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Kraisslite, a new platy arsenosilicate from Sterling Hill, New Jersey

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Abstract

Kraisslite is a new species from the Sterling Hill Mine, Ogdensburg, Sussex County, New Jersey. It closely resembles mcgovernite in physical appearance. The mineral occurs between the 700′ and 950′ levels in the central zincite zone, as films and lenses up to one inch thick along fractures. Twenty species were identified in the suite, of which sixteen are secondary minerals. Eveite, synadelphite, retzian, hodgkinsonite, holdenite, and austinite constitute new finds.

Kraisslite is hexagonal, a = 8.22(1) c = 43.88(5)A, space group $P6_322$, and is probably structurally related to hematolite and mcgovernite. Specific gravity 3.876, hardness between 3 and 4, cleavage {0001} perfect and inelastic, color deep coppery-brown, streak golden-brown, luster submetallic, uniaxial (+), birefringence weak, ω = 1.805(2). The chemical composition is $(Mn^{2+}_{0.89}Mg_{0.08}Fe^{2+}_{0.03})_{24}Zn_4(AsO_4)_4(SiO_4)_8(OH)_{12}$.

The new mineral honors Frederick and Alice Kraissl of Hackensack, New Jersey, devoted students of Franklin mineralogy.

Occurrence and paragenesis

The new species kraisslite is known only from the Sterling Hill Mine, Ogdensburg, Sussex County, New Jersey. We are indebted to Mr. John Kolic, who mined the area where specimens occurred and provided the bulk of the information on its occurrence. All samples came from the 1010 Stope, which is located in the narrow portion of the central zincite zone. Between the 950′ and 700′ levels, kraisslite was encountered in a variety of associations, usually along the surface of fractures in the ore. It occurred as films or lenses up to one inch thick along fractures mostly from the central portion of the ore to the footwall. The ore was cut by a series of faults, separated from each other by three to four feet, whose strike was north–south and dip approximately 45° west. The walls of the faults are slickensided, and their maximum displacement was about three feet. Associated minerals include pyrochroite, barite, sphalerite, rhodochrosite, and minor amounts of a host of arsenate minerals (Table 1). Mr. Kolic informs us that a crosscut between the east and west veins encountered arsenic, realgar, stibnite, berthierite, and arsenopyrite in the drift, about five feet east of the 1010 Stope hanging-wall contact.

The ore was high-grade and consisted of willemite, franklinite, and zincite, with little or no calcite. The willemite is flesh pink in color, and the grain size of the ore minerals is about 1–4 mm. A visit by the senior author to the 700′ level showed the narrow, thin faults and thin coatings of kraisslite. It was apparent that the occurrence of the arsenate minerals was very sporadic and comprised but a tiny fraction of the vein and fracture minerals, the greater portion being carbonates.

About thirty specimens were examined in more detail and identification was made by X-ray powder, single-crystal, and reflection goniometric techniques. Of the list in Table 1, eveite, synadelphite, and retzian were hitherto known only as late-stage fissure minerals from the manganese mines in central Sweden; austinite from oxidized zinc-ore deposits; holdenite, previously known only as a single specimen from the nearby Franklin Mine. Hodgkinsonite, sarkinite, synadelphite, retzian, eveite, and allactite occur as single crystals to 0.5 mm in greatest dimension, morphologically closely resembling earlier goniometric drawings of these species. One specimen in the Gerstmann collection shows dark-red hexagonal kraisslite

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plates up to 1 mm, but no goniometric results of pyramidal and prismatic faces could be obtained, as the surface evinced some later dissolution and etching.

The source of the As-bearing minerals is a puzzle. They all postdate the ores and gangue, but it is not clear if they are products of oxidation of pre-existing arsenides and sulfarsenides or if they crystallized from late-stage solutions from an entirely different source. The presence of arsenic-bearing minerals and of the borate sussexite may have originated from the reworking of an evaporite deposit, but the evidence is not clear. The duplication of unusual late-stage species between the Sterling Hill and Franklin deposits and the central Swedish manganese ore deposits is remarkable, the only substantial difference being the presence of major zinc in the New Jersey deposits. Of the list in Table 1, the eleven minerals which contain no zinc are known from both types of deposits, the six arsenite–arsenate minerals occurring exclusively in these deposits.

X-ray study

Kraisslite, originally suspected to be mcgovernite, is easily distinguished from that mineral only by X-ray diffraction. Optical, physical, and chemical properties so overlap that other tests are ambiguous. Owing to perfect basal cleavage, samples of kraisslite and mcgovernite ground in acetone and allowed to settle on glass slides afford mainly (000*l*) reflections, thus admitting a good refinement of the *c* axis. Randomly-oriented mounts of powders yield very complex powder patterns and the consequent difficulty of distinguishing a single phase from a mixture. Although no mcgovernite was found *in situ* in this study, investigation on that mineral was done on an old specimen from the 800′ level and approximately 700′ north in the west vein, proven to be identical with the original material studied by Palache and Bauer (1927).

Rotation, Weissenberg, and precession photographs about [0001], $[11\bar{2}0]$ and $[21\bar{3}0]$ show extinctions only for 000*l*, $l \neq 2n$, Laue class $6/m2/m2/m$, and the space group is therefore $P6_322$. The cell is a = 8.22(1) c = 43.88(5)A, distinct from c = 203.15(10)A for mcgovernite. Significant streaks parallel to the c^* axis suggest that stacking mistakes occur in the structure, which is not surprising when the layered hematolite structure to which kraisslite is related is considered. Structural relations between these and related phases were discussed earlier in Moore and Araki (1978).

Table 1. Ores, gangue, and secondary minerals with kraisslite

Ores	(synmetamorphic)
Franklinite	$(Zn,Mn)(Fe,Mn)_2O_4$
Willemite	Zn_2SiO_4
Zincite	ZnO
Gangue	
Calcite	$CaCO_3$
Secondary Minerals	(post-metamorphic)
Sphalerite	ZnS
Pyrochroite	$Mn(OH)_2$
Rhodochrosite	$MnCO_3$
Barite	$BaSO_4$
Hodgkinsonite	$MnZn_2(OH)_2[SiO_4]$
Sussexite	$Mn_2(OH)[B_2O_4(OH)]$
Magnussonite	$Mn_9^{2+}[As_6^{3+}Mn^{1+}O_{18}Cl]$
Synadelphite	$(Mn,Mg)_9(OH)_9(AsO_3)(AsO_4)_2$
Holdenite	$(Mn,Mg)_6Zn_3(OH)_8(AsO_4)_2(SiO_4)$
Kraisslite	$(Mn,Mg)_{24}Zn_4(OH)_{12}(AsO_4)_4(SiO_4)_8$
Chlorophoenicite	$(Mn,Mg)_3Zn_2(OH)_6[(As_{0.5}H_{0.5})(O,OH)_3]_2$
Austinite	$CaZn(OH)(AsO_4)$
Sarkinite	$Mn_2(OH)(AsO_4)$
Eveite	$Mn_2(OH)(AsO_4)$
Allactite	$Mn_7(OH)_8(AsO_4)_2$
Retzian	$Mn_2Y(OH)_4(AsO_4)$

Results of the powder diffractometer traces, using Cu*Kα* radiation and graphite monochromator, are given in Table 2, and the (000*l*) reflections were used to refine the *c* axis. Relative intensities on the diffractograms were matched with single-crystal photographs of the 000*l* row line.

Chemical composition

A specimen showing abundant kraisslite afforded flakes optically free from any other mineral. An analysis of mcgovernite was also made. SiO_2 was determined gravimetrically; Al_2O_3, MgO, FeO, and ZnO by atomic absorption analysis, and $H_2O(+)$ by Penfield tube. Care was taken to distinguish As_2O_3 and As_2O_5 by $KMnO_4$ titration and atomic absorption for total arsenic. The results are presented in Table 3. Kraisslite, although allied to mcgovernite, contains but little As_2O_3, less MgO, and considerably less H_2O than mcgovernite.

In the absence of detailed knowledge of the kraisslite crystal structure, an unambiguous formula is difficult to propose. The computed cations based on $\Sigma(Si + As) = 12$ lead to 54.10 cations in the formula unit. We propose $(Mn^{2+}_{0.89}Mg_{0.08}Fe^{2+}_{0.03})_{24}Zn_4(AsO_4)_4(SiO_4)_8(OH)_{12}$ which leads to a density of 3.903 g cm^{-3} which is in good agreement with the specific gravity of 3.876 (Berman torsion balance, T = 23.3°C, 13.653

Table 2. Kraisslite and mcgovernite. Powder diffractometric results[†]

Kraisslite				McGovernite							
I/Io	d_o	hkℓ	c(Å)	I/Io	d_o	hkℓ	c(Å)	I/Io	d_o	hkℓ	c(Å)
5	10.902Å	00.4	43.61	30	11.205	00.18	201.69	50	2.604	00.78	203.11
1	7.266	00.6	43.60	70	5.630	00.36	202.68	10	2.560	?	------
45	4.385	00.10	43.85	20	4.832	00.42	202.94	80	2.418	00.84	203.11
35	3.651	00.12	43.81	40	4.228	00.48	202.94	100	2.257	00.90	203.13
20	3.130	00.14	43.82	20	3.760	00.54	203.04	4	2.115	00.96	203.04
2	2.993	?	-----	10	3.419	?	------	4	1.9918	00.102	203.16
100	2.740	00.16	43.84	20	3.227	?	------	4	1.9533	?	------
55	2.437	00.18	43.87	6	3.116	?	------	6	1.8808	00.108	203.13
55	2.194	00.20	43.88	6	3.074	00.66	202.88	14	1.6943	00.120	203.32
1	1.4601	00.30	43.80	10	2.900	?	------	4	1.6216	?	------
2	1.2907	00.34	43.88	10	2.852	?	------	4	1.6122	00.126	203.14
7	1.2190	00.36	43.88	30	2.819	00.72	202.97	4	1.5461	?	------
2	1.1552	00.38	43.90	6	2.761	?	------	2	1.4721	00.138	203.15

?Reflections other than 000<u>ℓ</u>.

[†] The samples were not corrected for absorption and the <u>c</u>-axes reported in this study were obtained by extrapolation of $\frac{1}{2}[\cos^2\theta/\sin\theta + (\cos^2\theta/\theta)]$ to zero.

mg pure plates). Analysis of the kraisslite structure is presently in progress.

Physical properties

Kraisslite occurs as thin curved compact foliated scales of pale red-brown color to coarse (up to 1 cm) plates of deep coppery-brown color, much resembling mcgovernite, hematolite, and dixenite. The streak is golden-brown, luster submetallic, hardness between 3 and 4, cleavage {0001} perfect to micaceous. Thin plates are brittle and inelastic.

The mineral is coppery in reflected light and rich brown in transmitted light. It is uniaxial (+), birefringence weak, $\omega = 1.805(2)$. The mean index of refraction, calculated from the relation of Gladstone and Dale and using the chemical analysis and specific gravity, is $\langle n \rangle = 1.750$.

Table 3. Kraisslite. Chemical analysis and its interpretation

	1	2	3		4	5	6
As_2O_5	17.7%	15.22%	4.82		4.00	13.15%	12.48%
SiO_2	13.8	15.93	7.18		8.00	8.83	8.92
As_2O_3	0.87	-----	0.28		----	4.78	4.45
Al_2O_3	0.21	-----	0.13		----	0.12	nil
MgO	2.53	2.56	1.97	25.61	----	11.02	11.27
MnO	51.6	50.22	22.80		24.00	42.5	42.73
FeO	1.92	1.71	0.84		----	1.49	1.53
ZnO	8.47	10.78	3.26		4.00	10.58	10.22
H_2O^+	3.68	3.58	12.82		12.00	8.30	8.49
Total	100.78	100.00	54.10		52.00	100.77	100.09

[1] Kraisslite (type). Sterling Hill. Jun Ito, analyst. The specific gravity is 3.876. About 300 mg was analyzed.

[2] Computed weight percent for $(Mn_{.89}Mg_{.08}Fe_{.03})_{24}Zn_4(SiO_4)_8(AsO_4)_4(OH)_{12}$. $\rho = 3.903$ g cm^{-3}.

[3] Computed cations based on $\Sigma(Si+As) = 12$.

[4] Cations for ideal end-member formula $Mn_{24}Zn_4(SiO_4)_8(AsO_4)_4(OH)_{12}$.

[5] McGovernite. Jun Ito, analyst.

[6] McGovernite. L. H. Bauer analysis in Palache and Bauer (1927).

Name

It is a pleasure to name the new mineral in honor of Mr. Frederick and Mrs. Alice Kraissl of Hackensack, New Jersey, who play a pivotal role in the mineralogy of Franklin and Ogdensburg. They have been deeply involved in the Franklin-Ogdensburg Mineralogical Society and have contributed substantially to the Mineralogical Museum in Franklin. The new mineral and name received prior approval by the Commission on New Minerals and New Mineral Names, International Mineralogical Association.

The type samples are deposited in the Smithsonian Institution, National Museum of Natural History (NMNH 137017 and 137018). The mineral is not rare but usually occurs as thin films.

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