minerals

MDPI

Supplementary Materials: Mineralogical Distribution of Germanium, Gallium and Indium at the Mt Carlton High-Sulfidation Epithermal Deposit, NE Australia, and Comparison with Similar Deposits Worldwide

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Table S1. Summary of LA-ICP-MS trace element compositions of sulfates and silicates from Mt Carlton (data in ppm).

	Alunite		**Alunite**		**Barite**		**Dickite**		**Dickite**	
	Stage 1A		Stage 1B		Stage 2A		Stage 3		Stage 3	
	V2 pit; n=44		V2 pit; n=21		A39 pit; n=53		V2 pit; n=10		A39 pit; n=30	
Elements	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Al	ME	ME	ME	ME	4.8	bd-33	ME	ME	ME	ME
P	586	bd-4124	1855	429-4115	bd	bd	2183	316-5381	38	bd-478
Ca	447	bd-3314	510	133-1052	333	bd-610	307	bd-937	1.9	bd-57
Ti	38	bd-879	12	3.1-27	22	bd-183	1.5	bd-4.9	2.5	bd-16
Cr	11	bd-53	12	bd-23	0.1	bd-4.3	2.8	bd-6.5	9.8	3.7-21
Mn	2.9	bd-20	1.1	bd-3.5	0.0	bd-1.1	bd	bd	0.0	bd-0.4
Fe	208	bd-2053	48	bd-361	0.9	bd-17	312	208-440	64	bd-599
Cu	1.0	bd-14	20	bd-224	21	17-30	3.8	bd-12	6.2	bd-18
Zn	6.8	bd-83	9.4	bd-92	47	41-51	1.9	bd-6.4	11	bd-36
Ga	32	bd-109	72	1.7-339	0.4	bd-1.4	100	89-109	86	45-150
Ge	1.2	bd-9.1	0.9	bd-3.7	0.3	bd-1.8	3.1	0.9-4.1	5.2	bd-9.1
As	1.9	bd-20	2.8	bd-28	0.1	bd-5.2	22	9.6-34	2.0	bd-12
Se	0.8	bd-36	1.4	bd-17	bd	bd	bd	bd	0.9	bd-11
Rb	11	2.1-137	11	bd-35	0.2	bd-0.5	0.0	bd-0.4	0.0	bd-0.1
Sr	712	26-4383	1613	249-3644	2406	357-3802	1621	219-4465	19	bd-294
Mo	0.1	bd-0.9	0.0	bd	0.0	bd-0.1	0.5	0.2-1.0	0.4	bd-3.6
Ag	0.1	bd-0.8	0.1	bd-0.2	0.3	bd-13	0.3	bd-1.3	0.1	bd-1.3
In	0.1	bd-1.3	0.0	bd-0.2	0.0	bd-0.0	0.1	bd-0.5	0.0	bd-0.2
Sn	0.5	bd-6.6	2.5	bd-7.2	0.0	bd-0.2	0.2	bd-0.3	0.2	bd-0.4
Sb	0.3	bd-8.7	0.4	bd-3.4	0.0	bd-0.5	0.4	0.2-0.8	0.1	bd-1.9
Ba	1392	18-4328	634	7.8-4677	ME	ME	114	16-365	5.2	bd-34
La	23	0.3-123	93	16-350	202	0.3-410	10	1.6-25	0.3	bd-7.4
Ce	38	0.4-260	143	21-568	155	bd-361	18	2.7-45	0.4	bd-7.8
Au	0.0	bd-0.2	0.0	bd-0.2	0.0	bd-0.0	0.0	bd-0.0	0.0	bd-0.0
Pb	268	1.6-1564	710	30-10634	13202	39-22933	688	111-1978	14	0.0-110
Bi	0.0	bd-0.1	0.1	bd-1.0	0.0	bd-0.2	1.9	0.3-3.9	0.1	bd-1.6
Th	5.3	0.0-32	21	4.7-83	1.7	bd-7.5	1.7	0.3-4.1	0.1	bd-1.5
U	0.0	bd-0.4	0.9	0.0-4.7	0.0	bd-0.1	0.0	0.0-0.1	0.0	bd-0.2

Abbreviations: bd - below detection; ME - major element.

Table S2. Raw WDS data of argyrodite from Mt Carlton.

Spot ID	Se (wt %)	Ge	Ag	Te	S	As	Cu	Au	Sb	Bi	Pb	Total
HC09DD025-58-ARG-1	8.77	5.84	70.04	3.54	12.12	0.12	0.80	0.00	0.06	0.07	0.06	101.43
HC09DD025-58-ARG-2	8.86	5.82	69.20	4.48	12.04	0.07	1.04	0.00	0.00	0.17	0.00	101.69
HC09DD025-58-ARG-3	8.58	5.32	69.15	4.80	12.18	0.50	1.14	0.00	0.00	0.00	0.04	101.70
HC09DD025-58-ARG-4	9.33	5.47	69.69	3.30	12.19	0.15	1.22	0.00	0.00	0.09	0.13	101.56
HC09DD025-58-ARG-5	9.32	5.54	69.42	3.61	12.04	0.38	1.14	0.00	0.00	0.06	0.00	101.51
HC09DD025-58-ARG-6	9.05	5.88	69.31	3.87	12.02	0.20	1.12	0.02	0.00	0.11	0.00	101.58
HC09DD025-58-ARG-7	9.47	5.61	68.70	3.61	11.66	0.31	1.35	0.00	0.00	0.09	0.00	100.78
HC09DD025-58-ARG-8	8.45	5.62	69.77	4.35	12.13	0.24	0.63	0.00	0.00	0.10	0.10	101.39
HC09DD025-58-ARG-9	8.81	5.82	69.63	4.46	11.70	0.15	0.59	0.01	0.00	0.18	0.14	101.48
HC09DD025-58-ARG-10	8.94	5.44	70.03	3.83	11.93	0.27	0.67	0.02	0.00	0.11	0.06	101.29
HC09DD025-58-ARG-11	8.60	5.85	69.47	4.27	11.95	0.07	0.62	0.00	0.00	0.09	0.00	100.93
HC09DD025-58-ARG-12	8.74	5.19	69.71	4.43	12.00	0.36	0.71	0.03	0.00	0.00	0.00	101.15
HC09DD025-58-ARG-13	8.62	5.68	69.83	3.92	12.04	0.20	0.72	0.00	0.00	0.05	0.00	101.04
HC09DD025-58-ARG-14	8.41	5.74	69.92	4.05	11.90	0.09	0.72	0.00	0.00	0.03	0.00	100.85
HC09DD025-58-ARG-15	9.52	5.69	70.12	2.61	12.17	0.26	0.78	0.00	0.00	0.11	0.00	101.25
HC09DD025-58-ARG-16	8.34	5.80	70.16	4.90	11.74	0.03	0.67	0.02	0.00	0.00	0.00	101.66
HC09DD025-58-ARG-17	8.38	5.39	69.61	4.68	12.05	0.36	0.66	0.00	0.00	0.10	0.00	101.24
HC09DD025-58-ARG-18	9.28	5.71	69.30	3.69	12.00	0.07	0.70	0.00	0.00	0.04	0.00	100.78
HC09DD035-66-ARG-1	4.73	5.99	68.81	0.68	15.80	0.48	2.58	0.00	0.57	0.26	0.05	99.94
HC09DD035-66-ARG-2	5.66	6.95	68.56	0.62	16.18	0.24	2.49	0.00	0.06	0.21	0.12	101.08
HC09DD035-66-ARG-3	5.40	5.72	69.77	0.40	15.11	0.29	3.78	0.03	0.38	0.17	0.00	101.04
HC09DD035-66-ARG-4	5.89	6.31	70.30	0.59	16.17	0.20	2.19	0.00	0.00	0.10	0.01	101.77
HC09DD035-66-ARG-5	4.34	6.16	71.47	0.38	16.32	0.06	2.62	0.00	0.01	0.12	0.03	101.50
	Se (apfu)	Ge	Ag	Te	S	As	Cu	Au	Sb	Bi	Pb	
HC09DD025-58-ARG-1	1.32	0.96	7.72	0.33	4.49	0.02	0.15	0.00	0.01	0.00	0.00	
HC09DD025-58-ARG-2	1.33	0.95	7.62	0.42	4.46	0.01	0.20	0.00	0.00	0.01	0.00	
HC09DD025-58-ARG-3	1.29	0.87	7.60	0.45	4.50	0.08	0.21	0.00	0.00	0.00	0.00	
HC09DD025-58-ARG-4	1.40	0.89	7.64	0.31	4.50	0.02	0.23	0.00	0.00	0.00	0.01	
HC09DD025-58-ARG-5	1.40	0.90	7.63	0.34	4.45	0.06	0.21	0.00	0.00	0.00	0.00	
HC09DD025-58-ARG-6	1.36	0.96	7.62	0.36	4.45	0.03	0.21	0.00	0.00	0.01	0.00	
HC09DD025-58-ARG-7	1.44	0.92	7.63	0.34	4.36	0.05	0.25	0.00	0.00	0.00	0.00	
HC09DD025-58-ARG-8	1.28	0.92	7.72	0.41	4.51	0.04	0.12	0.00	0.00	0.01	0.01	
HC09DD025-58-ARG-9	1.34	0.96	7.75	0.42	4.38	0.02	0.11	0.00	0.00	0.01	0.01	
HC09DD025-58-ARG-10	1.35	0.90	7.76	0.36	4.45	0.04	0.13	0.00	0.00	0.01	0.00	
HC09DD025-58-ARG-11	1.31	0.97	7.72	0.40	4.47	0.01	0.12	0.00	0.00	0.00	0.00	
HC09DD025-58-ARG-12	1.32	0.86	7.74	0.42	4.48	0.06	0.13	0.00	0.00	0.00	0.00	
HC09DD025-58-ARG-13	1.30	0.93	7.74	0.37	4.49	0.03	0.14	0.00	0.00	0.00	0.00	
HC09DD025-58-ARG-14	1.28	0.95	7.78	0.38	4.46	0.01	0.14	0.00	0.00	0.00	0.00	
HC09DD025-58-ARG-15	1.43	0.93	7.71	0.24	4.50	0.04	0.15	0.00	0.00	0.01	0.00	
HC09DD025-58-ARG-16	1.27	0.96	7.80	0.46	4.39	0.00	0.13	0.00	0.00	0.00	0.00	
HC09DD025-58-ARG-17	1.27	0.89	7.72	0.44	4.49	0.06	0.12	0.00	0.00	0.01	0.00	
HC09DD025-58-ARG-18	1.41	0.94	7.69	0.35	4.48	0.01	0.13	0.00	0.00	0.00	0.00	
HC09DD035-66-ARG-1	0.67	0.93	7.19	0.06	5.55	0.07	0.46	0.00	0.05	0.01	0.00	
HC09DD035-66-ARG-2	0.79	1.06	7.03	0.05	5.58	0.04	0.43	0.00	0.01	0.01	0.01	
HC09DD035-66-ARG-3	0.77	0.88	7.26	0.03	5.29	0.04	0.67	0.00	0.03	0.01	0.00	
HC09DD035-66-ARG-4	0.82	0.96	7.19	0.05	5.56	0.03	0.38	0.00	0.00	0.01	0.00	
HC09DD035-66-ARG-5	0.61	0.94	7.32	0.03	5.62	0.01	0.46	0.00	0.00	0.01	0.00	

Mineral formulae calculated based on 15 atoms.

Table S3. Summary of LA-ICP-MS trace element compositions of sulfides and sulfosalts from Mt Carlton (data in ppm).

	Enargite		**Enargite**		**Sphalerite**		**Sphalerite**		**Sphalerite**		**Pyrite**		**Pyrite**		**Galena**		**Galena**	
	Stage 2A		Stage 2A		Stage 2A		Stage 2B		Stage 2B		Stage 2A		Stage 2B		Stage 2B		Stage 2B	
	V2 pit		A39 pit		V2 pit		V2 pit		A39 pit		V2 pit		V2 pit		V2 pit		A39 pit	
	n=14		n=20		n=5		n=44		n=10		n=14		n=14		n=10		n=7	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
V	4.5	bd-16	9.3	bd-37	0.4	bd-1.7	0.3	bd-1.1	0.2	bd-1.3	0.5	0.2-1.4	0.3	bd-1.5	bd	bd	bd	bd
Cr	0.2	bd-2.0	2.3	bd-34	0.8	bd-1.2	0.5	bd-1.7	0.7	bd-1.3	15	0.5-35	0.4	bd-2.3	bd	bd	bd	bd
Mn	0.6	bd-7.7	0.9	bd-6.9	4.5	3.5-5.4	6.0	bd-49	2.0	1.2-3.2	1.9	0.1-5.0	17	0.2-205	0.1	bd-0.8	bd	bd
Fe	182	bd-526	228	bd-1004	51	33-69	20	bd-121	178	139-311	ME	ME	ME	ME	bd	bd	bd	bd
Co	0.2	bd-0.8	0.3	bd-2.5	bd	bd	0.1	bd-1.0	0.0	bd-0.5	174	0.4-1255	0.6	bd-1.9	bd	bd	bd	bd
Ni	0.2	bd-1.4	8.2	bd-54	bd	bd	0.1	bd-1.0	0.1	bd-1.0	127	0.6-589	0.7	bd-4.4	0.3	bd-2.3	0.1	bd-0.5
Cu	ME	ME	ME	ME	6759	3303-16610	2013	33-9974	486	168-991	754	12--3189	773	8.2-3885	2390	40-5570	14	4.0-35
Zn	112	11-400	716	21-3656	ME	ME	ME	ME	ME	ME	184	2.8-809	88	1.4-533	284	1.5-1143	0.7	0.4-1.3
Ga	6.0	0.2-37	5.2	bd-35	677	370-1181	444	0.6-2829	260	174-476	0.2	0.1-0.4	0.1	bd-0.3	0.0	bd-0.1	bd	bd
Ge	86	21-330	612	78-2189	77	52-143	206	3.3-611	5.1	4.1-8.5	3.5	2.6-4.7	3.7	2.1-4.2	0.6	0.2-0.9	0.5	bd-0.8
As	ME	ME	ME	ME	907	546-1349	338	2.3-2090	118	54-177	185	3.2-985	2443	9.6-12202	14	bd-58	3.0	1.2-6.3
Se	204	9.3-896	210	10-944	103	47-156	20	bd-64	0.6	bd-6.3	61	9.5-333	35	bd-236	4.3	bd-33	1.4	bd-4.0
Mo	3.7	bd-28	34	bd-199	0.8	bd-3.8	0.0	bd-0.7	0.0	bd-0.1	0.2	0.0-0.6	0.7	0.1-6.8	0.0	bd-0.1	0.1	bd-0.6
Ag	119	18-478	757	8.1-3104	130	82-245	190	2.6-1235	38	11.6-71	475	2.6-2290	22	0.8-112	73	20-168	1443	1052-1927
Cd	26	2.4-81	61	4.3-311	3512	3222-3925	3985	1777-9186	4597	2469-7105	0.5	0.1-1.1	0.6	bd-2.4	393	12-1778	25	9.7-68
In	14	0.3-155	7.7	0.2-76	469	384-571	369	0.4-2169	20	6.1-40	0.1	0.0-0.2	0.1	bd-0.8	2.4	0.0-12	0.7	0.2-1.2
Sn	215	0.7-884	14	bd-50	0.9	0.4-1.7	0.7	0.2-8.3	0.4	0.3-0.5	1.1	0.1-9.4	0.9	bd-8.3	0.1	0.1-0.2	0.1	0.1-0.2
Sb	22868	7210-43647	8045	329-17759	394	299-486	151	0.2-950	665	302-941	9.5	0.1-72	5.2	0.1-28	1444	17-3447	3449	1896-6690
Te	120	bd-774	123	bd-724	388	97-709	68	bd-443	0.3	bd-0.9	16	0.7-98	86	0.2-353	1.6	bd-6.0	1.8	0.6-5.5
Au	12	0.1-62	0.2	bd-1.4	10	5.4-21	13	bd-75	0.5	0.1-2.1	2.4	0.1-11	56	0.2-367	1.1	0.4-2.1	0.4	0.1-0.9
Hg	1.3	bd-7.9	8.6	bd-53	95	83-107	135	47-195	57	50-65	1.2	0.2-7.4	0.3	bd-1.4	71	bd-342	1.0	0.2-2.4
Tl	0.4	bd-2.5	31	bd-355	0.5	0.1-1.3	1.0	bd-4.3	0.2	0.1-0.4	0.1	0.0-0.2	1.2	bd-16	0.0	bd-0.1	0.2	0.1-0.3
Pb	47	4.3-220	851	1.1-3173	1338	1148-1755	1078	0.7-7181	1283	407-3067	73	2.3-386	314	4.0-2792	ME	ME	ME	ME
Bi	6299	173-18952	190	bd-591	71	52-91	32	0.0-250	0.0	bd-0.2	7.3	0.2-31	4.0	0.0-17	1.7	0.1-5.9	0.1	0.0-0.1

Abbreviations: bd – below detection; ME – major element.

Table S4. Summary of LA-ICP-MS trace element compositions of enargite from worldwide high-sulfidation epithermal and porphyry deposits (data in ppm).

	Enargite		**Enargite**		**Enargite**		**Enargite**		**Enargite**		**Enargite**		**Enargite**	
	Lepanto		Laurani		La Mejicana		Motomboto		Chelopech		Cerro Quema		El Salvador	
	n=15		n=15		n=16		n=15		n=15		n=10		n=5	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
V	5.5	bd-21	0.1	bd-0.8	0.6	bd-1.8	0.3	bd-2.4	4.5	bd-12	4.6	bd-12	0.6	bd-1.1
Cr	1.0	bd-4.5	0.1	bd-1.8	0.5	bd-5.1	0.2	bd-3.1	0.4	bd-3.6	3.3	bd-22	1.0	bd-3.3
Mn	0.7	bd-1.8	0.4	bd-1.8	0.2	bd-1.3	0.5	bd-4.2	0.1	bd-1.0	0.7	bd-3.8	0.6	bd-1.6
Fe	167	16-932	64	23-105	107	bd-677	207	21-391	270	bd-1489	1342	bd-9123	36	bd-111
Co	0.1	bd-0.4	0.0	bd-0.2	0.1	bd-0.4	0.0	bd-0.2	0.2	bd-1.1	0.2	bd-1.1	0.1	bd-0.2
Ni	0.7	bd-4.7	bd	bd-bd	2.2	bd-10	bd	bd	0.2	bd-3.3	6.8	bd-43	bd	bd
Cu	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
Zn	31	1.7-101	381	23-1507	115	7.6-480	8.1	2.1-27	12	1.6-37	92	8.7-190	13	2.2-31
Ga	0.2	bd-1.3	0.0	bd-0.3	4.2	bd-15	0.4	bd-3.3	0.2	bd-0.6	0.1	bd-0.6	0.0	bd-0.1
Ge	38	15-57	12	8.3-15	717	15-2679	21	7.4-50	101	24-186	561	57-1202	12	6.9-24
As	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME	ME
Se	393	64-780	8.5	bd-42	27	3.1-84	121	bd-790	21	5.5-41	30	bd-66	17	bd-34
Mo	0.2	bd-1.8	2.5	bd-16	7.3	bd-81	0.2	bd-1.6	1.0	0.1-2.6	27	bd-71	0.5	bd-1.8
Ag	27	5.6-103	15	6.0-39	18	3.4-46	62	11-127	8.4	2.9-21	3.0	bd-15	30	20-43
Cd	38	1.4-103	130	49-253	16	0.2-166	1.9	0.2-8.5	0.3	bd-0.6	9.6	bd-26	6.5	1.0-11
In	3.7	1.1-8.0	9.1	4.2-17	5.2	1.1-18	1.3	0.9-1.8	1.1	0.8-1.3	1.4	1.1-2.0	1.3	1.0-1.6
Sn	590	22-1578	1851	750-3645	248	0.4-2698	28	1.2-128	0.8	bd-3.0	2.5	bd-8.2	100	14-172
Sb	4944	1462-9720	25830	5740-45543	14105	407-48214	11180	414-25128	10228	1830-16377	1153	37-5787	7567	3306-12433
Te	1419	22-7013	140	bd-950	37	bd-235	15	bd-152	2.9	bd-40	0.6	bd-2.8	107	0.1-322
Au	1.3	0.1-7.6	0.2	bd-1.4	1.4	bd-10	0.2	bd-0.8	0.1	bd-0.4	0.0	bd-0.3	15	bd-72
Hg	12	1.2-85	391	86-733	7.1	1.4-22	0.6	0.2-1.1	0.4	bd-0.8	132	7.5-287	0.4	bd-0.7
Tl	0.1	bd-0.8	0.0	bd-0.1	0.0	bd-0.0	0.1	bd-0.3	1.1	0.1-4.0	2.2	bd-8.2	0.0	bd-0.0
Pb	21	1.9-62	0.8	bd-3.8	1.9	0.1-7.5	51	1.4-225	19	2.1-78	22	bd-55	4.6	0.2-18
Bi	25	4.7-87	77	0.1-519	128	1.4-1178	4794	146-9624	330	2.5-684	1.7	bd-4.5	0.0	bd-0.2

Abbreviations: bd – below detection; ME – major element.