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X-RAY DIFFRACTION DATA OF ALUMINOCOPIAPITE[1]

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Aluminocopiapite, essentially $(Mg, Fe^{2+})Fe^{3+},Al)_4(SO_4)_6(OH)_2 \cdot 20 H_2O$, has been identified on the basis of chemical and optical analysis from material collected in Alaska. Although the lattice constants of several copiapites were determined by Berry (1938) and Palache, Peacock and Berry (1946), they did not publish X-ray diffraction patterns of these minerals. An X-ray diffraction pattern identified by Smith *et al.*, (1958) as being of copiapite is now believed to represent natrojarosite (pers. comm. Erd, 1966). Kubisz (1964) published unindexed X-ray diffraction and other data for several copiapites. Because of compositional variations, however, his X-ray data are not directly comparable to that obtained in the present study. Therefore, the authors feel that the X-ray diffraction data on the aluminocopiapite from Alaska will be useful in identifying this varietal type of copiapite.

The aluminocopiapite from Alaska was found along the north bank of Mosquito Fork of the Forty Mile River about 500 feet north of Gold Creek in the Eagle A-3 quadrangle. It occurs as a thin local efflorescence in sheared and crushed bedrock of the river bank near an old prospect pit. The bedrock in the area is probably the Precambrian or Paleozoic Birch Creek Schist (Mertie, 1937), but is so badly crushed that it could not be identified with certainty; however, the material appears to include fragments of quartzite and metashale. The crushed rock immediately associated with the aluminocopiapite is composed largely of quartz, albite, chlorite, kaolinite and lesser amounts of muscovite and pyrite.

The aluminocopiapite occurs as minute, fragile lemon-yellow scales and as earthy blooms covering surfaces in the sheared rocks and appears to form locally by the oxidation of pyrite. The mineral has the following optical properties.

Moderate axial angle (Optically positive)

α = undetermined	Y = colorless
$\beta = 1.535 \pm .002$	Z = greenish yellow
$\gamma = 1.585 \pm .002$	

Chemical and semiquantitative optical spectrographic analyses (Table 1) of material optically estimated to be at least 97 percent

[1] Publication authorized by Director, U. S. Bureau of Mines and Director, U. S. Geological Survey.

copiapite, indicate that the mineral is aluminocopiapite (Berry, 1946). Based on six sulfur atoms in the cell (Berry, 1946), the empirical formula of the mineral is $(Mg_{0.59}Al_{0.30}Fe^{2+}{}_{0.03}Co_{0.03}Cu_{0.02})$ $(Fe^{3+}{}_{3.56}Al_{0.44})$ $(SO_4)_6$ $(OH)_2 \cdot 19.7\ H_2O)$. The density of the mineral, unfortunately, was not physically determined, but the calculated density ($2.163 g \cdot cm^{-3}$) compares favorably with the other densities reported for copiapite.

The X-ray diffraction data (Table 2) were obtained with a 114.6 mm diameter Debye-Scherrer camera using Mn-filtered iron radiation (FeK_α $=1.9373$ Å). The mineral was gently crushed, put in 0.02-mm-diameter glass capillaries and exposed for 8 hours. Care must be taken not to excessively grind the mineral because aluminocopiapite will smear and become gummy and will yield a poor X-ray diffraction pattern with considerable line broadening.

TABLE 1. CHEMICAL ANALYSIS OF ALUMINOCOPIAPITE[1]

	1	2			3	4
MgO	1.94	1.97	X	Mg	.59	
CoO	0.16	0.16		Co	.03	
FeO	0.17	0.17		Fe^{2+}	.03	1.12
CuO	0.05	0.15		Cu	.02	
Fe_2O_3	23.16	23.58		Al	.30	
Al_2O_3	3.12	3.17	R^{3+}	Fe^{3+}	3.56	
SO_3	39.18	39.90		Al	.44	6.00
H_2O	30.40	30.90	S		6.00	18.00
Rem	1.40[1]	—	H_2O			(20.7)
Total	99.68	100.0				25.12

1. Analyst, H. Ice, U. S. Bureau of Mines.
2. Corrected to 100%, less Rem.
3. Total cation moles/6 S atoms.
4. Oxygen moles.

[1] Semiquantitative optical spectrographic analysis of aluminocopiapite indicated: >10%—Fe; 0.3–3.0%–Al, Mg; 0.1–1.0%—Ca, Si; 0.03–0.3%—Co, Cu, Mn; 0.01–0.1%—K, Na; <0.03%—Cr, Li, Ti.

The calculated values were derived from the following unit-cell data:

Triclinic $P\bar{1}$

$a = 7.251$ Å	$\alpha = 93°59'35''$
$b = 18.161$ Å	$\beta = 102°17'16''$
$c = 7.267$ Å	$\gamma = 97°57'46''$

These unit-cell data were obtained by computer using the U. S. Geo-

TABLE 2. X-RAY DIFFRACTION DATA OF ALUMINOCOPIAPITE

hkl	*d*(calc.)	*d*(obs.)	*I*	*hkl*	*d*(calc.)	*d*(obs.)	*I*
010	17.891	18.1	8	$\bar{2}20$	3.447	3.45*	1
020	8.945	9.2	10	$\bar{1}12$	3.435		
001	7.063	7.13[1]	<1	$\bar{1}41$	3.432		
100	6.997			$\bar{1}50$	3.411		
$\bar{1}10$	6.895			$0\bar{2}2$	3.406		
$0\bar{1}1$	6.812	6.82*	1	$\bar{1}12$	3.405		
		6.51[2]	<1	012	3.399		
011	6.351			$\bar{2}21$	3.348	3.36	<1
110	6.194	6.17	7	210	3.336		
$\bar{1}20$	5.987			$0\bar{5}1$	3.333		
030	5.964			$\bar{2}11$	3.332		
$0\bar{2}1$	5.842			131	3.331		
$\bar{1}01$	5.647	5.58	8	$\bar{1}22$	3.272	3.29	<1
$\bar{1}11$	5.456			$\bar{2}30$	3.249		
$\bar{1}\bar{1}1$	5.317	5.32*	3	$\bar{1}22$	3.222	3.22*	1
021	5.286			$0\bar{3}2$	3.185		
120	5.133			022	3.176		
$\bar{1}30$	4.939			$\bar{2}31$	3.140	3.14*	<1
$\bar{1}21$	4.876			$\bar{2}21$	3.118		
$0\bar{3}1$	4.806			220	3.097		
$\bar{1}\bar{2}1$	4.681	4.68*	3	$\bar{1}51$	3.086		
$1\bar{1}1$	4.537			051	3.068		
101	4.510			$1\bar{5}1$	3.057		
040	4.473	4.48	2	$\bar{1}32$	3.039	3.04*	1
031	4.343			150	3.000		
$1\bar{2}1$	4.311	4.31*	2	$\bar{2}40$	2.994		
130	4.223			060	2.982		
$\bar{1}31$	4.196	4.20*	3	$\bar{1}32$	2.979		
111	4.194			$\bar{1}5\bar{1}$	2.963		
$\bar{1}40$	4.070			141	2.935		
$\bar{1}3\bar{1}$	4.011	4.01*	3	$1\bar{1}2$	2.934		
$0\bar{4}1$	3.967			$2\bar{1}1$	2.930		
131	3.913	3.88	1	$0\bar{4}2$	2.921	2.92*	1
121	3.770			$\bar{1}60$	2.913		
041	3.615			032	2.911		
$\bar{1}41$	3.586			102	2.901		
050	3.578	3.58*	5	$\bar{2}21$	2.897		
$\bar{2}10$	3.540			$1\bar{2}2$	1.889		
$0\bar{1}2$	3.534			$\bar{2}41$	2.888		
002	3.532			201	2.887		
140	3.525			$\bar{2}3\bar{1}$	2.865		
200	3.499	3.50*	5	061	2.854		
$\bar{1}02$	3.484			230	2.830	2.83*	<1
$1\bar{4}1$	3.470			$\bar{2}02$	2.823		
$\bar{2}11$	3.466			$\bar{2}12$	2.809		
$\bar{2}01$	3.460			112	2.798		

TABLE 2—(*continued*)

hkl	*d*(calc.)	*d*(obs.)	*I*	*hkl*	*d*(calc.)	*d*(obs.)	*I*
231	2.794			160	2.599		
142	2.780			232	2.598		
052	2.777			151	2.596		
211	2.776			161	2.589		
212	2.770	2.77*	<1	240	2.567		
222	2.728	2.73*	<1	070	2.556		
250	2.724			170	2.533		
142	2.719			152	2.525		
161	2.699			232	2.508	2.508*	<1
161	2.687			071	2.486	2.485*	<1
222	2.659	2.67	1			2.360*	1
052	1.653					2.289*	<1
061	2.651					2.165*	<1
122	2.646					2.101*	<1
042	2.643					2.063*	2
241	2.641					2.009	<1
251	2.630					1.984*	<1
221	2.619	2.62*	<1			1.825	<1
142	2.619					1.727	<1
241	2.607					1.668	<1

* Lines used in final cell-parameter calculation.

[1] May be kaolinite impurity.

[2] Line cannot be accounted for.

logical Survey least-square unit-cell refinement program (pers. commun. Appleman, Evans, Handwerker, 1966).

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