, perhaps 0.6%, which is still lower than the bulk-sample chemical value of 0.99 wt% S (Table 1).

Although no carbonate minerals were observed during the optical examination, a subsequent application of alizarin solution to a portion of the unmounted crushed sample revealed the presence of sub-millimetric calcite veinlets in two of the chips. The calcite was identified by its red stain rather than from effervescence. Application of 15% HNO_3 to the sample resulted in immediate and vigorous effervescence from the two veinlets. As well, four other chips were observed to effervesce, but it was uncertain whether the source was calcite or dolomite.

The measured NP of the bulk sample is 24.6 (Table 1). The sample does not contain olivine and has little serpentine (Table 7), thus suggesting that a significant portion of the NP is carbonate-sourced. However, the low C_{total} (Table 1) does not support the suggestion.

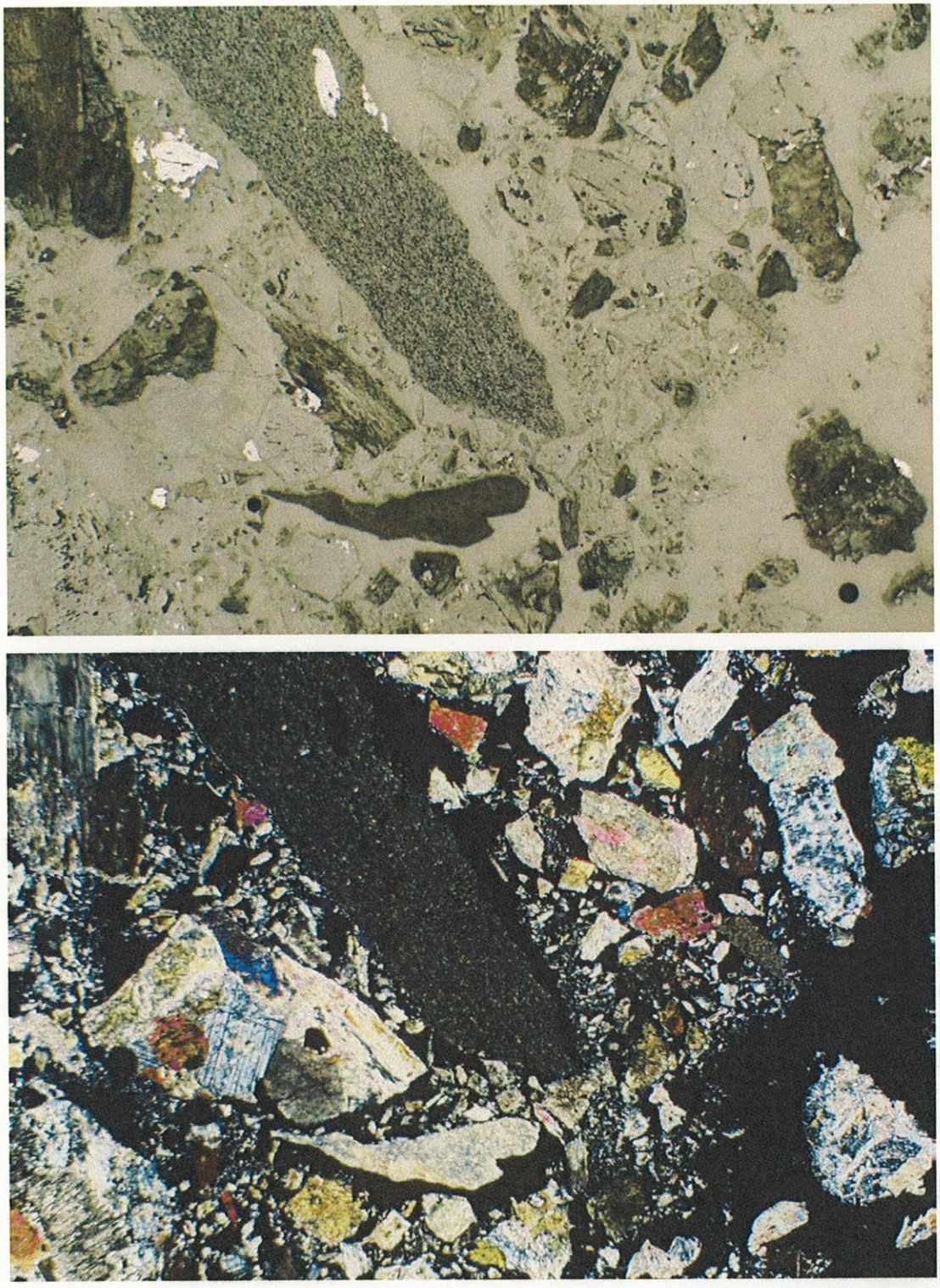


Figure 14. Sample VR71275A in plain reflected light (top) and in same field in transmitted light with crossed polarizers (bottom), width of field 5.1 mm. The elongate, fine-grained chip trending northwest is siltstone with pyrrhotite (white). In the lower photo, the gray twinned grain slightly below mid-height on the left is plagioclase, and the bright variegated particles are talc.

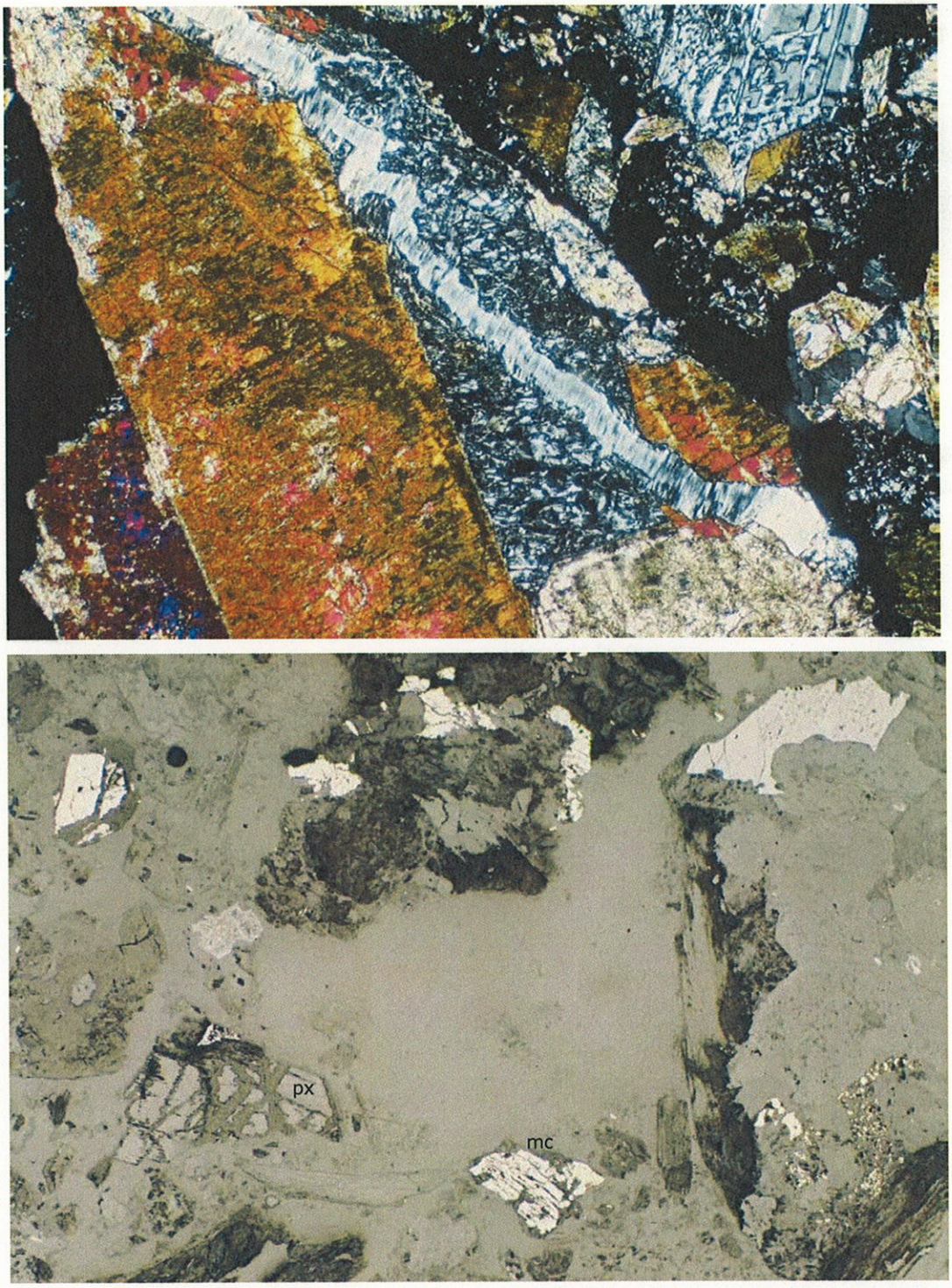


Figure 15. Sample VR71275A. The upper photo, in transmitted light with crossed polarizers, width of field 5.1 mm, shows a large prismatic clinopyroxene grain on the left, and adjacent on the right is chlorite cut by a cross-fiber veinlet, also of chlorite. At the top right is plagioclase veined by chlorite. In the lower photo in plain reflected light, width of field 2.6 mm, the whitish particle at the top right is ilmenite, the whitish particle below center is marcasite (**mc**), and to its left is veined orthopyroxene (**px**).

Sample VR91267A

Crushed sample VR91267A, which is classified as peridotite (Table 1), was noted to be similar in appearance to that of the preceding sample of pyroxenite. However, the core of the peridotite sample is the darker of the two, and even though the size of the coarsest grains in both seems to be alike megascopically, the peridotite has less color contrast among the minerals and therefore gives the impression of being the finer grained. Pyrrhotite ± chalcopyrite occurs as sparingly disseminated grains that are up to 2 × 5 mm, and one segmented particle is ~2½ × 8 mm. A poorly visible, pale greenish, irregular and ramifying veinlet, variable from 1 to 3 mm in width and probably consisting largely of serpentine or chlorite, cuts the core almost perpendicular to the elongation. One portion within the veinlet, about ½ mm wide and 7 mm long, consists solidly of calcite; otherwise, however, calcite is erratic and sparse within the remainder of the veinlet, and only a trace of calcite was detected in the remainder of the host peridotite.

The optical section contains >100 chips, all of which are <2 mm across. Megascopically visible sulfide grains span the size range of the chips. Viewed microscopically in transmitted light, a notable feature is the higher content of plagioclase relative to that in preceding pyroxenite VR71275A. The grain-size difference from that of VR71275 is indistinct except that plagioclase is locally coarser, and one of the observed laths is 1.7 mm long. The rock consists largely of clinopyroxene, plagioclase, and chlorite (Table 8). The presence of 1% olivine in the X-ray quantitative mineralogy is at marginal detection limits because of the complexity of the X-ray diffractogram, and no olivine was observed in the optical section. Orthopyroxene is present in only small amounts because most has been extensively altered (Fig. 16), and the mineral was not detected in the X-ray pattern. Because of its low olivine content, the rock is perhaps more appropriately grouped with pyroxenite rather than with peridotite.

Table 8. Quantitative mineralogy of VR91267A

wt%				
	quartz	1.9	chlorite	26.5
	plagioclase	20.0	talc	6.3
	biotite	6.7	lizardite	3.8
	amphibole	6.5	pyrrhotite	3.8
	clinopyroxene	21.5	ilmenite	2.1
	olivine	1.0		

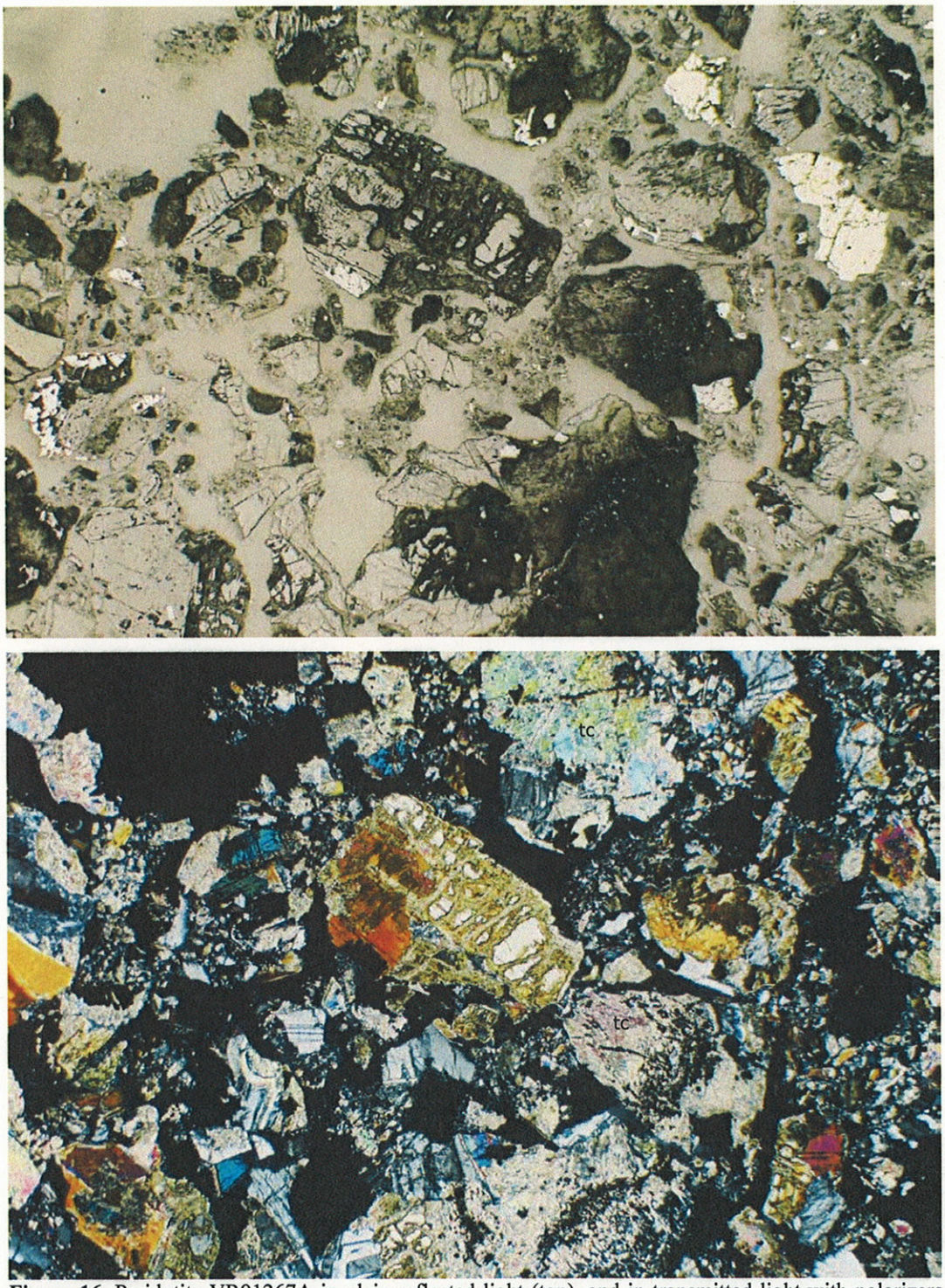


Figure 16. Peridotite VR91267A in plain reflected light (top), and in transmitted light with polarizers crossed, width of field 5.1 mm. Near the center is a veined, largely replaced stubby prism of orthopyroxene; the attached high-reflectance grain (upper photo) is magnetite with laths of ilmenite, and the large whitish grains at the upper right corner and at the extreme left are pyrrhotite. In the lower photo, the brownish mineral associated with the orthopyroxene is amphibole, the gray-to-white grains with lamellar twinning are plagioclase, the solidly bright blue grains are clinopyroxene, and the variegate grains are talc (**tc**).

Only one monomineralic carbonate grain, a liberated cleavage fragment about 230 μm along an edge, was observed in the section. A small chip of chlorite contains a cluster of several grains of carbonate, the largest 150 × 250 μm. Tests with alizarin solution indicated the liberated grain and the cluster to be dolomite, thus contrasting with the presence of veinlet calcite observed in the core.

The sulfides in the section occur both as liberated grains and as intergrowths within the pyroxenite. The largest sulfide grain, almost 1 mm across, consists of chalcopyrite and lesser pyrrhotite, with the two in a simple 'mutual boundary' contact; the pyrrhotite contains traces of replacement marcasite. Other grains vary from pyrrhotite–pentlandite–chalcopyrite intergrowths to liberated monomineralic pyrrhotite and chalcopyrite; pentlandite, however, typically occurs as middlings with pyrrhotite. A few grains contain laths or rods of chalcopyrite in pyrrhotite; the texture is identical to that shown in Figure 8 of Part 1. The sulfide relative proportions in the section are pyrrhotite > chalcopyrite > pentlandite. The sulfides are unevenly distributed, and some fields of view in the section are almost sulfide-barren whereas others have percentage amounts. The average content was estimated to be ≥1%.

The measured NP of the sample is 22.2 (Table 1), which indicates that a significant proportion of the NP must be present as carbonates. Testing of a portion of the unmounted crushed material by the application of alizarin solution did not give an observable reaction. However, upon the addition of 15% HNO_3, three areas gave a slow effervescence, which is typical of the reaction from dolomite rather than calcite. Two of the areas continued to effervesce, without exhaustion, for several minutes, suggesting that the dolomite particles were not minute.

Sample VR71373A

Unlike all preceding cores, which are quarters, sample VR71373A is a half core, ~63 mm in diameter. The sample is of 'mineralized peridotite', and the megascopic appearance is like that of pyroxenite VR712754A. The sulfide content is about 5% and is predominantly pyrrhotite, apparently with pentlandite > chalcopyrite. The bulk of the sulfides occurs as large (2 3 mm) equant to elongate particles evenly distributed throughout the rock. No fractures are evident.

The optical section contains >50 chips, the largest ~2½ × 4 mm. Many of the chips consist solely of sulfides, and megascopically visible sulfide fines bring the total content of these minerals to percentage amounts. Microscopic examination revealed that pyrrhotite > chalcopyrite > pentlandite, but all three are abundant. Marcasite is common but not as widespread; it appears to have formed locally as partial to rarely complete replacements of pyrrhotite (Fig. 17). The partial replacements are invariably concentrated at the margins of the pyrrhotite, and in some cases the marcasite projects into the surrounding silicates as sawtooth-like, extremely fine-grained, fibrous crystals. Trace amounts of pyrite occur as subhedral grains and aggregates within pyrrhotite and within marcasite (Fig. 17). One chip consists largely of two, almost-touching, elongate segments of homogeneous pyrite whose combined large size, 0.26 × 1 mm, is unusual; the pyrite seems to have been part of a veinlet, but the texture is not definitive. Primary magnetite and ilmenite are present, but ilmenite is predominant among the coarser, equant-type grains whereas the content of magnetite is supplemented by thread-like grains that accompany serpentine in altered olivine (Table 9). Textures of the sulfides vary from monomineralic and liberated, to variously intergrown (Fig. 18), depending mainly on the extent to which the particle had been crushed.

The host rock was optically identified as containing major amounts of olivine, plagioclase, and clinopyroxene, among which olivine is the most extensively altered. Plagioclase is almost fresh, but all olivine has been at least partly altered to a mesh texture in which the veinlets are of serpentine and threads of magnetite within the serpentine (Figs. 18, 19). Although a few pseudomorphs after olivine are present, serpentinization seems not to have progressed beyond mesh-texture development; rather, local overprinting by chloritization of the partly serpentinized olivine has produced the pseudomorphs, hence accounting for the lack of a gradation from mesh textures to total serpentinization. Chlorite and talc occur abundantly as late-stage minerals. Brown amphibole and biotite are commonly associated with plagioclase–

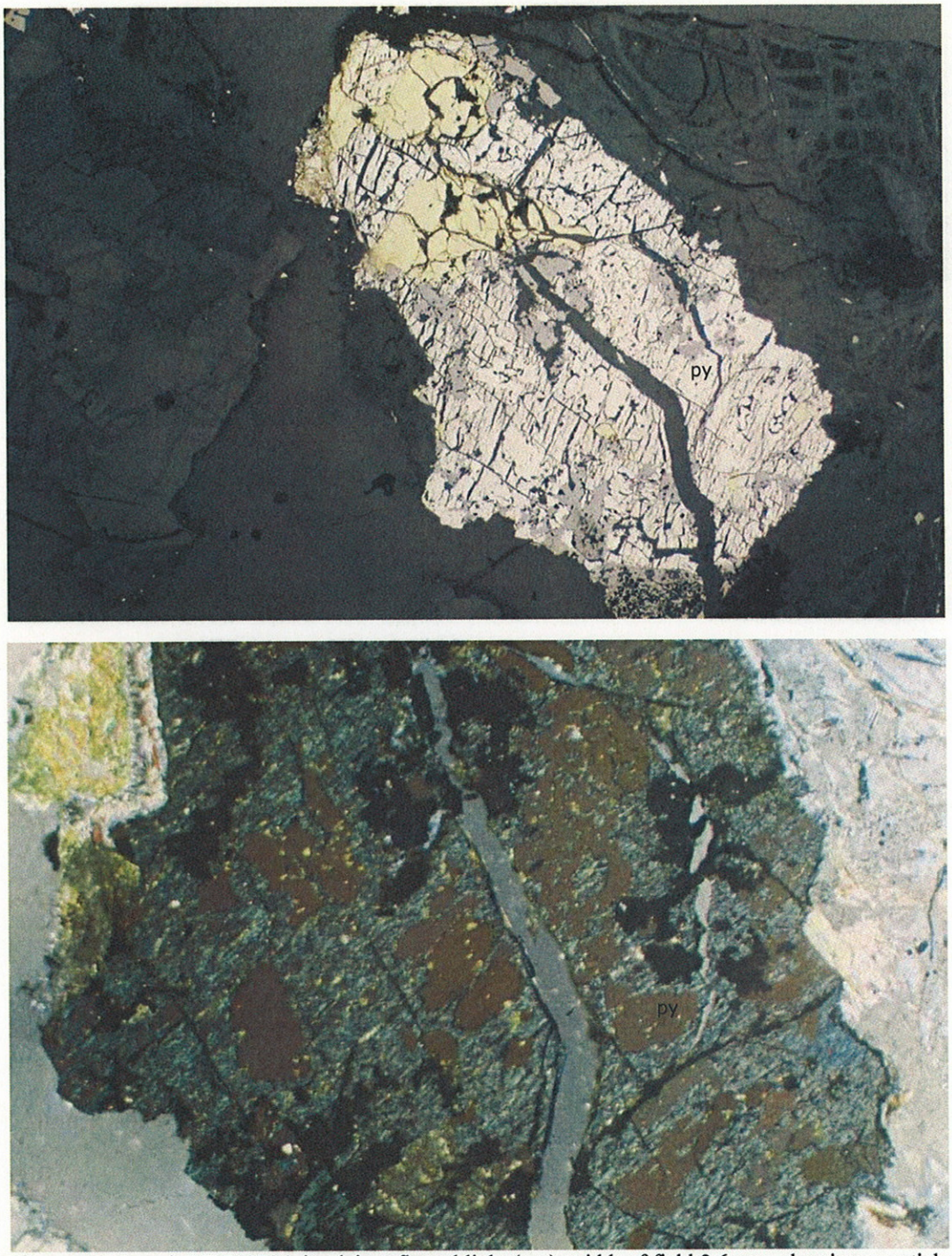


Figure 17. Sample VR71373A in plain reflected light (top), width of field 2.6 mm, showing a particle interpreted to be a pseudomorph after pyrrhotite. The yellow mineral is chalcopyrite, and the main white with parallel cracks is marcasite, within which are smooth white grains of pyrite (**PY**). The gray mineral is magnetite, and the slightly brownish gray grains to the right of chalcopyrite at the top are ilmenite; the black 'veinlets' are epoxy-filled cracks. The lower photo is the same area at higher magnification (width of field 1.25 mm) and slightly rotated clockwise; **PY** is the same grain as labelled in the upper photo. The strongly anisotropic, finely polycrystalline matrix is marcasite, and the black grains are magnetite.

Table 9. Quantitative mineralogy of peridotite sample VR71373A

wt%	quartz	1.7	talc	7.6
	olivine	8.8	lizardite	3.3
	clinopyroxene	14.0	magnetite	5.9
	plagioclase	13.8	ilmenite	1.5
	amphibole	6.4	pyrrhotite	5.6
	biotite	4.6	pentlandite	1.6
	chlorite	22.8	dolomite	2.5

clinopyroxene intergrowths (Fig. 19), and orthopyroxene prisms, which have been particularly susceptible to replacement by talc, are insufficiently abundant to have been included in the quantitative mineralogy (Table 9). The X-ray data indicate that the serpentine mineral is lizardite, and no asbestiform serpentine was observed either macroscopically or microscopically.

Only two grains of carbonates were observed in the optical section, and both have a distinct association in that they occur as the infill of chlorite-lined vugs. One of the grains is about 100 μm across, but the other approximates 1 mm. Testing of the carbonates with alizarin solution showed the mineral to be calcite (Fig. 20). The occurrences indicate that the calcite is part of the peridotite assemblage rather than related to later veining.

In subsequent testing of a portion of the crushed sample, no reaction was observed upon the application of alizarin solution. With 15% HNO_3, however, several areas effervesced slowly to rapidly. The results suggested that both dolomite and calcite were present, but the lack of persistence of the effervescence is likely an indication that the grains were small and were rapidly consumed. The 2.5% dolomite reported in the quantitative mineralogy (Table 9) is too high relative to the content of carbonates observed in the optical section, but the detection of dolomite further suggests that two carbonate minerals are present in the bulk sample.

The measured NP value of 32.4 is the highest in the ten-sample suite. A substantial portion of the NP is attributable to the presence of olivine and serpentine; the C_{total} of 0.06 wt% (Table 1) indicates a supplementary contribution of NP by carbonate minerals whose chemically measured magnitude of abundance is in accord with the microscopic and megascopic observations.

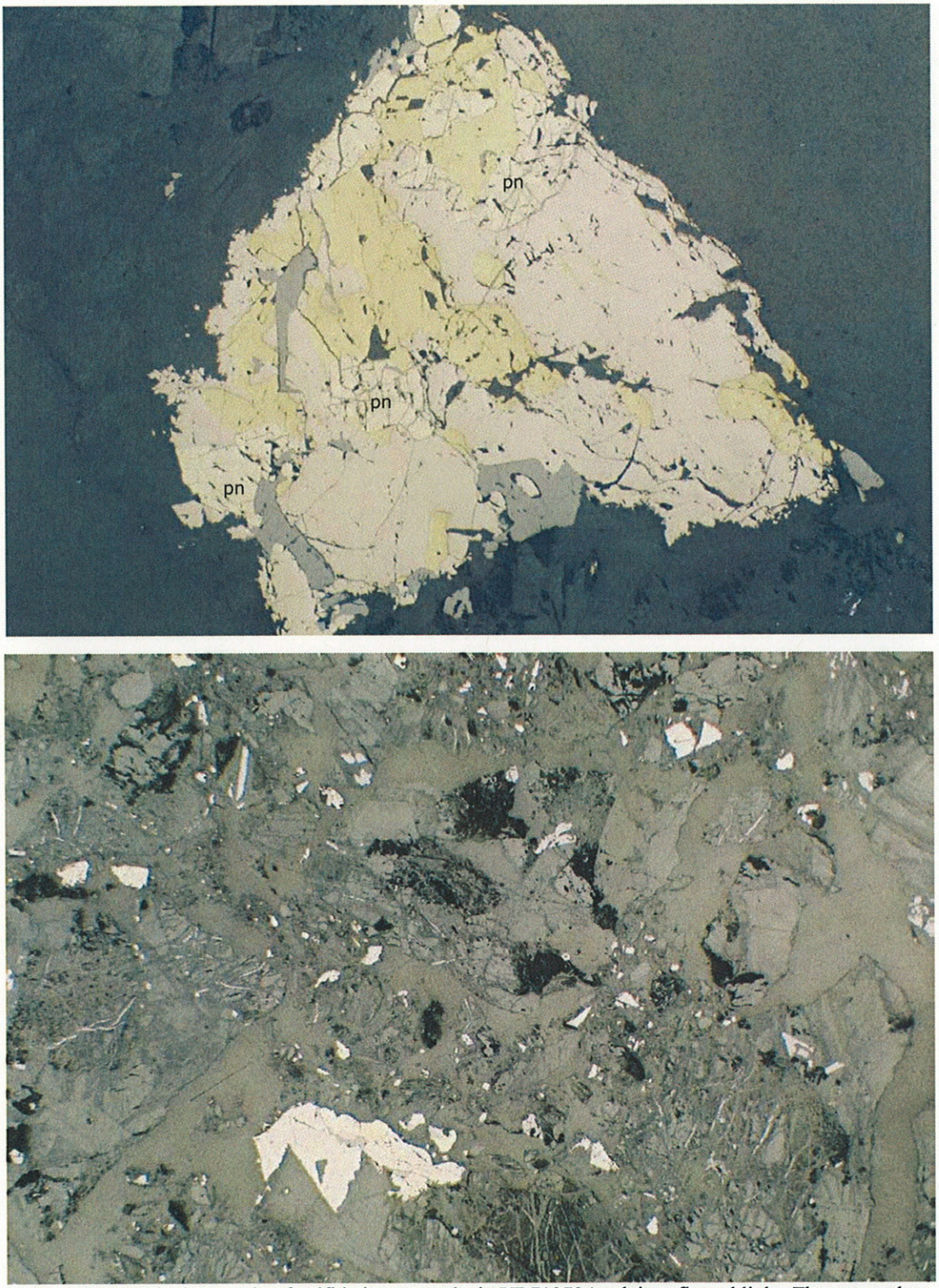


Figure 18. A typical example of sulfide intergrowths in VR71373A, plain reflected light. The upper photo (width of field 2.6 mm) shows yellow chalcopyrite, slightly pinkish pyrrhotite, pentlandite (**pn**), and grayish ilmenite. The lower photo (width of field 5.1 mm) shows mainly whitish pyrrhotite. Olivine is identifiable by the presence of whitish, thread-like grains of magnetite associated with serpentinization. Figure 19 is the same field of view in transmitted light.

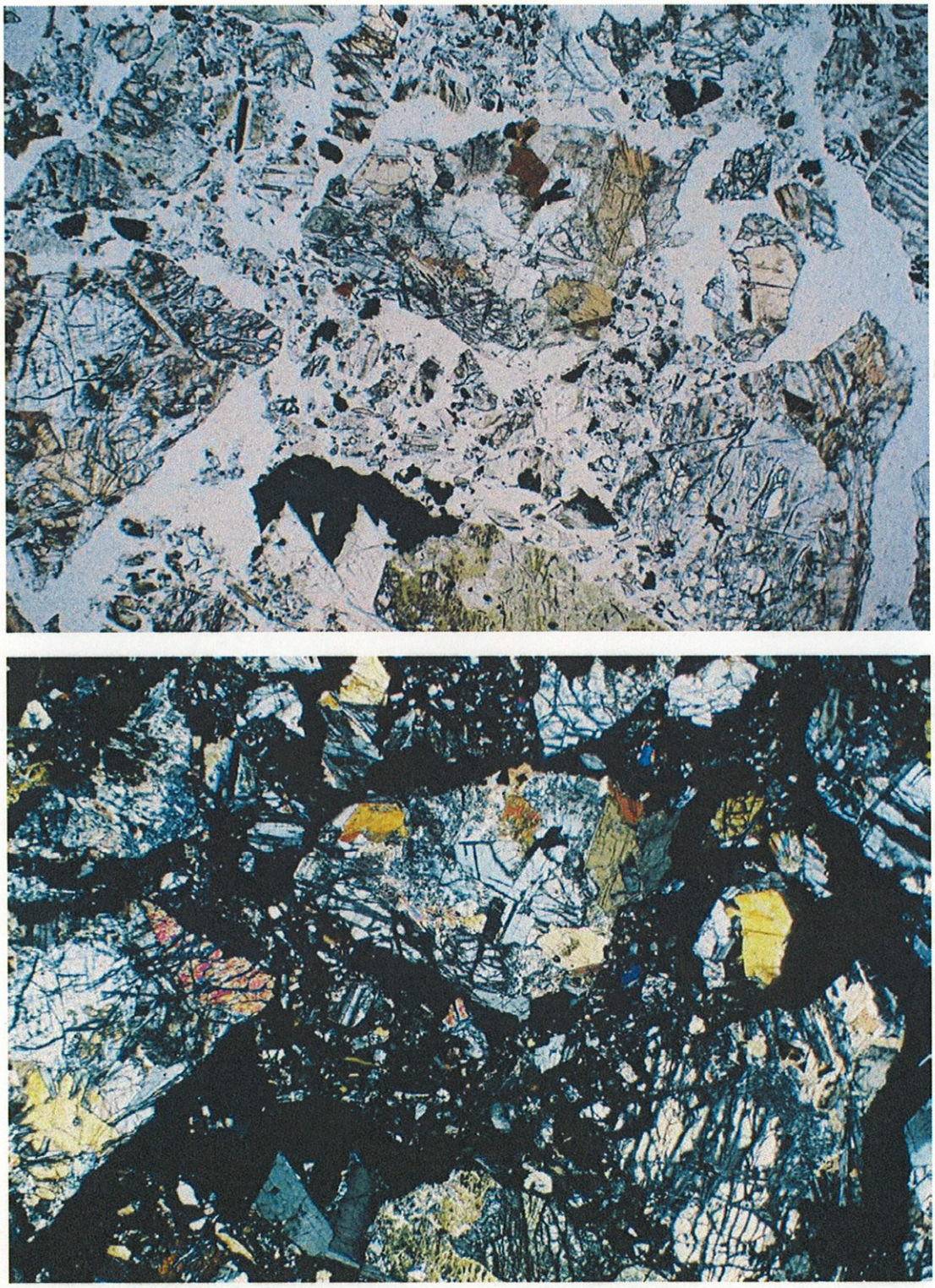


Figure 19. VR71373A in plain transmitted light (top), and with polarizers crossed (bottom), showing the same field of view as in the lower photo of Figure 18. In the upper photo, the brownish grains on the right of the chip slightly above center are amphibole, and to their left the associated gray, twinned grains (lower photo) are plagioclase.

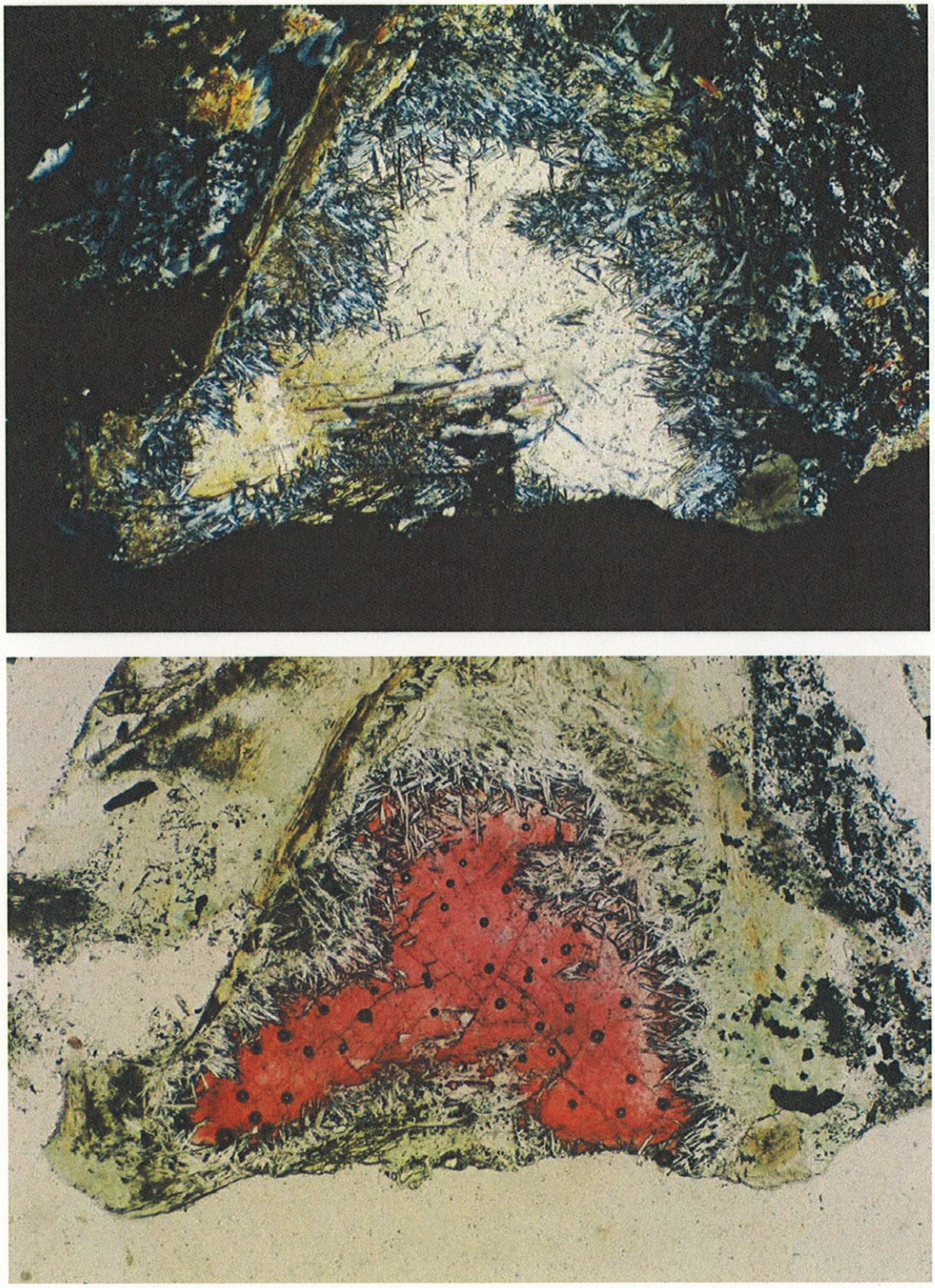


Figure 20. Sample VR71373A in transmitted light, width of field 2.6 mm. Upper photo, with polarizers crossed, shows acicular to lath-like chlorite projecting into a former vug infilled with calcite. The lower photo, in plain light, shows the distinct effect of alizarin solution, which stains the calcite to a vivid red

Sample VR90181A

The sample is a cut half-core of massive sulfide in which at least three sulfide minerals are present and are taken to be pyrrhotite, chalcopyrite, and pentlandite, with pyrrhotite predominant and the other two in percentage amounts. The sulfides have a chaotic, brecciated appearance, with some centimeters-size pyrrhotite-dominant fragments apparently cemented by chalcopyrite–pentlandite; in contrast, other fragments are of mixed sulfides and have at least a partial pyrrhotite-rich rim, thus suggesting that reversals occurred in the order of sulfide crystallization. One end of the core is a random break, but the other end is a rough fracture surface at a steep angle to the core length. Part of the fracture surface is black and possibly chloritic, and part of the same surface is discontinuously calcite-bearing. Otherwise, however, no calcite was detected in the core.

The crushed material, after further reduction of the size of the chips in a random split, was used for the polished thin section. The section contains >50 chips that are 1 2 mm across, plus abundant finer particles. Nearly all are sulfides and associated magnetite; microscopic examination showed that the non-opaque content is negligible (<0.1%). The sulfide assemblage consists of pyrrhotite > chalcopyrite > pentlandite. No marcasite or pyrite was observed. Textures are relatively simple (Figs. 21, 22). Pentlandite occurs mainly as large homogeneous grains, and although flames of pentlandite in pyrrhotite are present, they account for only a small fraction of a percentage of total pentlandite.

The sample was not subjected to quantitative mineralogical analysis because of the low content of non-opaque minerals. However, the few translucent grains that were observed occurred mainly at the edges of sulfide particles and were tentatively identified to be a carbonate mineral. Testing with 15% HNO_3 gave no reaction, thus suggesting that the veinlets consisted of siderite [$FeCO_3$]. Because siderite had not been identified previously in the Eagle assemblages, five areas were examined by SEM–EDS analysis. All proved to be siderite. The spectra for three of the grains, which illustrate the maximum compositional variation obtained, are shown in Figures 22 and 23. Substitution of Fe by Mg, Mn, and Ca is evident but is not appreciable, and the average composition is well toward that of end-member siderite.

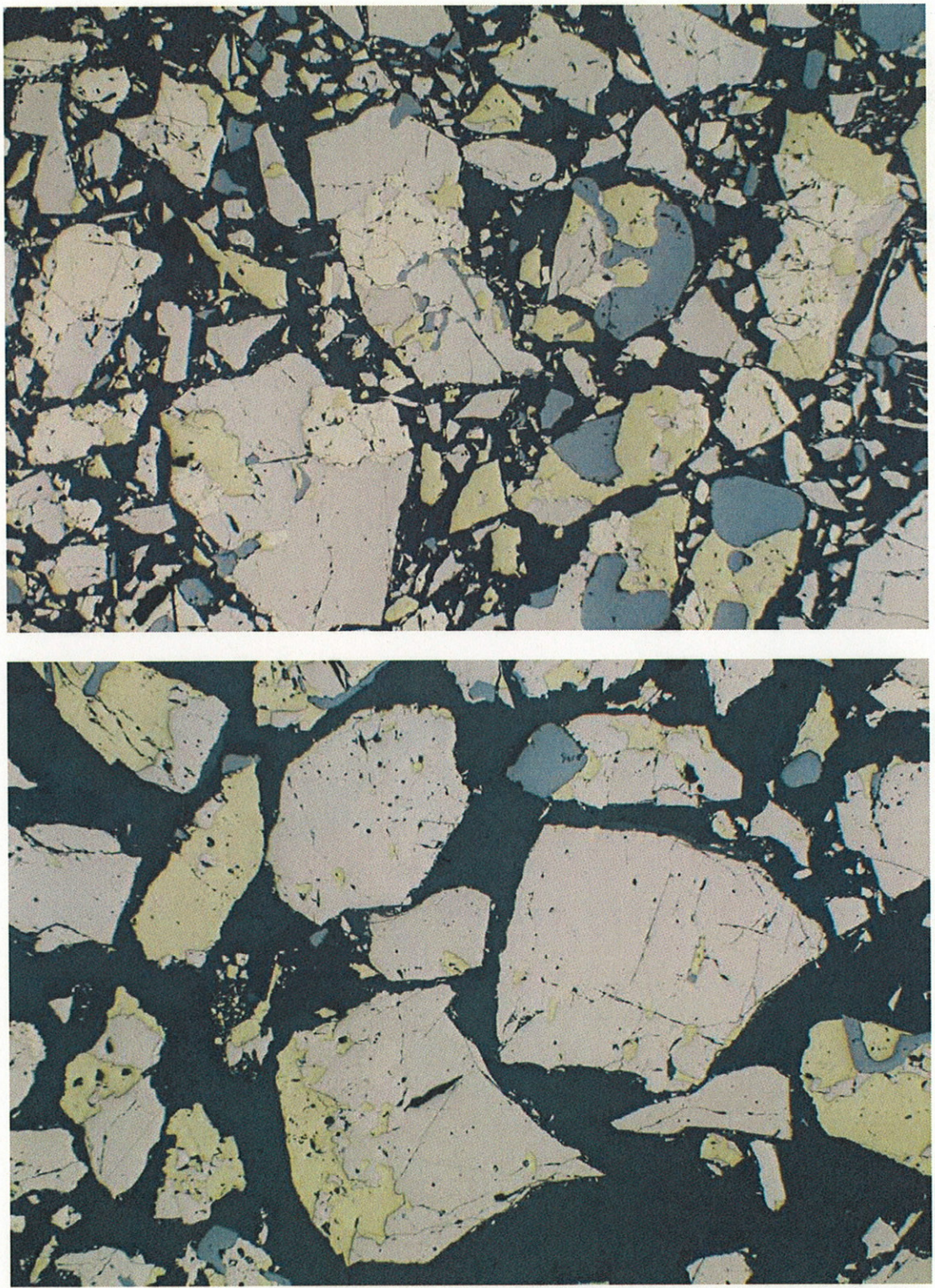


Figure 21. Massive sulfide sample VR90181A in plain reflected light, width of field 5.1 mm. In the upper photo, yellow grains are chalcopyrite, slightly pinkish = pyrrhotite, off-white = pentlandite, gray = magnetite, and no other minerals are present. In the lower photo, the arrows at the bottom right and in the large pyrrhotite grain left of center point to siderite veinlets.

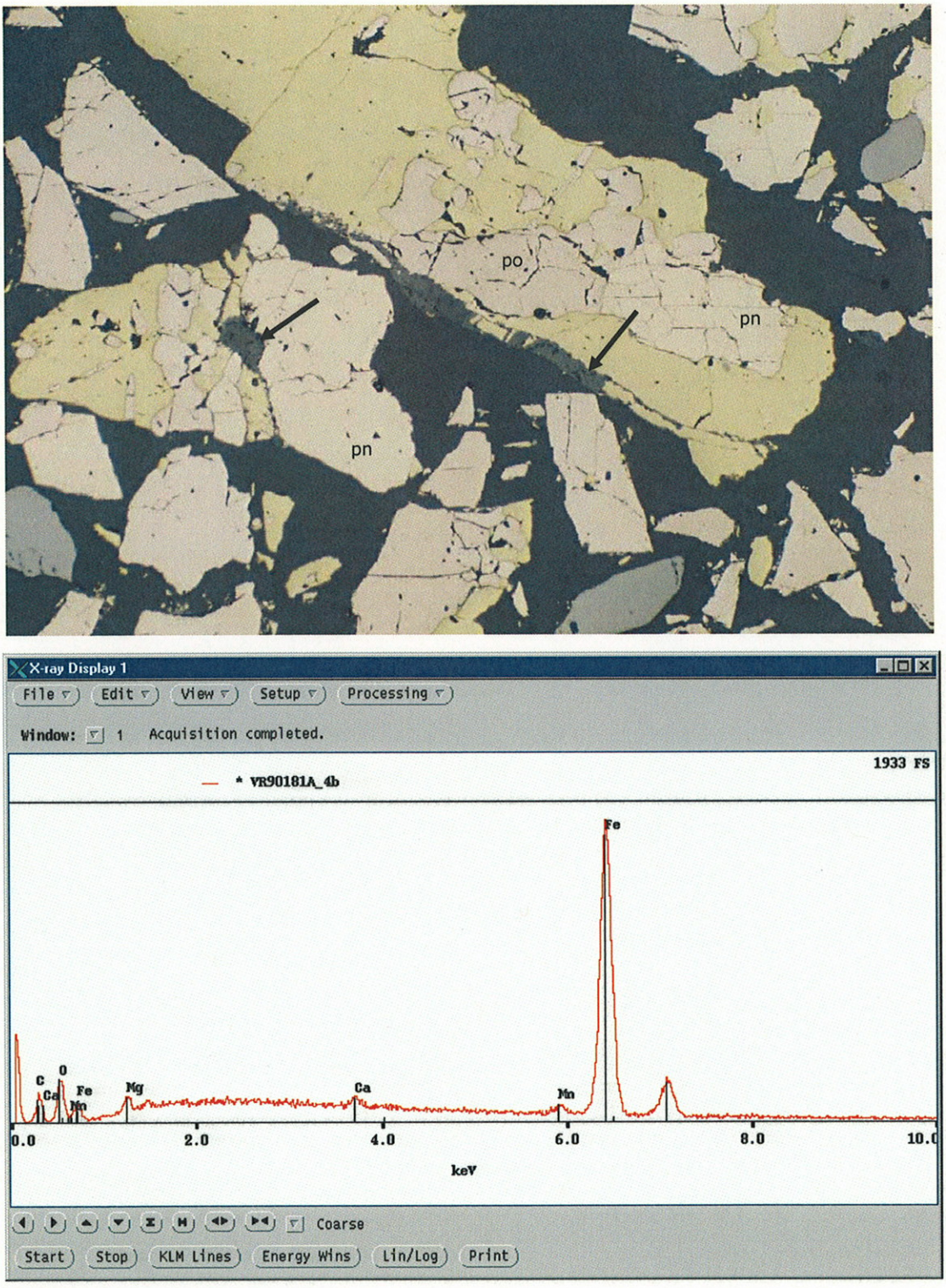


Figure 22. Massive sulfide sample VR90181A in plain reflected light, width of field 2.6 mm; yellow is chalcopyrite, **po** is pyrrhotite, and **pn** is pentlandite. The two arrows point to a grain of siderite and a veinlet of siderite. The EDS spectrum is for the veinlet. The spectrum for the grain is similar to that shown in the lower part of Figure 23.

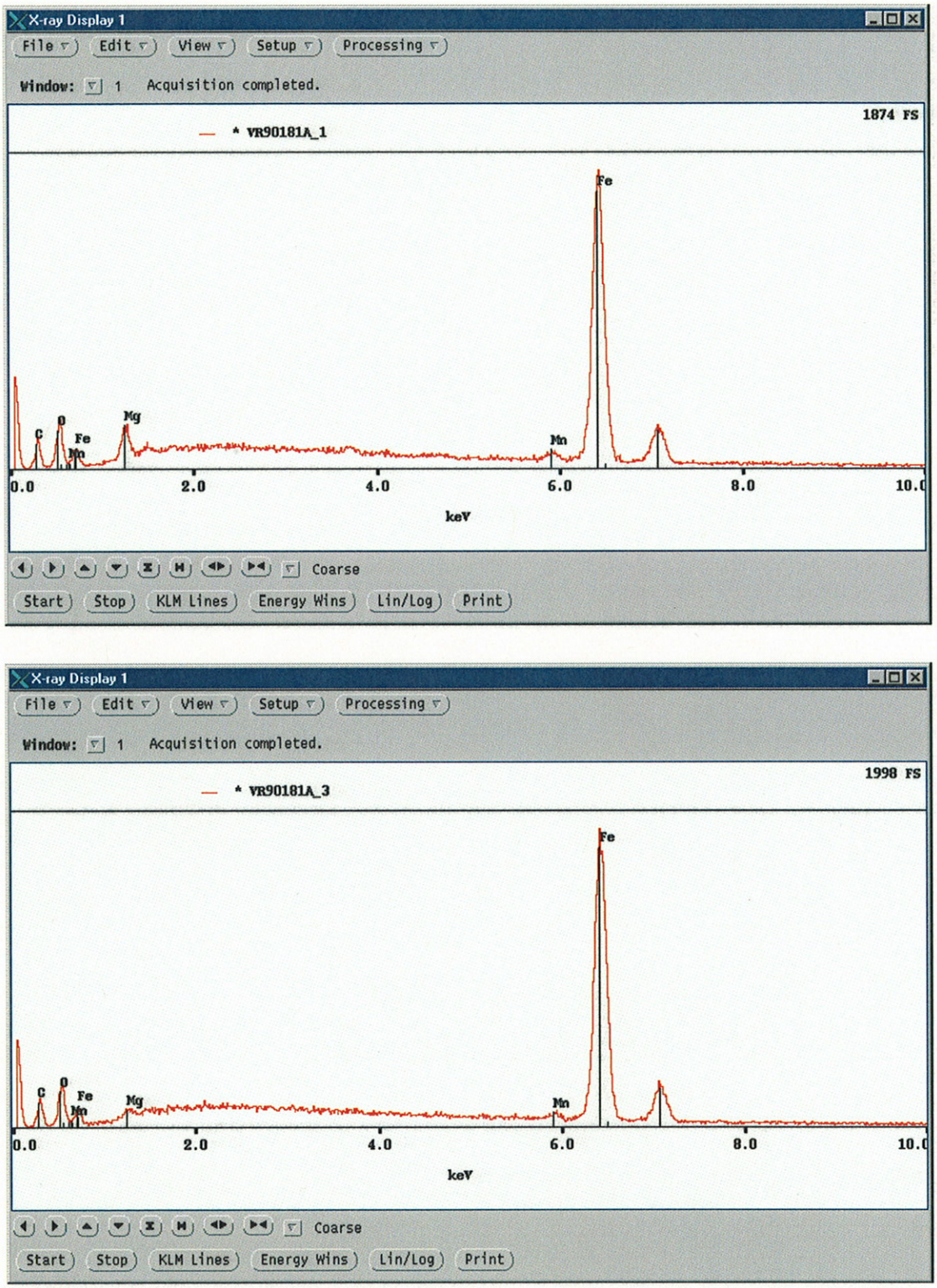


Figure 23. EDS spectra of siderite in VR90181A. The upper spectrum is for the veinlet on the left in the lower photo of Figure 21. The lower spectrum, for an occluded grain in sulfides, shows only traces of Mg and Mn; similar results were obtained for the occluded grain on the left in the photo of Figure 22.

Sample VR90125A

The sample is of semi-massive sulfides, megascopically identified as predominantly of pyrrhotite, with pentlandite and chalcopyrite common but much subordinate in abundance. The cut surface of the half-core shows a fairly uniform distribution of sulfides, whereas at the core exterior there are two slightly finer grained, seemingly mafic-poor areas that are also relatively sulfide-poor. One end of the core is a random break, but the other is a rough, steep-angle fracture along which a small portion is a chloritic or serpentinitic surface. No calcite was detected at the fracture surface or in any part of the core. The crushed sample, after splitting and size reduction, was used for the polished thin section.

The optical section contains >100 chips, the largest ~2 mm across. Microscopic examination showed that, unlike the samples of massive sulfides, silicates predominate and sulfides are subordinate. Pyrrhotite is the most abundant sulfide, but both chalcopyrite and pentlandite are common. A few grains of pyrrhotite contain flames of pentlandite, but quantitatively nearly all pentlandite occurs as anhedral grains, like those of pyrrhotite and chalcopyrite. A few grains of pyrrhotite contain flames and rods of marcasite (Fig. 24), but extensive replacement of pyrrhotite by marcasite of the type illustrated in Figures 15 and 17 is not present, and there is no relationship between flame-like pentlandite and marcasite other than their exclusive occurrence within pyrrhotite. Although several grains of ilmenite were observed, the principal primary oxide is magnetite rather than ilmenite, and one of the magnetite grains is 300 × 550 μm across. Magnetite also occurs as thread-like grains associated with the serpentine alteration of olivine.

The silicate assemblage consists principally of plagioclase, clinopyroxene, olivine, and alteration products (Figs. 25, 26). A few grains of orthopyroxene are present, but are insufficient to have been detected in the quantitative mineralogical analysis. Talc is the most abundant

Table 10. Quantitative mineralogy of semi-massive sulfide sample VR90125A

wt%				
	plagioclase	13.2	talc	20.0
	clinopyroxene	17.6	lizardite	3.1
	olivine	7.4	pyrrhotite	16.2
	amphibole	2.4	pentlandite	4.2
	magnetite	9.7	chalcopyrite	2.7
	biotite	1.5	dolomite	2.0

replacement mineral, and although chlorite is optically evident, the X-ray data indicate that most of the fine-grained alteration products are talc. The seemingly mafic- and sulfide-poor areas noted megascopically are probably of the type illustrated in Figure 25, wherein the assemblage consists chiefly of an intergrowth of clinopyroxene and plagioclase.

A portion of the crushed sample was tested with alizarin solution and then with 15% HNO_3, and with neither was the presence of carbonates detected. Although one carbonate-mineral particle associated with chlorite was observed in the optical section (Fig. 27), all but a minute amount of the bulk-sample NP of 23.9 (Table 1) must be assigned to the silicate assemblage.



Figure 24. Sample VR90125A in plain reflected light, width of field 0.625 mm, showing oriented rods and flames of marcasite (white) within pyrrhotite. The attached sulfide on the left is pentlandite.

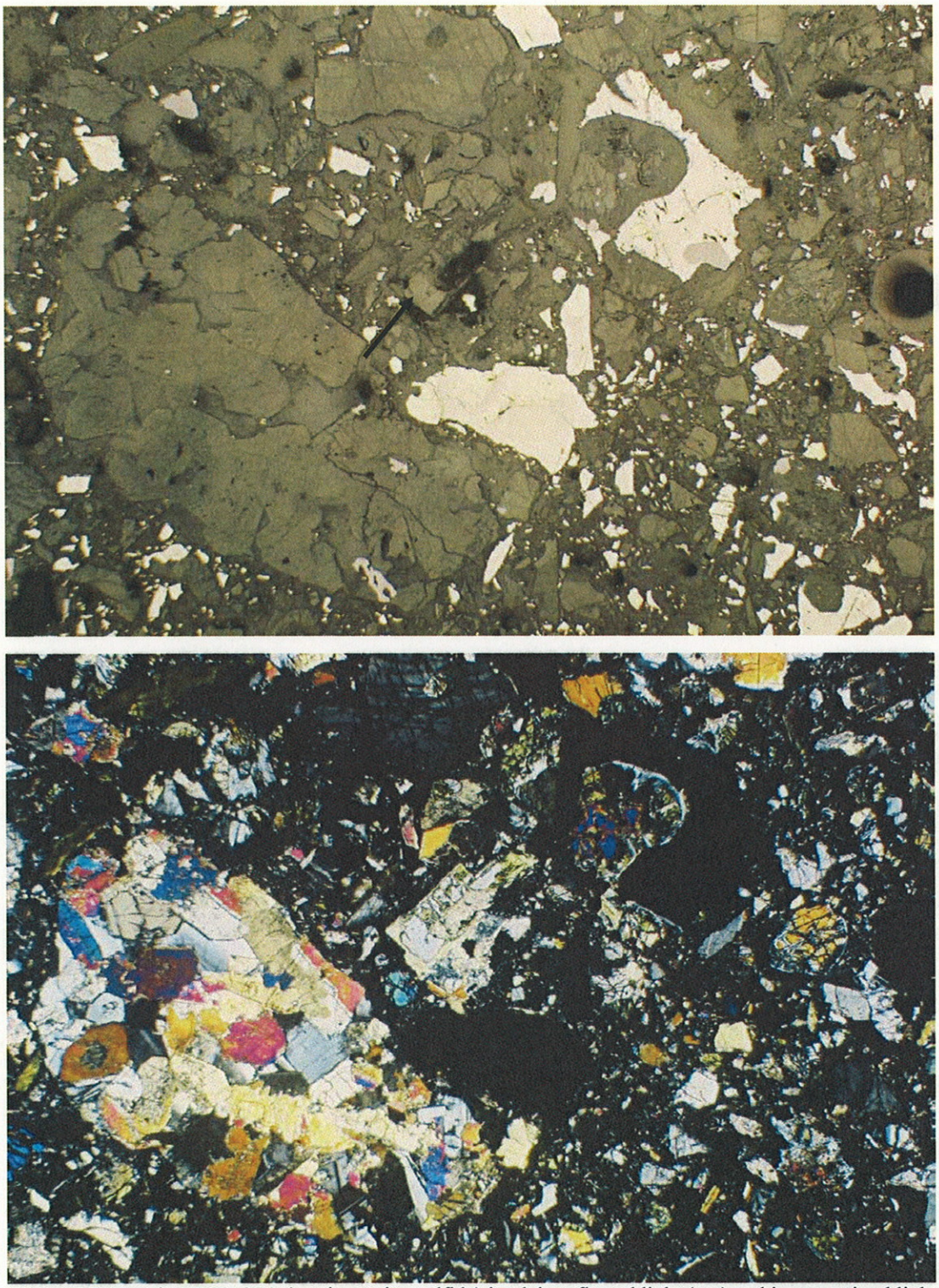


Figure 25. Sample VR90125A (semi-massive sulfide) in plain reflected light (top) and in transmitted light with crossed polarizers (bottom), width of field 5.1 mm. The large sulfide particle slightly below center consists mainly of pyrrhotite and pentlandite, and other whitish grains are mainly pyrrhotite. The left half of the field consists chiefly of a large particle of intergrown clinopyroxene (colored grains, lower photo) and plagioclase (twinned, gray to white). The arrow at the center of the upper photo points to a prismatic grain of orthopyroxene, partly altered to talc.

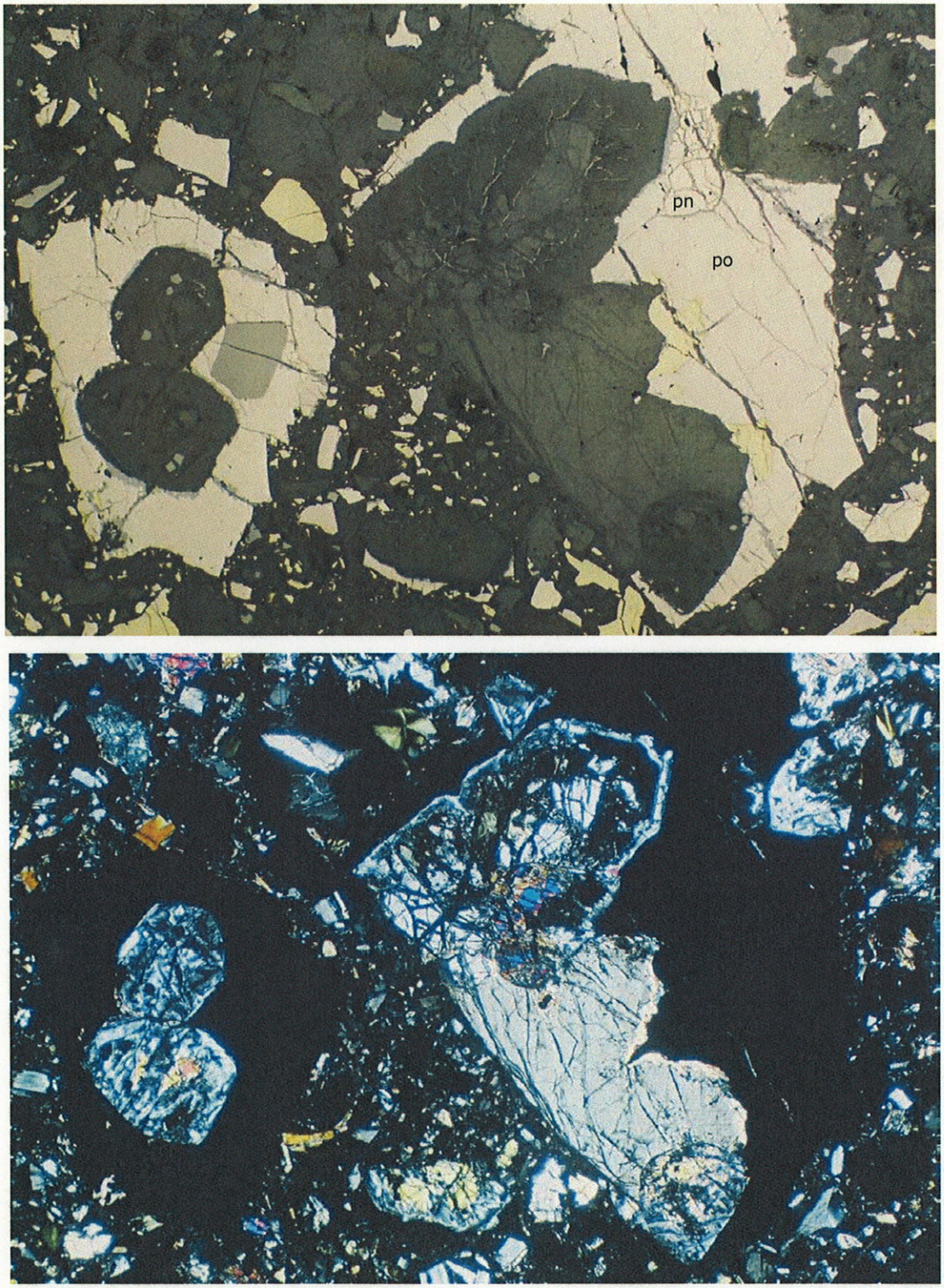


Figure 26. Semi-massive sulfide VR90125A in plain reflected light (top) and in transmitted light with polarizers crossed (bottom), width of field 2.6 mm. The yellow mineral in the upper photo is chalcopyrite, slightly pinkish is pyrrhotite (**po**), and off-white is pentlandite (**pn**). Threads of magnetite to the left of **pn** are in altered olivine, and on the far left are two equant grains of almost completely serpentinized olivine enclosed within pyrrhotite and magnetite.

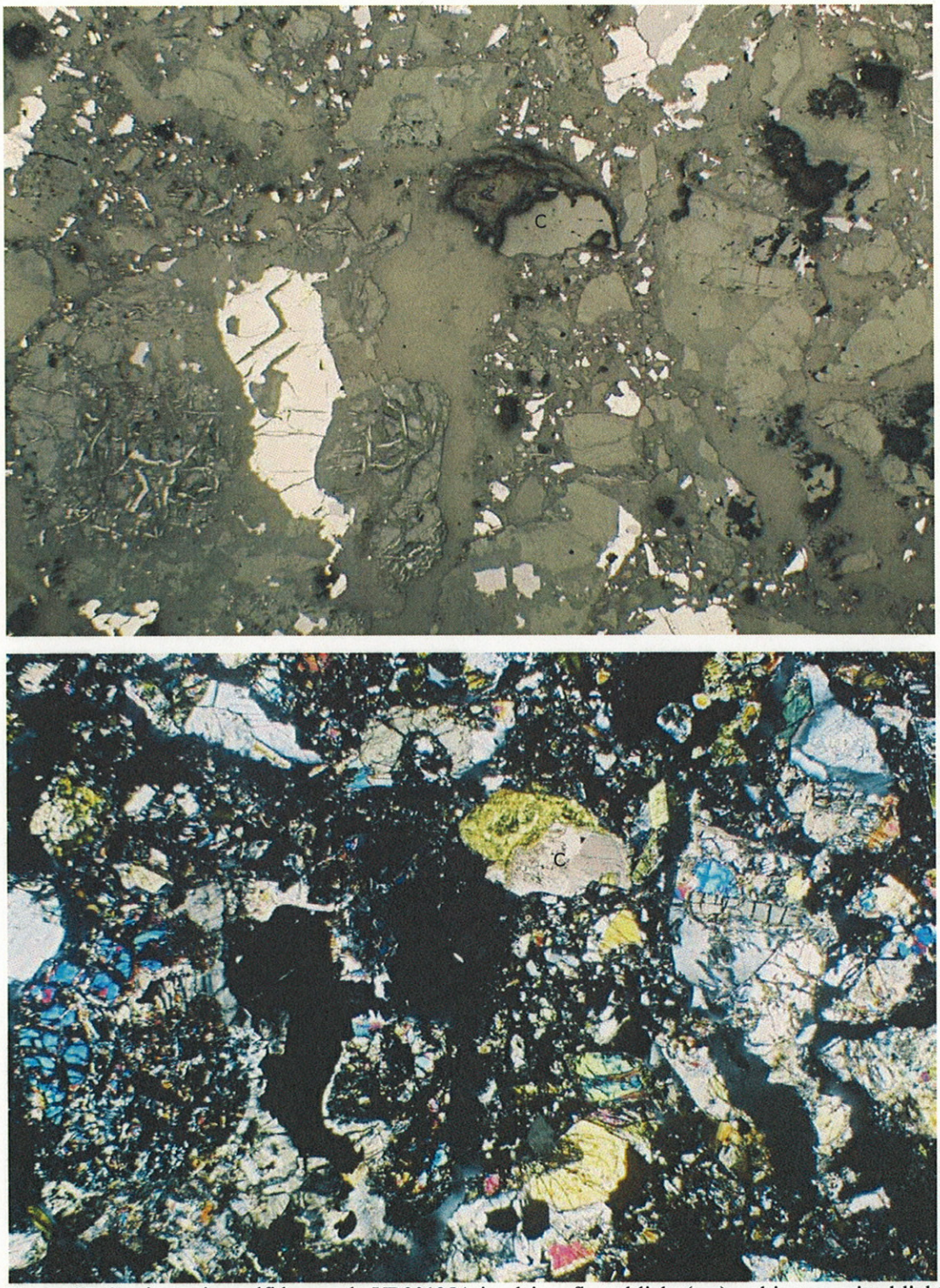


Figure 27. Semi-massive sulfide sample VR90125A in plain reflected light (top) and in transmitted light with crossed polarizers (bottom), width of field 5.1 mm. Most of the white grains in the upper photo are pyrrhotite, and flanking the largest particle (lower left) are threads of magnetite in partly serpentinized olivine. In the lower photo, above and right of center is a yellowish, fine-grained aggregate of chlorite to which is attached a large particle of a carbonate mineral, probably calcite (**C**).

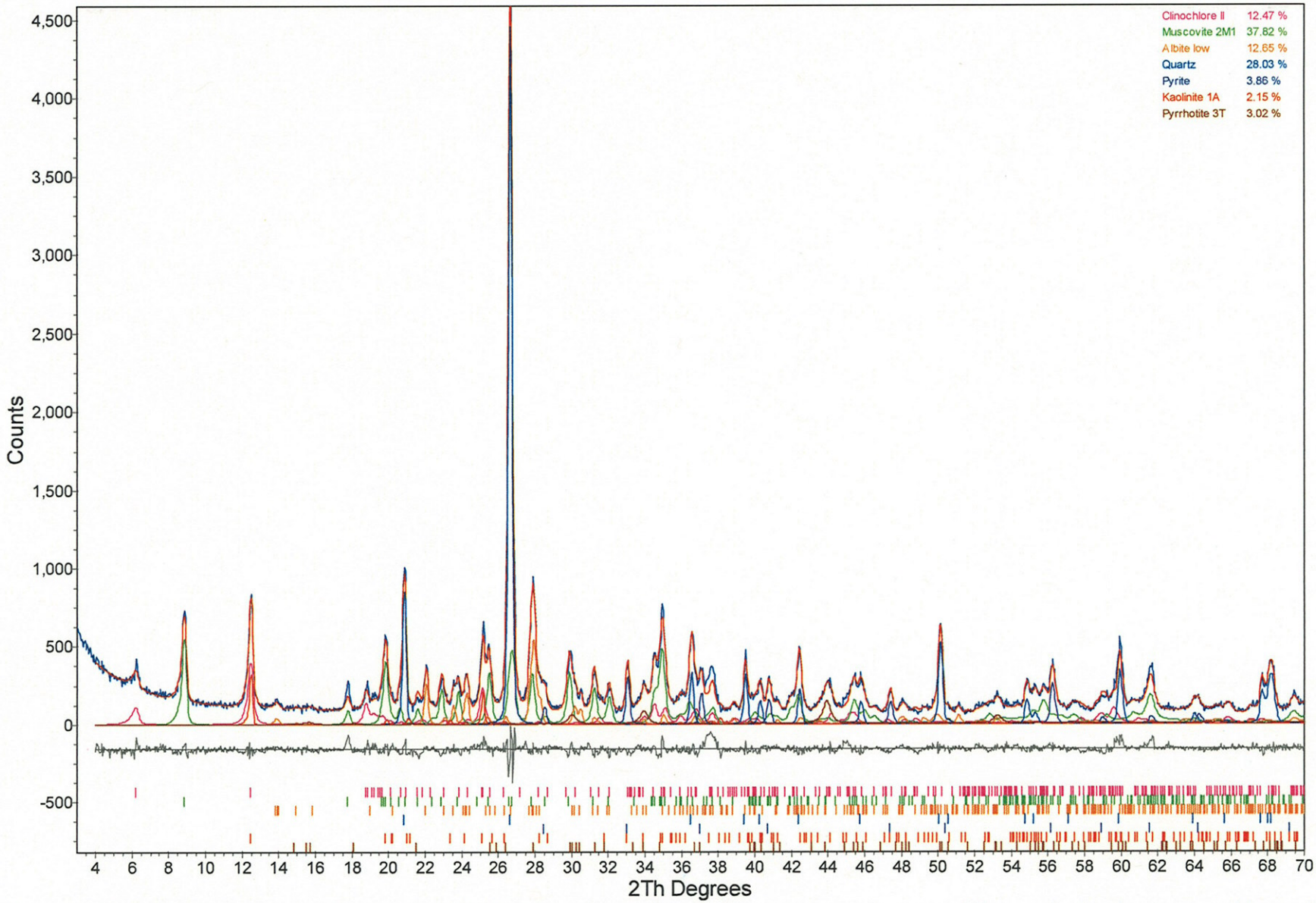


Figure 1. Rietveld refinement plot for sample **VR71100** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

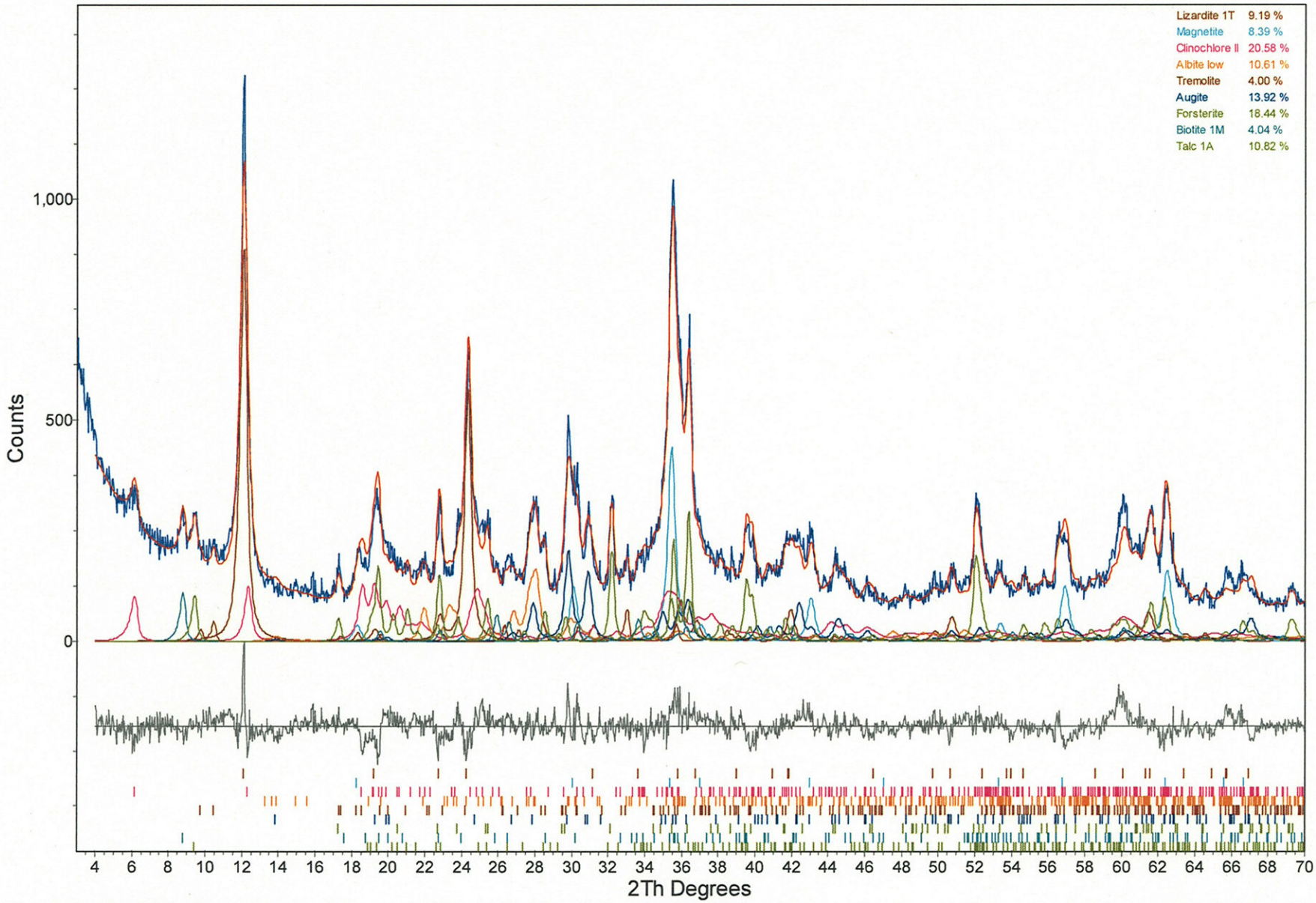


Figure 2. Rietveld refinement plot for sample **VR71213** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

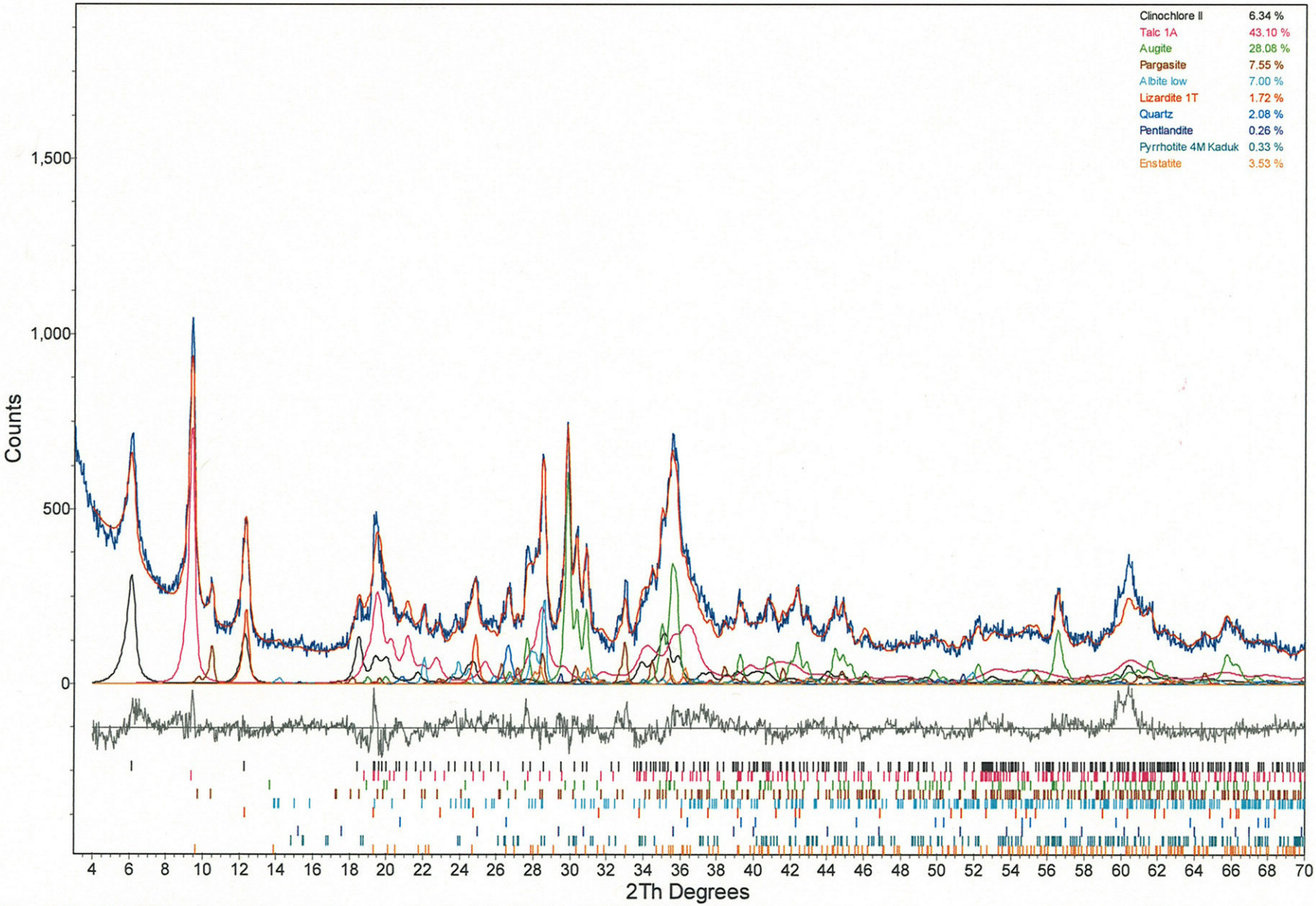


Figure 3. Rietveld refinement plot for sample **CEMI 18782 (VR71275A)** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

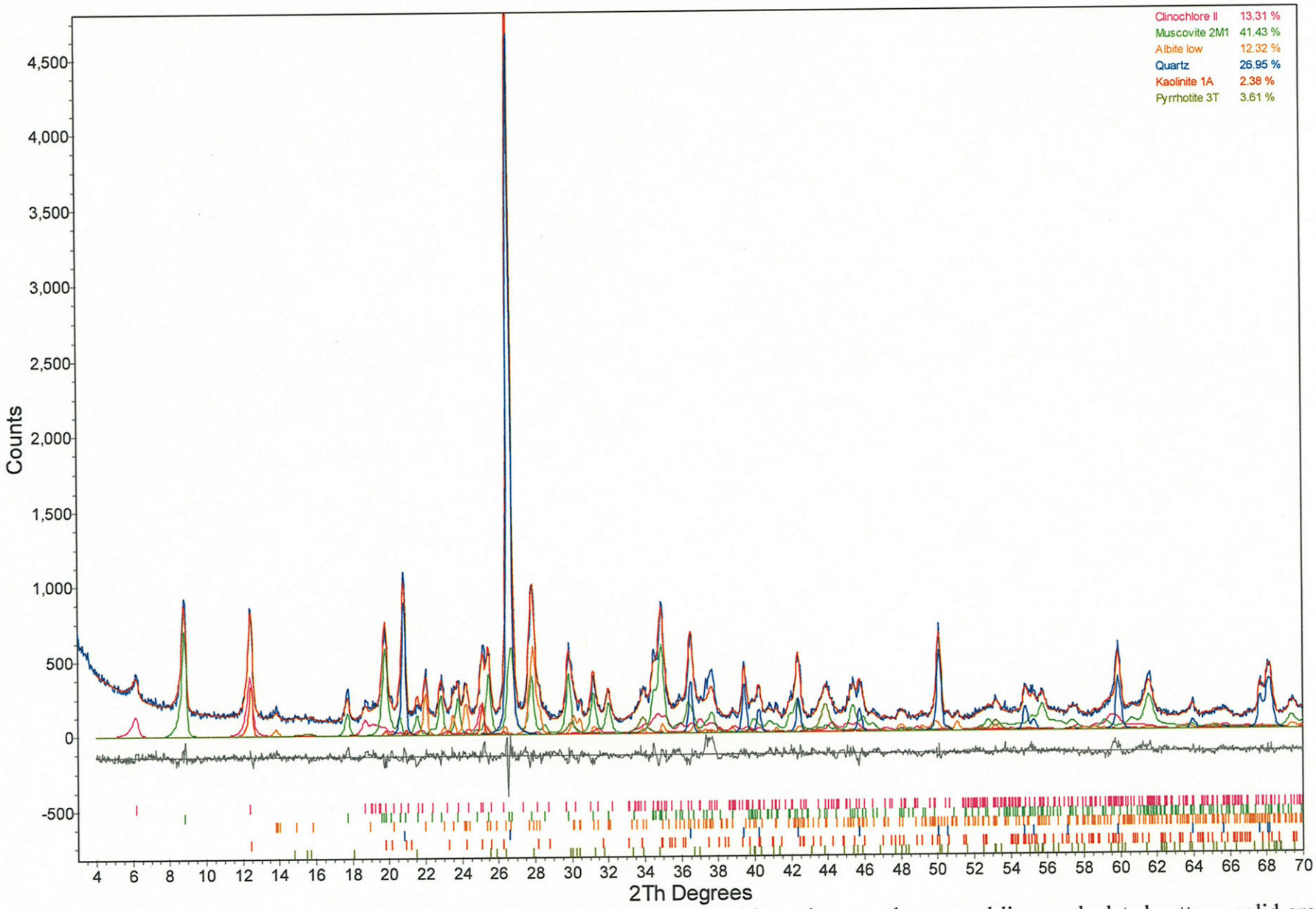


Figure 4. Rietveld refinement plot for sample **VR71499A** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

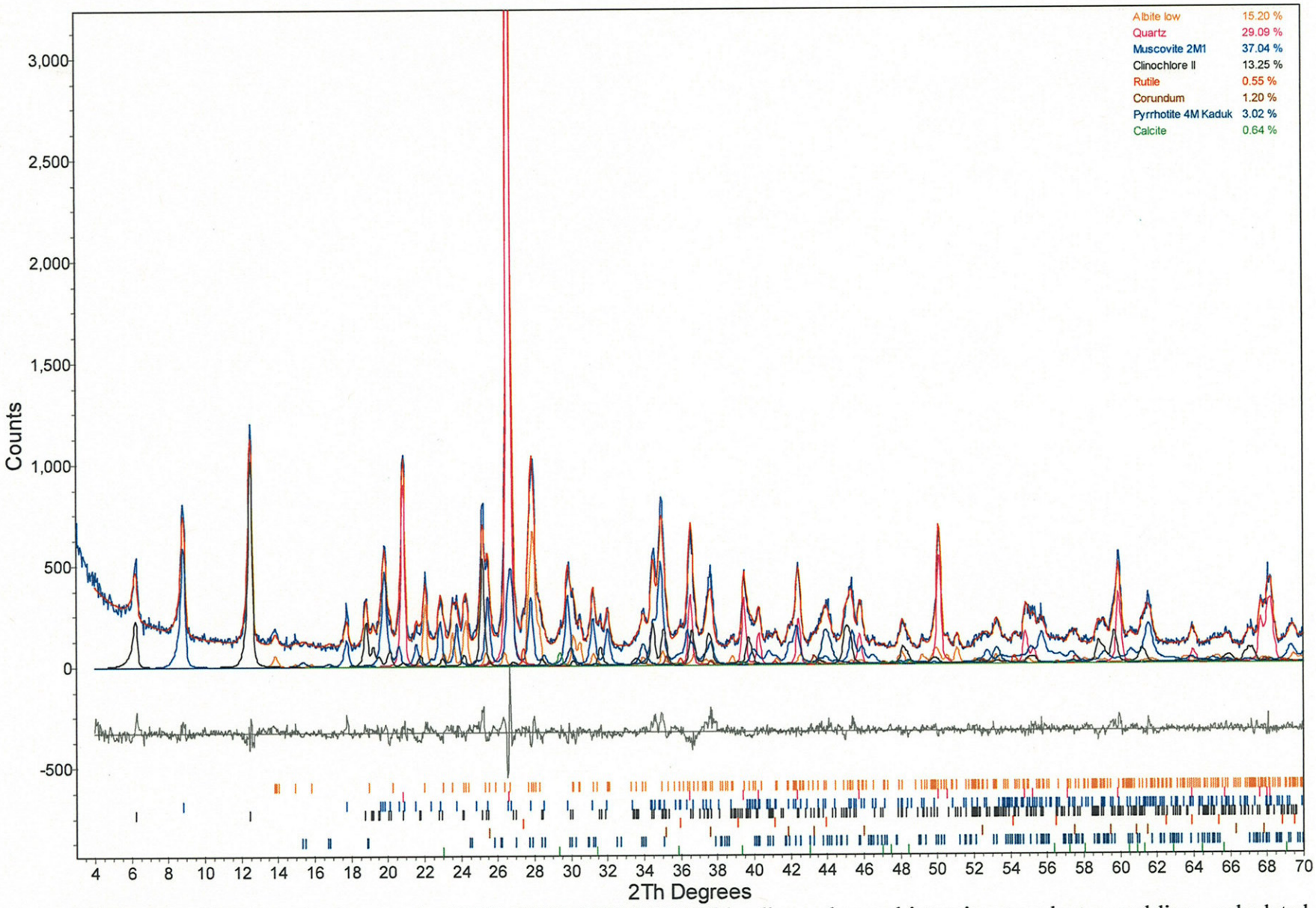


Figure 5. Rietveld refinement plot for sample **CEMI 18789 (VR91625A)** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

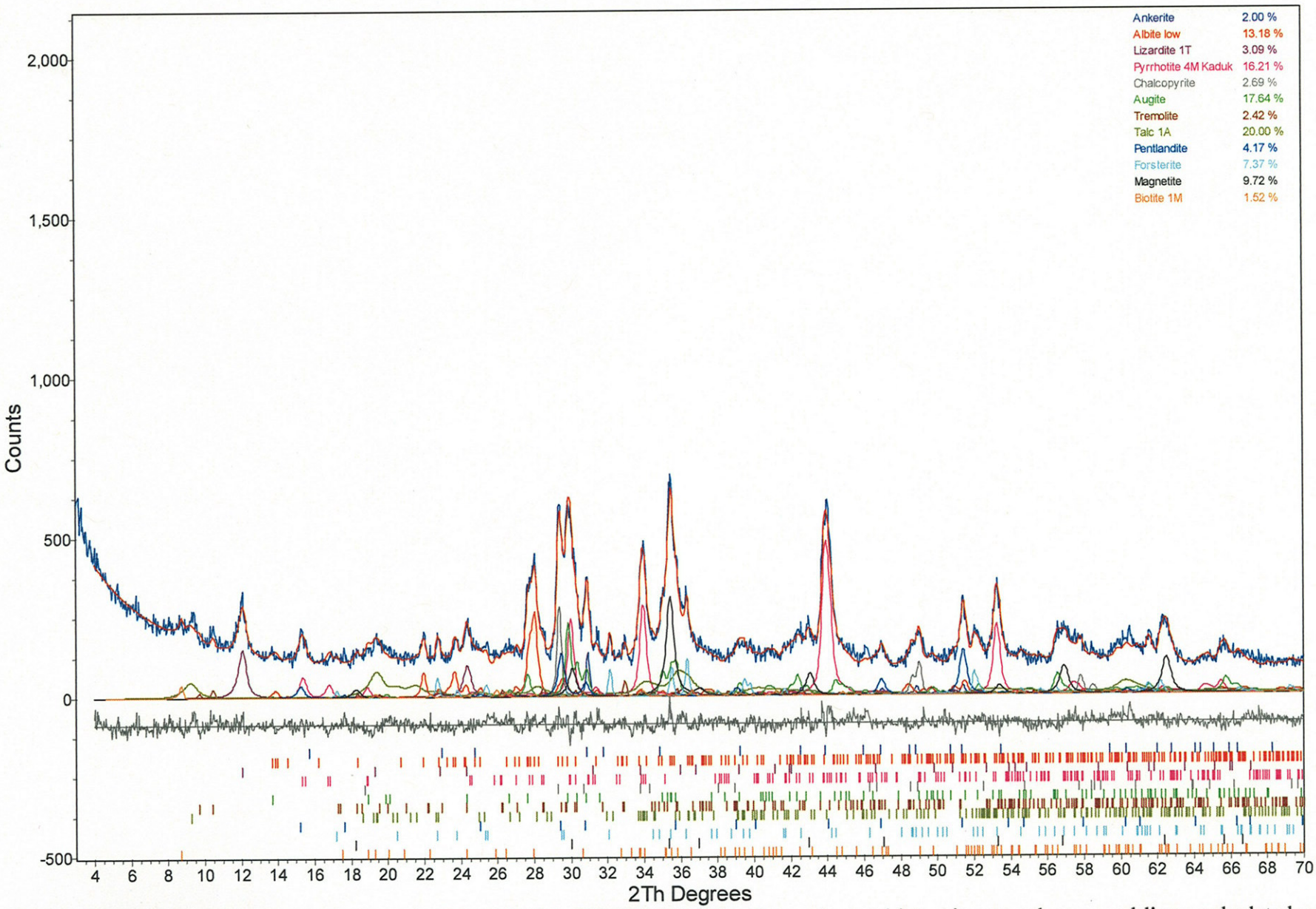


Figure 6. Rietveld refinement plot for sample **CEMI 18790 (VR90125A)** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

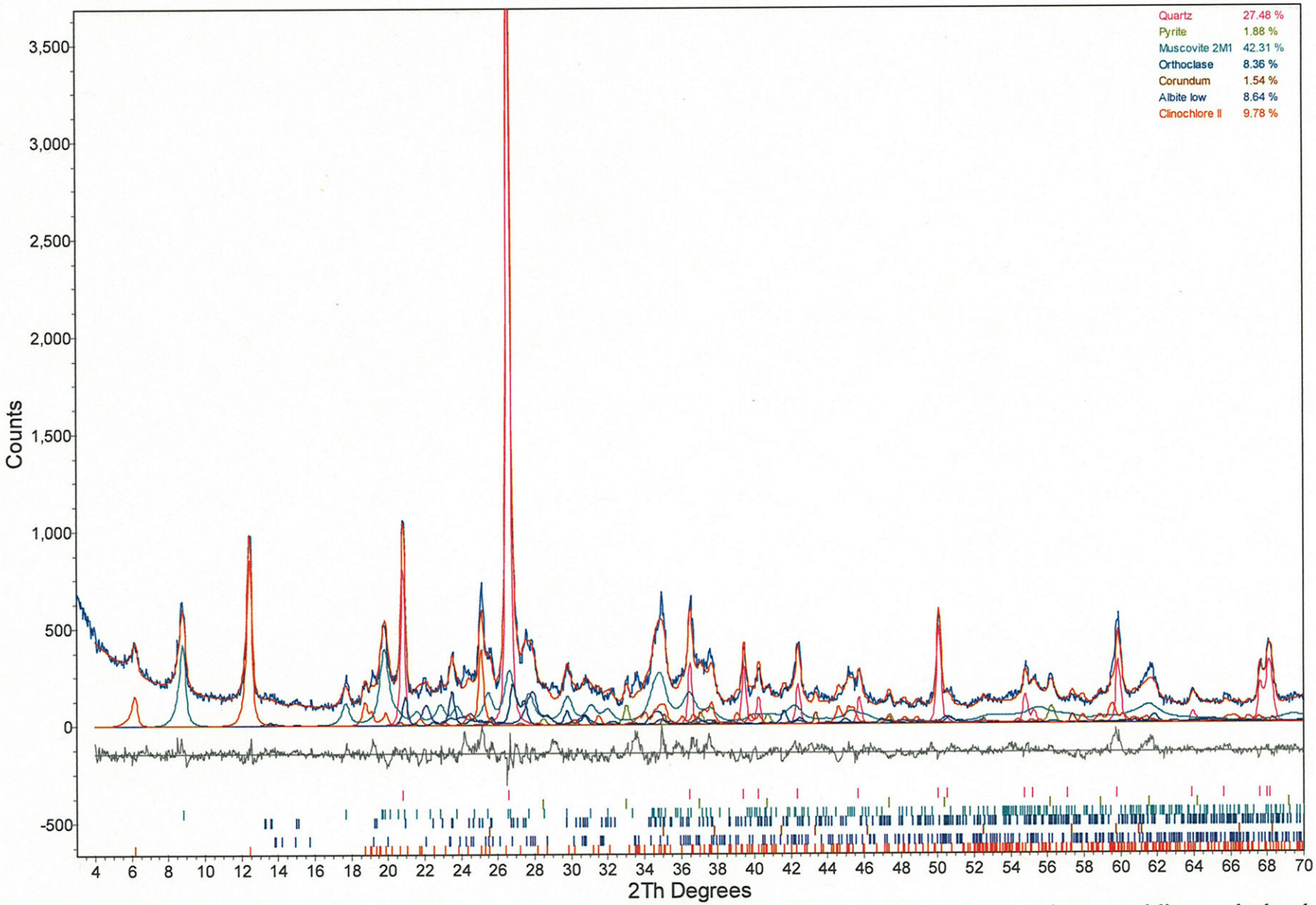


Figure 7. Rietveld refinement plot for sample **CEMI 18794 (VR90425A)** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

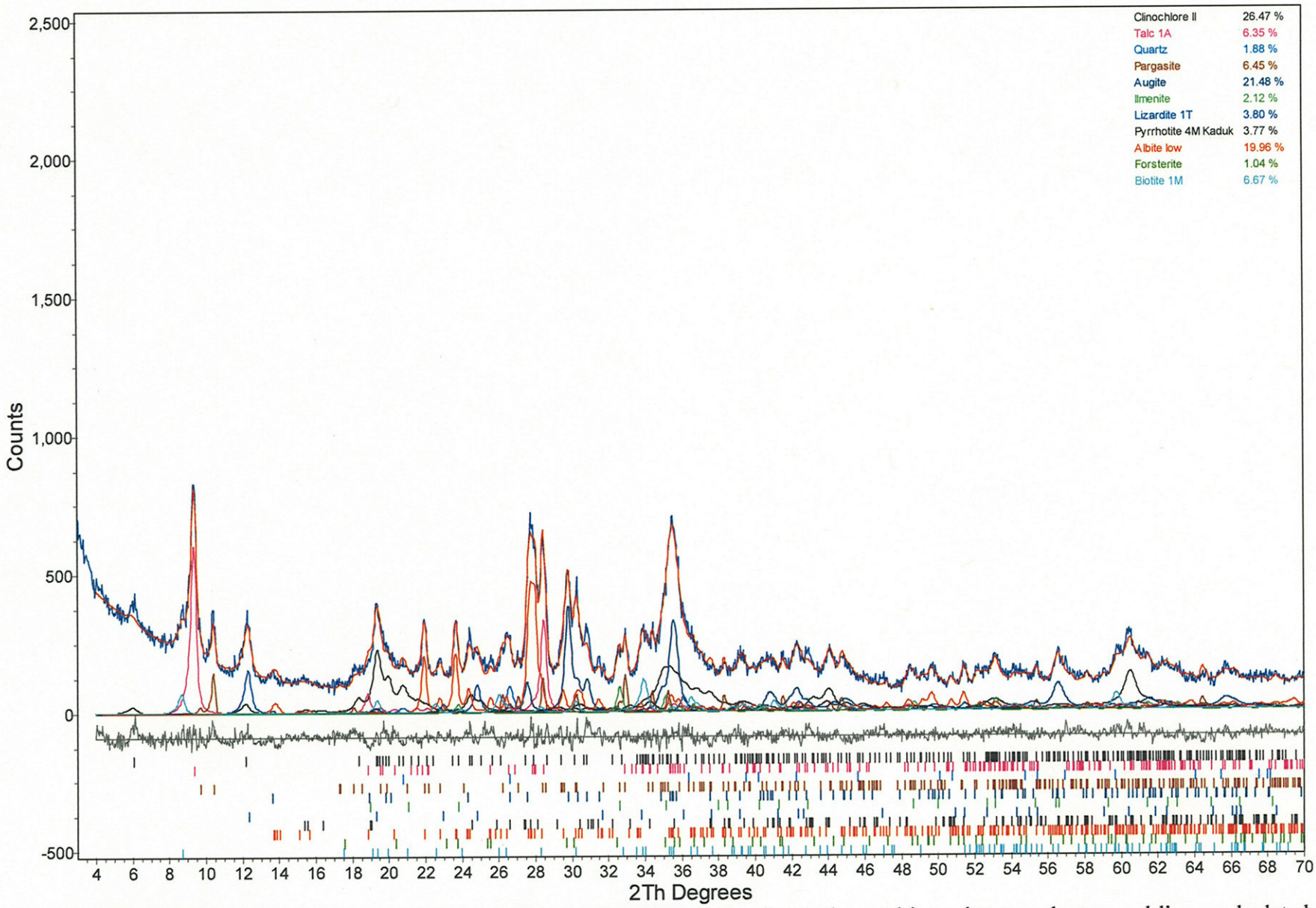


Figure 8. Rietveld refinement plot for sample **CEMI 18796 (VR91267A)** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

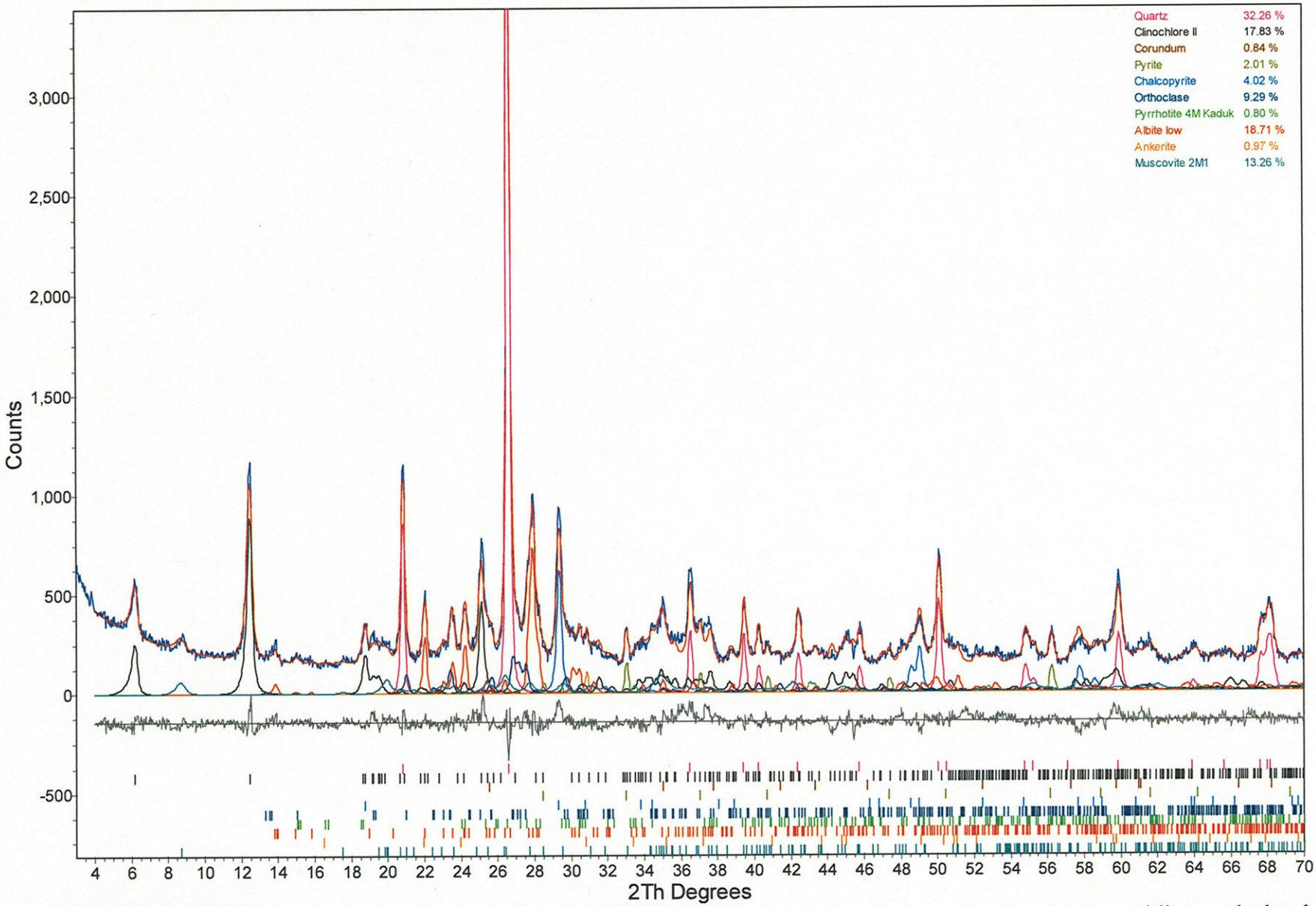


Figure 9. Rietveld refinement plot for sample **CEMI 18797 (VR91306A)** (blue line - observed intensity at each step; red line - calculated pattern; solid grey line below – difference between observed and calculated intensities; vertical bars, positions of all Bragg reflections). Coloured lines are individual diffraction patterns of all phases.

APPENDIX 2

EDS analyses of carbonates and chlorite

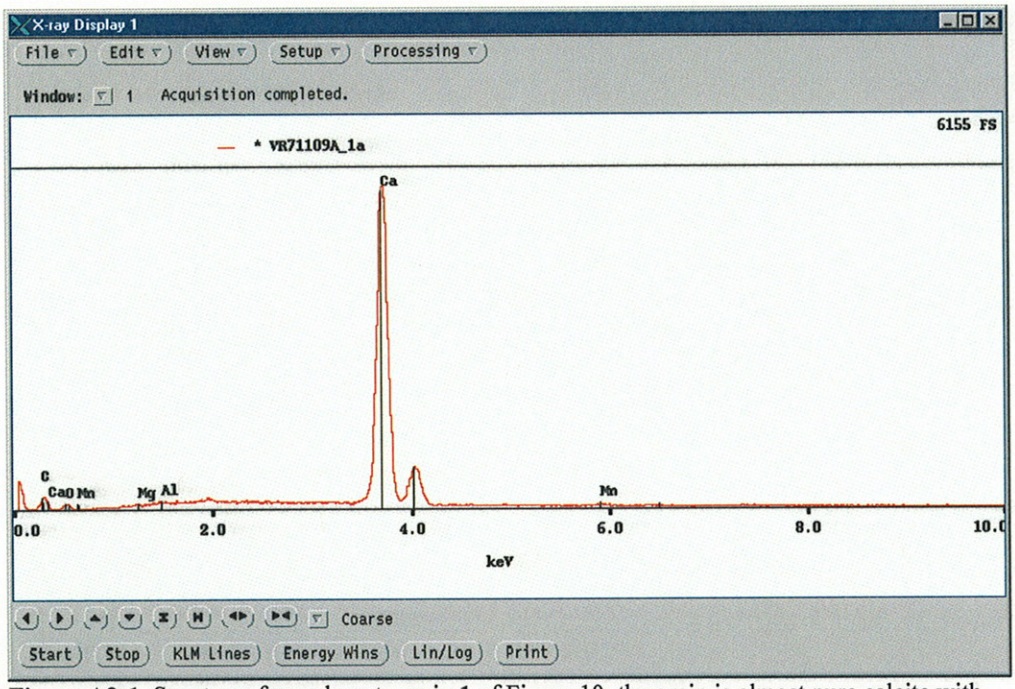


Figure A2-1. Spectrum for carbonate grain **1** of Figure 10; the grain is almost pure calcite with no more than traces of other elements.

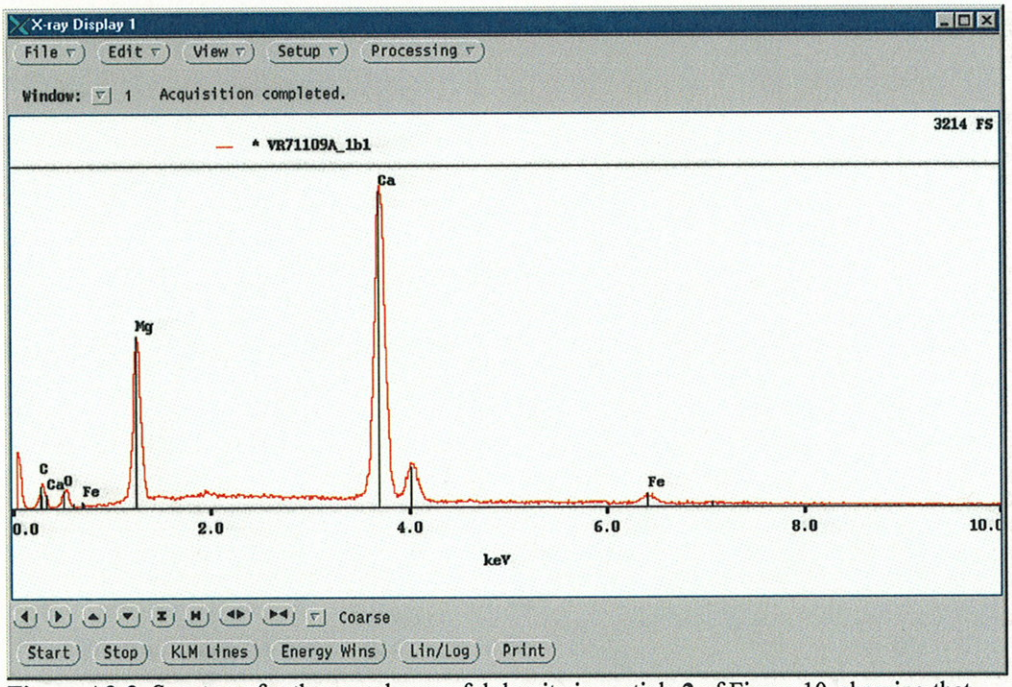


Figure A2-2. Spectrum for the zoned core of dolomite in particle **2** of Figure 10, showing that only a small amount of Fe is present.

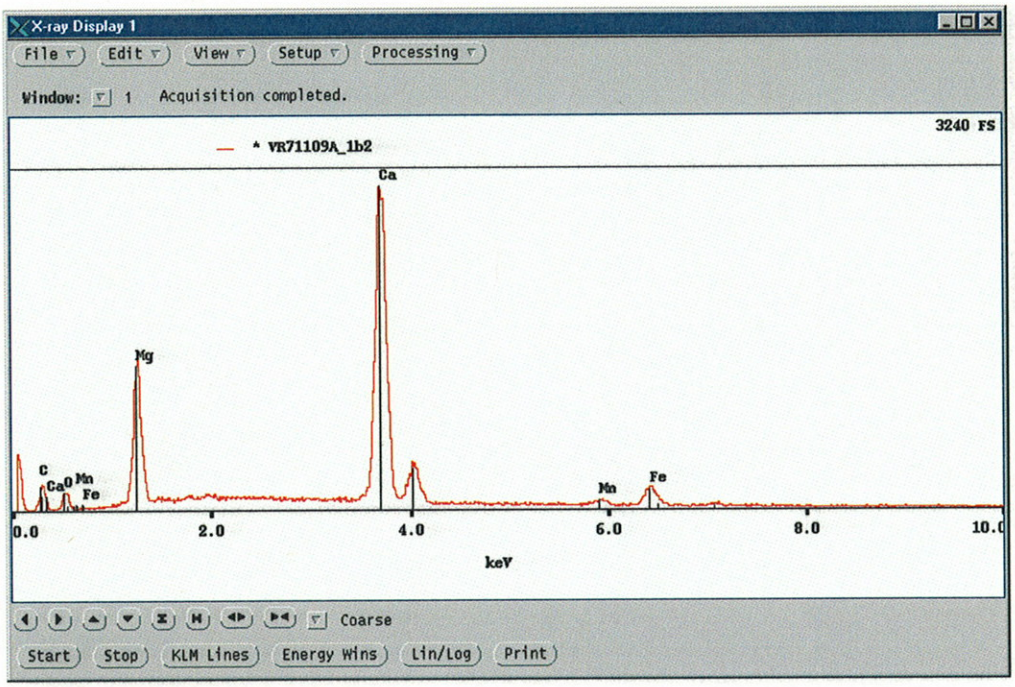


Figure A2-3. Spectrum of the zoned dolomite in particle **3** of Figure 10. The Fe and Mn contents are slightly higher than those in particle **2**.

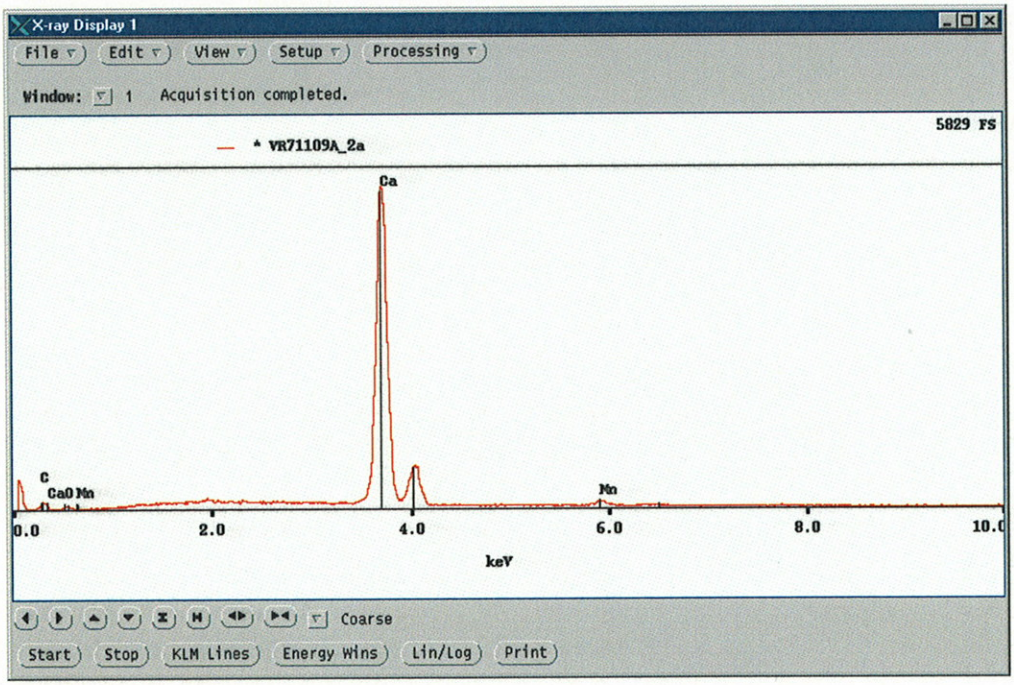


Figure A2-4. Spectrum of grain **1** calcite in VR71109A, Figure 8, lower photo. The calcite is almost of end-member composition, with only a trace of Mn detectable.

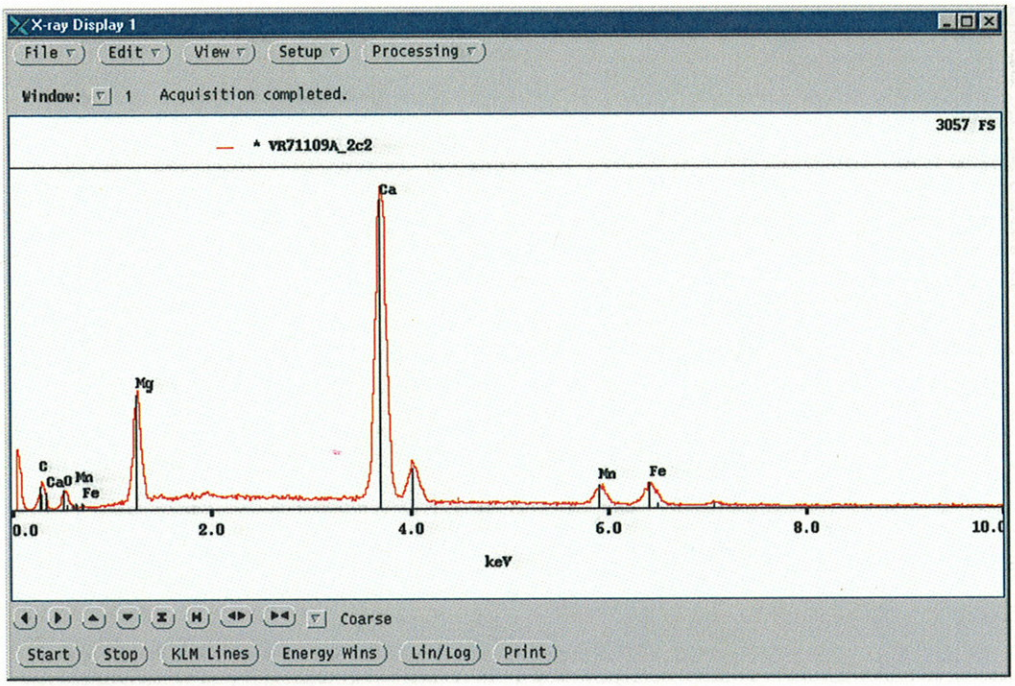


Figure A2-5. Spectrum of dolomite in area **3** of VR71109A. The dolomite is a slightly zoned particle that is surrounded by the main carbonate mass, which is almost pure calcite. The combined Fe + Mn contents are the highest that were obtained for dolomite in the Eagle samples.

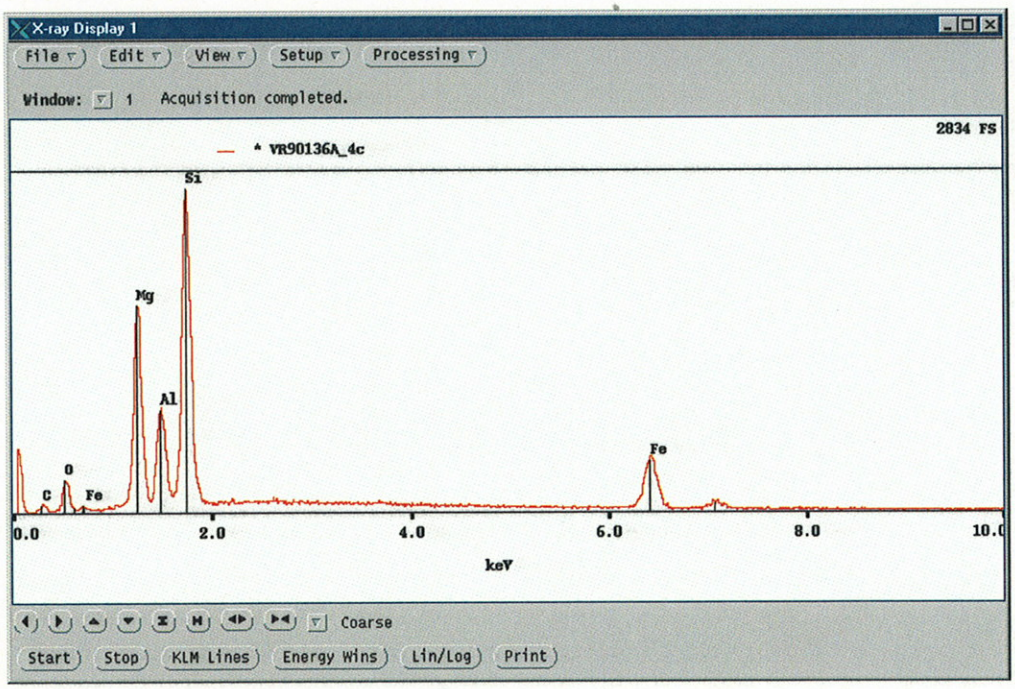


Figure A2-6. Chlorite in VR91306A. The spectrum is for the brownish mass associated with carbonate shown on the left of Figure 12.

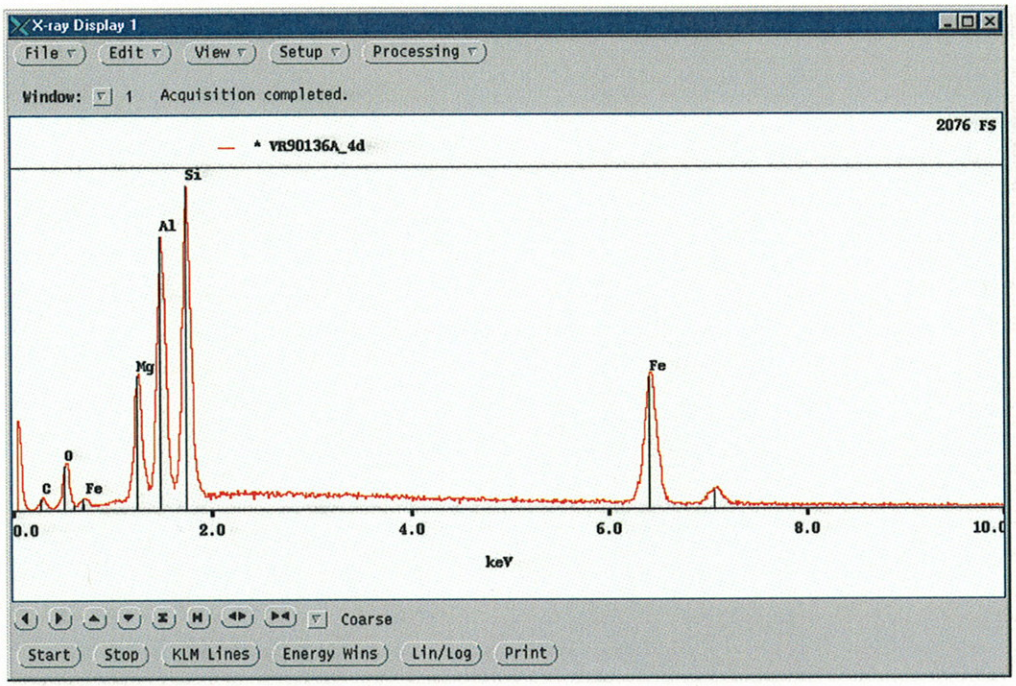
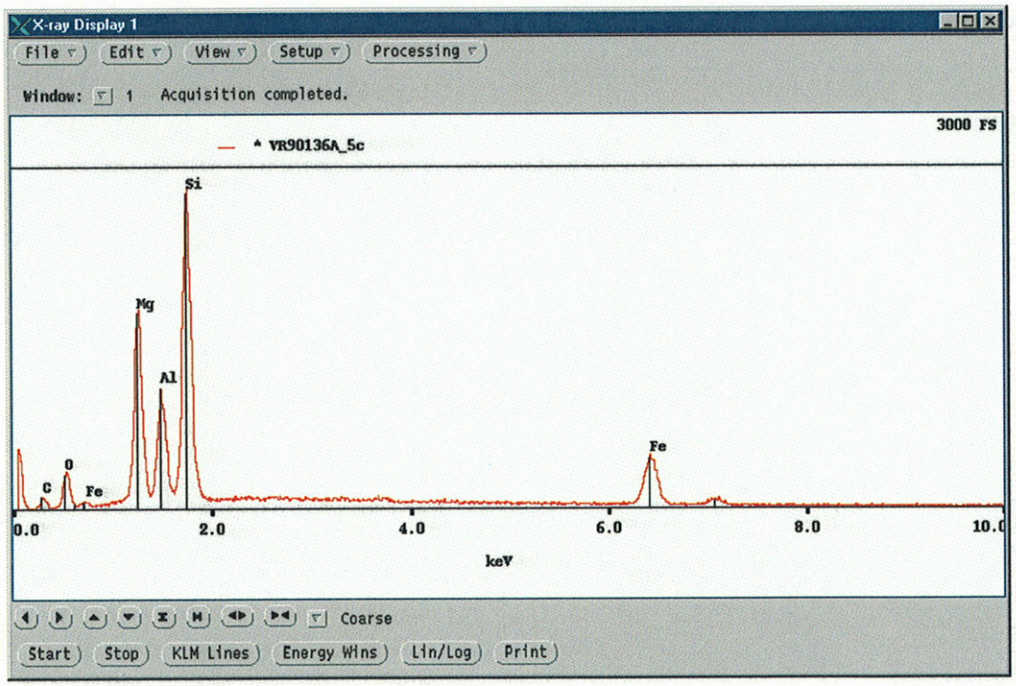


Figure A2-7. Chlorite in VR91306A. The spectrum is for the almost colorless particle shown on the right of Figure 12. The particle is richer in Fe and Al, and has less Mg than the brownish particle at the left of Figure 12.



FigureA2-8. Spectrum of the chlorite veinlet at the far left of Figure 11, sample VR91306A. The composition is close to that of the brownish chlorite aggregate at the left of Figure 12.

ELECTRON-MICROPROBE COMPOSITIONS OF CARBONATES

The carbonate grains illustrated in Figures 8 and 10 were analyzed to obtain a correlation with the EDS spectra. Whereas the correlation proved to be feasible for calcite, which is homogeneous and unzoned, specific correlations were not possible for zoned dolomite because it was not possible to return to exactly the same point at which the EDS analyses were obtained. Nevertheless, the data confirm the spectral indications that Fe and Mn in both calcite and dolomite are typically low; many of the spectra that were obtained, but which are not illustrated, showed Fe and Mn contents to be at the lowest end of the substitutional range. Thus, for calcite the average composition is interpreted to >95 molar % $CaCO_3$, and for dolomite the average is at least 90 molar % $CaMg(CO_3)_2$. No ankerite has been detected.

Microprobe compositions of carbonates in VR71109A

EDS spectra	A2-1		A2-2		A2-3		A2-4					
Mineral	calcite		dolomite		dolomite		calcite		dolomite		calcite	
Grain, Fig.	Gr. 1, Fig. 10		Gr. 2, Fig. 10		Gr. 3, Fig. 10		Gr. 1, Fig. 8		Gr. 2, Fig. 8		Gr. 3, Fig. 8	
Spot	a	b	a	b	a	b	a	b	a	b	a	b
Wt% MgO	0.05	0.05	19.12	19.74	19.29	19.15	0.18	0.11	17.66	18.55	0.14	0.11
CaO	55.74	55.11	30.71	30.30	30.59	30.62	53.59	55.21	30.36	30.30	55.80	54.83
MnO	0.69	1.15	0.32	0.32	0.37	0.33	2.14	2.01	1.18	1.01	0.67	0.69
FeO	0.22	0.21	2.21	2.07	2.27	2.33	0.18	0.06	4.53	3.30	0.25	0.24
$[CO_2]$*	44.36	44.15	46.53	46.80	46.69	46.57	43.69	44.73	46.62	46.68	44.51	43.72
Sum	101.06	100.67	98.89	99.23	99.21	99.00	99.78	102.12	100.35	99.84	101.37	99.59
					formula contents							
Mg	0.00	0.00	0.90	0.92	0.90	0.90	0.01	0.01	0.83	0.87	0.01	0.01
Ca	1.97	1.96	1.04	1.02	1.03	1.03	1.93	1.94	1.02	1.02	1.97	1.97
Mn^{2+}	0.02	0.03	0.01	0.01	0.01	0.01	0.06	0.06	0.03	0.03	0.02	0.02
Fe^{2+}	0.01	0.01	0.05	0.06	0.06	0.06	0.01	0.00	0.12	0.09	0.01	0.01