

prvek	Ar	prvek	Ar	prvek	Ar	
Ag	107.8682	Cu	63.546	S	32.0675	sfalerit ZnS do strukturi do strukturi
As	74.9216	Fe	55.845	Sb	121.76	
Bi	208.9804	Hg	200.59	Se	78.96	
Cd	112.411	Mn	54.93805	Zn	65.38	
Co	58.9332	Pb	207.2	Ni	58.6934	

wteight %									
DataSet/Pc	Comment	Ag	S	Pb	Hg	Cd	Cu	Fe	
13 / 1 .	HB bl 22	0.03	33.57	0.08	0.00	0.05	0.00	6.77	
14 / 1 .	HB bl 22	0.00	33.29	0.00	0.06	0.02	0.00	6.61	

;
ní pozice k Zn vstupuje také Fe, Mn, Cd, In, atd
ní pozice k S vstupuje také Se

Zn	Ni	Co	Mn	As	Se	Sb	Total
60.02	0.01	0.00	0.19	0.12	0.00	0.00	100.82
60.19	0.00	0.00	0.20	0.00	0.00	0.04	100.43

detection limit ppm

Ag	S	Pb	Hg	Cd	Cu	Fe	Zn	Ni	
2412	551	1686	1112	1281	-1	360	472	340	
1	585	0	1449	1273	474	358	478	-1	

Co	Mn	As	Se	Sb	
	363	256	2291	0	0
	0	252	0	0	1552

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Cd	112.411	Mn	54.93805	Zn	65.38	
Co	58.9332	Pb	207.2	Ni	58.6934	

		Weight%								
DataSet/Pc	Comment	Ag	S	Pb	Hg	Cd	Cu	Fe		
11 / 1 .	HB bl 22	0.00	21.50	0.06	0.00	0.03	0.00	0.00	35.53	
15 / 1 .	HB bl 22	0.01	21.39	0.00	0.00	0.00	0.00	0.00	35.73	

yrit FeAsS

Zn	Ni	Co	Mn	As	Se	Sb	Total	Det.Lim ppb
0.01	0.15	0.02	0.01	42.74	0.00	0.09	100.14	-1
0.00	0.01	0.00	0.03	42.58	0.00	0.22	99.95	2223

m	Pb	Hg	Cd	Cu	Fe	Zn	Ni	Co	
S	548	1743	0	1296	0	558	363	404	435
	527	0	0	-2	-1	560	0	398	0

Mn	As	Se	Sb
279	2813	0	1598
266	2863	0	1576

The tetrahedrite group: Nomenclature and classification

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ABSTRACT

The classification of the tetrahedrite group minerals in keeping with the current IMA-accepted nomenclature rules is discussed. Tetrahedrite isotypes are cubic, with space group symmetry $I\bar{4}3m$. The general structural formula of minerals belonging to this group can be written as ${}^{M(2)}A_6{}^{M(1)}(B_4C_2)^{X(3)}D_4{}^{S(1)}Y_{12}{}^{S(2)}Z$, where A = Cu⁺, Ag⁺, □ (vacancy), and (Ag₆)⁴⁺ clusters; B = Cu⁺, and Ag⁺; C = Zn²⁺, Fe²⁺, Hg²⁺, Cd²⁺, Mn²⁺, Cu²⁺, Cu⁺, and Fe³⁺; D = Sb³⁺, As³⁺, Bi³⁺, and Te⁴⁺; Y = S²⁻ and Se²⁻; and Z = S²⁻, Se²⁻, and □. The occurrence of both Me⁺ and Me²⁺ cations at the M(1) site, in a 4:2 atomic ratio, is a case of valency-imposed double site-occupancy. Consequently, different combinations of B and C constituents should be regarded as separate mineral species. The tetrahedrite group is divided into five different series on the basis of the A, B, D, and Y constituents, i.e., the tetrahedrite, tennantite, freibergite, hakite, and giraudite series. The nature of the dominant C constituent (the so-called “charge-compensating constituent”) is made explicit using a hyphenated suffix between parentheses. Rozhdestvenskayaite, arsenofreibergite, and goldfieldite could be the names of three other series. Eleven minerals belonging to the tetrahedrite group are considered as valid species: argentotennantite-(Zn), argentotetrahedrite-(Fe), kenoargentotetrahedrite-(Fe), giraudite-(Zn), goldfieldite, hakite-(Hg), rozhdestvenskayaite-(Zn), tennantite-(Fe), tennantite-(Zn), tetrahedrite-(Fe), and tetrahedrite-(Zn). Furthermore, annivite is formally discredited. Minerals corresponding to different end-member compositions should be approved as new mineral species by the IMA-CNMNC following the submission of regular proposals. The nomenclature and classification system of the tetrahedrite group, approved by the IMA-CNMNC, allows the full description of the chemical variability of the tetrahedrite minerals and it is able to convey important chemical information not only to mineralogists but also to ore geologists and industry professionals.

Keywords: Tetrahedrite group, sulfosalts, nomenclature, classification

The general structural formula of the tetrahedrite group minerals can best be defined as ${}^{M(2)}A_6{}^{M(1)}(B_4C_2)^{X(3)}D_4{}^{S(1)}Y_{12}{}^{S(2)}Z$, where the upper cases represent the following constituents:

A = Cu⁺, Ag⁺, □ (vacancy); (Ag₆)⁴⁺ clusters are also possible, coupled with Z vacancies (see below);

B = Cu⁺, Ag⁺;

C = Zn²⁺, Fe²⁺, Hg²⁺, Cd²⁺, Mn²⁺, Cu²⁺, Cu⁺, Fe³⁺;

D = Sb³⁺, As³⁺, Bi³⁺, Te⁴⁺;

Y = S²⁻, Se²⁻;

Z = S²⁻, Se²⁻, □.

mol. Hm. 107.8682 32.065 207.2 200.59 208.9804 112.411 35.453

Weight%

DataSet/Pc	Comment	Ag	S	Pb	Hg	Bi	Cd	Cl
1 / 1 .	D2	0.044	21.643	0	19.591	0.012	0.015	0.008
2 / 1 .	D2	0	22.482	0	18.481	0.039	0	0.006
11 / 1 .	D12	0.216	25.195	0	0.091	0	0	0.007

12 / 1 .	D12	0.27	25.552	0.025	0.065	0	0.039	0.006
16 / 1 .	D5	0.201	24.209	0	8.592	0.304	0	0.015
17 / 1 .	D5	0.232	24.166	0	8.483	0.425	0	0
18 / 1 .	D5	0.213	24.106	0	9.285	0.35	0	0.006
19 / 1 .	D5	0.17	24.101	0	8.982	0.362	0	0.006
26 / 1 .	D7	0.178	25.807	0	2.321	0.171	0	0.007
27 / 1 .	D7	0.23	25.743	0	2.242	0.185	0	0

TABLE 2. Nomenclature and classification of the tetrahedrite group mineral

Tetrahedrite series		Tetrahedrite gro
Tetrahedrite-(Fe)	$\text{Cu}_6(\text{Cu}_4\text{Fe}_2)\text{Sb}_4\text{S}_{13}$	
Tetrahedrite-(Zn)	$\text{Cu}_6(\text{Cu}_4\text{Zn}_2)\text{Sb}_4\text{S}_{13}$	
<i>Tetrahedrite-(Cd)</i>	$\text{Cu}_6(\text{Cu}_4\text{Cd}_2)\text{Sb}_4\text{S}_{13}$	
<i>Tetrahedrite-(Cu)</i>	$\text{Cu}_6(\text{Cu}_4\text{Cu}_2)\text{Sb}_4\text{S}_{13}$	
<i>Tetrahedrite-(Hg)</i>	$\text{Cu}_6(\text{Cu}_4\text{Hg}_2)\text{Sb}_4\text{S}_{13}$	
<i>Tetrahedrite-(Mn)</i>	$\text{Cu}_6(\text{Cu}_4\text{Mn}_2)\text{Sb}_4\text{S}_{13}$	
Freibergite series		
Argentotetrahedrite-(Fe)	$\text{Ag}_6(\text{Cu}_4\text{Fe}_2)\text{Sb}_4\text{S}_{13}$	
Kenoargentotetrahedrite-(Fe)	$\text{Ag}_6(\text{Cu}_4\text{Fe}_2)\text{Sb}_4\text{S}_{12}\square$	
<i>Argentotetrahedrite-(Cd)</i>	$\text{Ag}_6(\text{Cu}_4\text{Cd}_2)\text{Sb}_4\text{S}_{13}$	
<i>Argentotetrahedrite-(Hg)</i>	$\text{Ag}_6(\text{Cu}_4\text{Hg}_2)\text{Sb}_4\text{S}_{13}$	
Hakite series		
Hakite-(Hg)	$\text{Cu}_6(\text{Cu}_4\text{Hg}_2)\text{Sb}_4\text{Se}_{13}$	
<i>Hakite-(Cd)</i>	$\text{Cu}_6(\text{Cu}_4\text{Cd}_2)\text{Sb}_4\text{Se}_{13}$	
<i>Hakite-(Cu)</i>	$\text{Cu}_6(\text{Cu}_4\text{Cu}_2)\text{Sb}_4\text{Se}_{13}$	
<i>Hakite-(Fe)</i>	$\text{Cu}_6(\text{Cu}_4\text{Fe}_2)\text{Sb}_4\text{Se}_{13}$	
<i>Hakite-(Zn)</i>	$\text{Cu}_6(\text{Cu}_4\text{Zn}_2)\text{Sb}_4\text{Se}_{13}$	
Rozhdestvenskayaite series		
Rozhdestvenskayaite-(Zn)	$\text{Ag}_6(\text{Ag}_4\text{Zn}_2)\text{Sb}_4\text{S}_{13}$	
<i>Rozhdestvenskayaite-(Fe)</i>	$\text{Ag}_6(\text{Ag}_4\text{Fe}_2)\text{Sb}_4\text{S}_{13}$	
<i>Rozhdestvenskayaite-(Hg)</i>	$\text{Ag}_6(\text{Ag}_4\text{Hg}_2)\text{Sb}_4\text{S}_{13}$	

Note: Italicized names require official approval by the IMA-CNMNC.

63.546 55.845 65.38 58.6934 58.9332 54.93805 74.9216 78.96 121.76

Cu	Fe	Zn	Ni	Co	Mn	As	Se	Sb
33.036	0.045	0.3	0	0.012	0	0.443	0	24.576
34.282	0.267	0.817	0.001	0.031	0	4.672	0	18.668
38.119	0.546	7.483	0	0	0.008	0.78	0	28.092

38.56	0.756	7.297	0	0	0.001	2.855	0	25.252
37.664	3.091	0.18	0.001	0	0	3.601	0	22.254
37.587	3.089	0.172	0	0	0	3.76	0	22.004
37.573	2.876	0.157	0	0.009	0	4.177	0.014	21.452
37.472	2.899	0.279	0	0	0	3.598	0.013	22.367
40.776	4.657	0.204	0.006	0.001	0.003	6.144	0.014	20.159
40.693	4.586	0.214	0	0.012	0	6.017	0	20.721

Is

up

Tennantite series	
Tennantite-(Fe)	$\text{Cu}_6(\text{Cu}_4\text{Fe}_2)\text{As}_4\text{S}_{13}$
Tennantite-(Zn)	$\text{Cu}_6(\text{Cu}_4\text{Zn}_2)\text{As}_4\text{S}_{13}$
<i>Tennantite-(Cu)</i>	$\text{Cu}_6(\text{Cu}_4\text{Cu}_2)\text{As}_4\text{S}_{13}$
<i>Tennantite-(Hg)</i>	$\text{Cu}_6(\text{Cu}_4\text{Hg}_2)\text{As}_4\text{S}_{13}$
<i>Tennantite-(Mn)</i>	$\text{Cu}_6(\text{Cu}_4\text{Mn}_2)\text{As}_4\text{S}_{13}$
Arsenofreibergite series	
Argentotennantite-(Zn)	$\text{Ag}_6(\text{Cu}_4\text{Zn}_2)\text{As}_4\text{S}_{13}$
<i>Argentotennantite-(Fe)</i>	$\text{Ag}_6(\text{Cu}_4\text{Fe}_2)\text{As}_4\text{S}_{13}$
Giraudite series	
Giraudite-(Zn)	$\text{Cu}_6(\text{Cu}_4\text{Zn}_2)\text{As}_4\text{Se}_{13}$
<i>Giraudite-(Cu)</i>	$\text{Cu}_6(\text{Cu}_4\text{Cu}_2)\text{As}_4\text{Se}_{13}$
<i>Giraudite-(Fe)</i>	$\text{Cu}_6(\text{Cu}_4\text{Fe}_2)\text{As}_4\text{Se}_{13}$
<i>Giraudite-(Hg)</i>	$\text{Cu}_6(\text{Cu}_4\text{Hg}_2)\text{As}_4\text{Se}_{13}$
Goldfieldite series	
Goldfieldite	$(\text{Cu}_4\text{□}_2)\text{Cu}_6\text{Te}_4\text{S}_{13}$
<i>"Stibiogoldfieldite"</i>	$\text{Cu}_6\text{Cu}_6(\text{Sb}_2\text{Te}_2)\text{S}_{13}$
<i>"Arsenogoldfieldite"</i>	$\text{Cu}_6\text{Cu}_6(\text{As}_2\text{Te}_2)\text{S}_{13}$

Total	Det.Lim ppm Comment	Ag	S	Pb	Hg	Bi	Cd
99.724	D2	1726	336	0	1142	1684	1003
99.546	D1	1587	353	-7	1137	1563	1006
100.437	D12	1382	345	0	980	0	-1

100.437	D12	1505	341	0	1033	0	-28
100.074	D5	1582	327	0	1104	1636	0
100.12	D5	1533	362	-1	1058	1550	0
100.249	D5	1582	346	-1	1077	1619	0
100.247	D6	1559	351	0	1057	1569	0
100.31	D7	1489	357	0	1001	1527	-1
100.644	D7	1475	345	0	991	1515	-1

Cl	Cu	Fe	Zn	Ni	Co	Mn	As	Se	
190	416	278	316	0	295	0	1814	-1	
191	403	272	307	-2	286	-1696	1831	804	
174	407	263	312	-1	0	193	1968	0	

179	408	256	308	-1	-1	192	1937	0
178	408	276	302	300	-3	-7	1846	0
0	413	275	305	0	-4	-2	1868	-1
184	405	281	311	-4	280	-2	1884	832
188	404	268	303	0	-2	207	1864	-3
178	400	270	302	289	274	194	2017	850
-1	399	279	299	-2	269	-1	1951	-1

Sb	Date
1324	#####
1270	#####
1212	#####

1193 #####
1232 #####
1256 #####
1242 #####
1216 #####
1233 #####
1201 #####