AXINITE FROM CALIFORNIA.

LOCALITIES.

Well-crystallized axinite has been found at two widely separated points in California. In 1903–4 some large brownish crystals were found in Moosa Canyon, near Bonsall, San Diego County, by Mr. T. Freeman and forwarded by him to Dr. G. F. Kunz of New York, who determined them as axinite. The writer visited the locality in 1904 and collected a suite of the specimens which form the basis of this description. The work of collection was greatly facilitated through the kindness of Mr. Freeman and of Mr. J. J. Mack, both of San Diego County, whose assistance was of great value. A specimen of axinite from the Consumnes Copper Mine, Amador County, was lent to the writer from the collection of the University of California through the kindness of Prof. A. S. Eakle. The axinite, which is probably of contact origin, is associated with large epidote and small quartz crystals.

AXINITE FROM SAN DIEGO COUNTY.

OCCURRENCE.

The axinite of San Diego County appears in detached crystals associated with quartz, epidote, and a little laumontite in a much decomposed granite, and its true mode of occurrence is not determinable, for all the rock in the vicinity is greatly altered. The crystals range from minute size to a length of nearly 5 centimeters; they are generally flattened, rough, worn, and opaque, with small transparent areas scattered throughout the crystal mass. A few, which are highly decomposed, appear as a black mass consisting largely of manganese dioxide. The quartz on which the axinites are often grouped is found both in massive pieces and in distinct crystals. It is characteristically of the smoky variety, and often very closely resembles the axinite in color. A very few specimens consisted of radiated greenish epidote, surrounded by idiomorphic axinite into which the epidote fibers penetrate. The laumontite occurs sparingly as isolated white crystals situated on the other minerals.

CRYSTALLOGRAPHY.

The larger crystals of axinite are simple in their combinations and show the usual axinite forms, such as *m*, *M*, *r*, *z*, *c*, *s*, and *x*. The smaller crystals are more perfect and show a greater number of forms. Only a few of the crystals are at all suitable for measurement, most of them being too dull and uneven. Many, too, are considerably striated, and often a number are grouped in nearly parallel position.

The forms identified on these crystals are as follows, the position chosen being that of Miller as modified by Goldschmidt in his Winkeltabellen: {010}, {110}, {$1\bar{1}0$}, {$1\bar{2}0$}, {$0\bar{3}1$}?, {$0\bar{1}1$}, {$0\bar{1}2$}, {101}, {112}, {$1\bar{2}1$}, {$1\bar{1}1$}, {$\bar{1}\bar{1}1$}, {$\bar{1}\bar{1}2$}, {$\bar{2}\bar{2}1$}.

The following table gives the measurements of these forms as compared with the calculated values taken from Goldschmidt's Winkeltabellen and with the letters and symbols given by Dana for the same forms:

Forms and angles for axinite from San Diego County.

Goldschmidt's symbols.		Dana's symbols.		Measured.				Calculated.			
Letter.	Symbol.	Letter.	Symbol.	ϕ		ρ		ϕ		ρ	
				°	′	°	′	°	′	°	′
c	010	*M*	$1\bar{1}0$	0	00	90	00	0	00	90	00
w	110	*w*	$1\bar{3}0$	60	27	90	00	60	16	90	00
u	$1\bar{1}0$	*m*	110	135	22	90	00	135	24	90	00
l	$1\bar{2}0$	*a*	100	150	42	90	00	151	23	90	00
ϕ	$0\bar{3}1$	ϕ	$3\bar{3}1$	176	50	68	11	177	20	71	36
r	$0\bar{1}1$	*r*	$1\bar{1}1$	172	03	46	22	172	02	45	21
z	$0\bar{1}2$	*z*	$1\bar{1}2$	164	07	27	36	164	24	27	32
a	101	*y*	021	106	00	49	00	104	04	49	10
o	112	*o*	$\bar{1}32$	53	38	32	00	53	49	31	19
s	$1\bar{2}1$	*s*	201	153	31	68	29	153	49	68	32
x	$1\bar{1}1$	*x*	111	138	44	59	44	138	48	59	36
n	$\bar{1}\bar{1}1$	*n*	$1\bar{3}1$	117	17	57	43	117	16	57	38
δ	$\bar{1}\bar{1}2$	δ	$1\bar{3}2$	115	27	40	28	115	08	40	26

Of these forms {010}, {110}, {$1\bar{1}0$}, {$1\bar{2}1$}, and {$0\bar{1}1$} are large, the other forms occur as small faces.

The form κ {$\bar{2}\bar{2}1$} was noted on one crystal in a zone with the forms {110} large, {$\bar{2}\bar{2}1$} line face, {$\bar{1}\bar{1}1$} medium, and {$\bar{1}\bar{1}2$} line face.

CHEMICAL COMPOSITION.

A large sample was crushed and the clear fragments of axinite picked out. Treatment with heavy solution served to remove a little quartz similar in color and appearance which had been picked up with the axinite. The following is the average of several analyses. The water was given off above 110° and its amount was determined directly.

Analysis of axinite, San Diego County.

SiO_2	42.61
Al_2O_3	17.43
Fe_2O_3	.38
FeO	7.53
MnO	4.10
MgO	.44
CaO	19.74
H_2O	1.56
B_2O_3	6.04
	99.83

As this analysis was made before the oxidizing effect of grinding was known, the true amount of ferric oxide in the mineral may be even less than that given.

The ratios calculated from the analysis are shown herewith.

Ratios of analysis of axinite, San Diego County.

SiO_2	0.710=8.00
Al_2O_3, Fe_2O_3	.173=1.95
FeO, MnO, MgO	.174=1.96
CaO	.353=3.97
H_2O	.087= .98
B_2O_3	.086= .97

The above figures indicate the formula for axinite to be $8SiO_2.2Al_2O_3.2(Fe,Mn,Mg)O.4CaO.1H_2O.1B_2O_3$. If all the bivalent bases are grouped together, the formula reduces to $8SiO_2.2Al_2O_3.1B_2O_3.7RO$, the one proposed by Ford[1] for the mineral in a discussion of several analyses including his own, in the course of which paper he shows that the general formula for axinite may be written:

$$8SiO_2.\ B_2O_3.\ 2R_2'''O_3.\ 7R''O$$
$$R'''=Al,Fe'''$$
$$R''=Ca,Fe'',Mn,Mg,H_2$$

Examination of the more recent trustworthy analyses of axinite has convinced the writer that the calcium content is constant, and that, as the iron and manganese vary reciprocally, there are two end products, one free from iron and the other free from manganese, and that all axinites may be considered as isomorphous mixtures of these two end products.

Thirteen trustworthy analyses, in nearly all of which the water was determined directly, were selected, and the ratios of the various constituents calculated. These analyses, arranged in the order of increasing amounts of manganese, are given below.

[1] Ford, W. J., On the chemical composition of axinite: Am. Jour. Sci., 4th ser., vol. 15, 1903, p. 195.

Analyses of axinite.

No.	SiO_2.	B_2O_3.	Al_2O_3	Fe_2O_3	FeO.	MnO.	CaO.	MgO.	H_2O.	K_2O.	Na_2O.	(Cu, Zn, Pb)O.
1	42.89	6.02	18.25	0.64	7.11	1.06	19.89	2.23	2.14	0.11	0.36	......
2	43.46	5.61	16.33	2.80	6.78	2.62	20.19	1.73	1.45	.11	......	......
3	42.78	6.12	17.67	.99	6.02	2.99	20.16	2.41	1.40	......	......	......
4	41.53	4.62	17.90	3.90	4.02	3.79	21.66	.74	2.16	......	......	......
5	42.10	4.64	17.40	3.06	5.84	4.63	20.53	.66	1.80	......	......	......
6	42.40	4.71	17.39	.59	4.89	6.16	19.57	1.69	1.64	.25	.24	(F=.22)
7	42.40	4.88	17.26	1.33	4.27	6.97	19.53	1.30	1.90	......	......	......
8	42.55	4.20	16.37	3.79	4.06	7.69	19.28	1.02	(1.33)	......	......	......
9	41.96	4.61	17.69	.81	3.61	8.51	19.71	.97	1.93	......	......	(F=1.11)
10	42.85	5.17	16.96	5.00	......	9.59	18.49	.87	(.75)	......	......	.19
11	41.80	5.61	17.15	1.11	2.84	10.71	19.51	.21	1.22	......	......	......
12	42.47	5.05	16.85	1.16	......	13.14	18.35	.26	1.21	......	......	1.73
13	42.77	5.10	16.73	1.03	......	13.69	18.25	.23	1.29	......	......	1.60

1. Jannasch and Locke, Zeitschr. anorg. Chemie, vol. 6, 1894, p. 57.
2. Rammelsberg, Zeitschr. Deutsch. geol. Gesell., vol. 21, 1869, p. 689.
3, 11. Ford, Am. Jour. Sci., 4th ser., vol. 15, 1903, p. 195.
4, 5. Whitfield, Am. Jour. Sci., 3d ser. vol. 34, 1887, p. 286.
6, 7, 9. Mauzelius, Geol. för. Förh., vol. 17, 1895, p. 279.
8. Cleve, Geol. för. Förh., vol. 17, 1895 p. 279.
10, 12, 13. Genth, Am. Jour. Sci., 3d ser. vol. 41, 1891, p. 394.

In analyses 8 and 10 the water content was determined by ignition, and the ratios are for that reason omitted in the following table. The figures for the water content in analyses 12 and 13 are those obtained by Ford.[1] The percentage of fluorine (1.11) given in analysis 9 is undoubtedly too high.

Ratios from the foregoing analyses are shown in the following table. The small amounts of zinc, lead, copper, soda, and potash present have been added to the magnesia ratio.

Ratios of axinite analyses.

Analysis No.—	SiO_2.	B_2O_3.	Al_2O_3.	FeO.	MnO.	CaO.	MgO.	H_2O.
1	7.96	0.96	2.06	1.10	0.16	3.98	0.70	1.34
2	8.14	.90	2.00	1.06	.42	4.04	.50	.90
3	8.02	.98	1.98	.94	.48	4.04	.74	.86
4	7.82	.76	2.28	.64	.60	4.38	.20	1.36
5	7.92	.74	2.14	.92	.74	4.14	.18	1.14
6	7.84	.76	1.96	.76	.98	3.92	.54	1.16
7	7.84	.78	2.00	.66	1.10	3.90	.12	1.18
8	8.10	.70	2.12	.64	1.24	3.96	.32	......
9	7.88	.74	2.02	.56	1.36	4.00	.28	1.32
10	8.10	.84	2.26	None.	1.54	3.78	.26	......
11	7.84	.92	1.98	.44	1.72	3.98	.06	.76
12	8.08	.84	1.98	None.	2.12	3.76	.32	.78
13	8.38	.86	1.96	None.	2.28	3.84	.30	.84

The average of the above ratios of the 13 analyses given is $7.99SiO_2$. $0.83B_2O_3$. 2.06 $(Al,Fe)_2O_3$. 2.07 (Fe,Mn,Mg)O. 3.90CaO. $1.05H_2O$. The boric acid ratio is a little low because of the incomplete extraction of B_2O_3 in the analyses. The average ratios, like

[1] Loc. cit.

those of the analysis of axinite from Bonsall, San Diego County, are very close to the simple formula:

$$8SiO_2.2Al_2O_3.1B_2O_3.2(Fe,Mn,Mg)O.4CaO.1H_2O.$$

As can be seen by the table of analyses on page 40, the ferrous iron and manganese vary reciprocally, because of which fact the writer considers axinite an isomorphous mixture of the two minerals, ferroaxinite, $Al_2BHCa_2FeSi_4O_{16}$ and manganoaxinite, $Al_2BHCa_2MnSi_4O_{16}$. Whitfield[1] suggested that there were two such end products, but his formulas differed from those given above. These two compounds may be readily distinguished qualitatively, where either preponderates sufficiently in a mixture, by the color of the bead of the fused mineral. That of ferroaxinite is black, and that of manganoaxinite is very light colored or gray if a slight amount of iron is present.

One analysis, that by Baumert,[2] is purposely omitted, as the high calcium content (30.21 per cent) obtained occasions some doubt as to the accuracy of the analysis, especially as the sequioxides are also low.

The specific gravity of the mineral apparently increases with the amount of manganese present, as is shown in the following table, but it is probable that careful determinations on pure material will show that ferroaxinite is slightly the heavier.

Specific gravity of axinite.

Analysis No.—	Per cent MnO.	Specific gravity.
1	1.06	3.268
2	2.62	
3	2.99	3.287
4	3.79	
5	4.63	
6	6.16	3.28
7	6.97	3.30
8	7.69	
9	8.51	3.30
10	9.59	3.299
11	10.71	[a] 3.302
12	13.14	3.306
13	13.69	3.358

[a] Given by Ford (loc. cit.) as 3.028 by mistake. Ford has informed the writer that the value should be as given above.

It was proposed to investigate the various physical constants of axinite in order to see if corresponding variations could be determined for the different ratios of FeO to MnO, but the material available was lost by fire before the work could be undertaken.

[1] Am. Jour. Sci., 3d ser., vol. 34, 1887, p. 286.

[2] Zeitsch. Nat. Halle, vol. 42, 1889, p. 1, and Dana's System of Mineralogy, 6th ed., p. 529.

AXINITE FROM AMADOR COUNTY.

CRYSTALLOGRAPHY.

The crystals of axinite from the Consumnes copper mine, Amador County, are very small, their dimensions rarely exceeding 2 millimeters, and are for the most part transparent and highly polished. They are associated with large epidote and quartz crystals, which are covered with a drusy coating of small axinites. These axinites lie on the epidote and quartz, and also penetrate them to some extent, some axinite being entirely embedded in the quartz. Preliminary measurements of two crystals showed that the small crystals were very rich in forms, and it was intended to continue the study of these crystals, as well as of the mineral axinite in general, at some future time. Of 24 forms noted on the crystals, 8 are apparently new. The list of forms follows, the symbols being given in Miller's orientation as modified by Goldschmidt in his Winkeltabellen. New forms are starred. {010}, {100}, {110}, *{210}, {120}, *{14.1.0}, {$1\bar{1}0$}, {$3\bar{4}0$}, {$2\bar{3}0$}, {$3\bar{5}0$}, {$1\bar{3}0$}, {$9\bar{7}0$}, *{$9\bar{4}0$}, *{$7\bar{2}0$}, *{$9.\bar{10}.0$}, *{$2\bar{9}0$}, {$1\bar{2}0$}, *{$7\bar{8}0$}, *{$1.\bar{13}.0$}, {112}, {011}, {$0\bar{1}1$}, {$1\bar{2}1$}, {$1\bar{1}1$}.

The average measurements of these forms as compared with the calculated values are shown in the table below.

Forms and angles, axinite.

[Asterisks indicate new form.]

Goldschmidt.		Dana.		Measured.				Calculated.			
Letter.	Symbol.	Letter.	Symbol.	ϕ		ρ		ϕ		ρ	
				°	′	°	′	°	′	°	′
c	010	*M*	$1\bar{1}0$	0	00	90	00	0	00	90	00
M	100	*b*	010	102	27	90	00	102	30	90	00
γ	120	......	$1\bar{2}0$	36	15	90	00	36	15	90	00
w	110	*w*	$1\bar{3}0$	61	58	90	00	60	16	90	00
**A*	210	......	$1\bar{6}0$	80	22	90	00	80	06	90	00
**C*	14. 1. 0	......	1. 29. 0	99	23	90	00	99	22	90	00
**D*	$7\bar{2}0$	......	160	113	56	90	00	114	08	90	00
**E*	$9\bar{4}0$	......	270	119	45	90	00	119	51	90	00
S	$9\bar{7}0$	......	7. 11. 0	129	55	90	00	129	58	90	00
u	$1\bar{1}0$	*m*	110	135	24	90	00	135	24	90	00
**F*	$9.\bar{10}.0$	......	540	137	49	90	00	137	47	90	00
**G*	$7\bar{8}0$	......	430	138	22	90	00	138	26	90	00
α	$3\bar{4}0$	*α*	210	142	19	90	00	141	58	90	00
H	$2\bar{3}0$	*H*	310	144	07	90	00	144	40	90	00
β	$3\bar{5}0$	*β*	510	147	24	90	00	147	03	90	00
l	$1\bar{2}0$	*a*	100	151	21	90	00	151	23	90	00
h	$1\bar{3}0$	*h*	$3\bar{1}0$	159	18	90	00	158	58	90	00
**N*	$2\bar{9}0$	......	$9\bar{5}0$	165	18	90	00	165	12	90	00
**P*	$1.\bar{13}.0$	......	$13.\bar{15}.0$	174	34	90	00	174	26	90	00
e	011	*e*	$\bar{1}11$	6	36	45	42	7	58	45	16
x	$1\bar{1}1$	*x*	111	138	45	60	57	138	48	59	36
s	$1\bar{2}1$	*s*	201	153	00	69	05	153	49	68	32

Of the above forms, $\gamma\{120\}$ was first given by Sjögren[1] on axinite from Nordmarken.

The measurements of the narrow face gave the following values:

Measurements of $\gamma\{120\}$.

Symbol.	Measured.	Calculated.	Difference.
	° ′	° ′	° ′
$010 \wedge 120$	36 15	36 15	0 00
$110 \wedge 120$	24 12	24 01	0 11
$\bar{1}10 \wedge 120$	98 55	99 09	0 14

The form $S\{9\bar{7}0\}$ was first noted by Franck[2] and was observed once as a narrow face giving a poor reflection.

Measurements of $S\ \{9\bar{7}0\}$.

Symbol.	Measured.	Calculated.	Difference.	Franck's measurement.
	° ′	° ′	° ′	° ′
$0\bar{1}0 \wedge 9\bar{7}0$	50 05	50 02	0 03	49 44
$\bar{1}\bar{2}0 \wedge 9\bar{7}0$	21 27	21 25	0 02	....
$100 \wedge 9\bar{7}0$	27 07	27 28	0 21	....
$9.\bar{10}.0 \wedge 9\bar{7}0$	7 54	7 49	0 05	....

The following eight prisms are evidently new—at least they are not described in the literature of the subject, so far as known to the writer.

The form $A\{210\}$ occurs as a line face giving a poor reflection.

Measurements of $A\{210\}$.

Symbol.	Measured.	Calculated.	Difference.
	° ′	° ′	° ′
$100 \wedge 210$	22 08	22 24	0 16
$14.1.0 \wedge 210$	19 01	19 16	0 15

The prism $C\{14.1.0\}$ has more of a vicinal symbol than most of the new prisms, but the measured and calculated angles agree so well that the form is considered established. It occurs as a line face giving a poor reflection.

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[1] Sjögren, Hj., Beiträge z. Mineralogie Schwedens: Bull. Geol. Inst. Upsala, vol. 1, 1892, p. 1.

[2] Franck, A., Bull. Acad. Belgique, vol. 25, 1893, p. 17.

Measurements of $C\{14.1.0\}$.

Symbol.	Measured.	Calculated.	Difference.
	° ′	° ′	° ′
$1\bar{1}0 \wedge 14.1.0$	36 01	36 02	0 01
$100 \wedge 14.1.0$	3 07	3 08	0 01

The new form $D\{7\bar{2}0\}$ is present once as a line face giving a poor reflection.

Measurements of $D\{7\bar{2}0\}$.

Symbol.	Measured.	Calculated.	Difference.
	° ′	° ′	° ′
$0\bar{1}0 \wedge 7\bar{2}0$	66 04	65 52	0 12
$100 \wedge 7\bar{2}0$	11 08	11 38	0 30
$9\bar{4}0 \wedge 7\bar{2}0$	5 49	5 43	0 06

The prism $E\{9\bar{4}0\}$ occurs with the preceding form, and, like it, is a line face giving a poor reflection.

Measurements of $E\{9\bar{4}0\}$.

Symbol.	Measured.	Calculated.	Difference.
	° ′	° ′	° ′
$0\bar{1}0 \wedge 9\bar{4}0$	60 15	60 09	0 06
$100 \wedge 9\bar{4}0$	16 57	17 21	0 24
$9.\bar{10}.0 \wedge 9\bar{4}0$	18 04	17 56	0 08

The form $F\{9.\bar{10}.0\}$ approaches to a vicinal form, though the measured and calculated angles agree well. It is present as a narrow face much broader than a line face and gives a fairly good reflection. Apparently, it replaces the form $u\{1\bar{1}0\}$, for the two are not found together.

Measurements of $F\{9.\bar{10}.0\}$.

Symbol.	Measured.	Calculated.	Difference.
	° ′	° ′	° ′
$0\bar{1}0 \wedge 9.\bar{10}.0$	42 11	42 13	0 02
$1\bar{2}0 \wedge 9.\bar{10}.0$	13 33	13 36	0 03
$100 \wedge 9.\bar{10}.0$	35 01	35 17	0 16

The new prism $G\{7\bar{8}0\}$ is v
measured and calculated angles
with or near to the form $\{15.\bar{17}.$
It is present as a line face wit
County. The reflection was fa

Measurem

Symbol.	Measured
	°
$0\bar{1}0 \wedge 7\bar{8}0$......	41
$1\bar{1}0 \wedge 7\bar{8}0$......	2
$1\bar{2}0 \wedge 7\bar{8}0$......	12

The form $N\{2\bar{9}0\}$ occurs as
reflection.

Measure

Symbol.	Me
$0\bar{1}0 \wedge 2\bar{9}0$......	1
$1\bar{2}0 \wedge 2\bar{9}0$......	1
$1\bar{1}0 \wedge 2\bar{9}0$......	2

The new prism $P\{1.\bar{13}.0\}$ is c
the other forms here described
agree well. It is present as a
good reflection.

Measurem

Symbol.	
$0\bar{1}0 \wedge 1.\bar{13}.0$...	
$1\bar{2}0 \wedge 1.\bar{13}.0$...	2
$1\bar{1}0 \wedge 1.\bar{13}.0$...	3

[1] Offret, A., and Gonnard, F., Note cristallo
éral., vol. 16, 1893, p. 75.

The new prism $G\{7\bar{8}0\}$ is very close to the above, though the measured and calculated angles agree well. It is probably identical with or near to the form $\{15.\bar{17}.0\}$, described by Offret and Gonnard.[1] It is present as a line face with $u\{1\bar{1}0\}$ on the crystal from Amador County. The reflection was fairly good.

Measurements of G $\{7\bar{8}0\}$.

Symbol.	Measured.	Calculated.	Difference.	Measured by Offret and Gonnard.
	° ′	° ′	° ′	° ′
$0\bar{1}0 \wedge 7\bar{8}0$	41 38	41 34	0 04	....
$1\bar{1}0 \wedge 7\bar{8}0$	2 58	3 02	0 04	2 48
$1\bar{2}0 \wedge 7\bar{8}0$	12 39	12 57	0 18	....

The form $N\{2\bar{9}0\}$ occurs as a narrow face giving a fairly good reflection.

Measurements of $N\{2\bar{9}0\}$.

Symbol.	Measured.	Calculated.	Difference.
	° ′	° ′	° ′
$0\bar{1}0 \wedge 2\bar{9}0$	14 42	14 48	0 06
$1\bar{2}0 \wedge 2\bar{9}0$	13 45	13 49	0 04
$1\bar{1}0 \wedge 2\bar{9}0$	29 54	29 48	0 06

The new prism $P\{1.\bar{13}.0\}$ is of a vicinal character, but, like some of the other forms here described, the measured and calculated angles agree well. It is present as a narrow face next to $\{0\bar{1}0\}$, and gives a good reflection.

Measurements of $P\{1.\bar{13}.0\}$.

Symbol.	Measured.	Calculated.	Difference.
	° ′	° ′	° ′
$0\bar{1}0 \wedge 1.\bar{13}.0$	5 26	5 34	0 08
$1\bar{2}0 \wedge 1.\bar{13}.0$	23 11	23 25	0 14
$1\bar{1}0 \wedge 1.\bar{13}.0$	39 10	39 02	0 08

[1] Offret, A., and Gonnard, F., Note cristallographique sur l'axinite de l'Oisans: Bull. Soc. franç. minéral., vol. 16, 1893, p. 75.

CHEMICAL COMPOSITION.

Lack of material made it impossible to obtain enough axinite for a more complete analysis than is here given. The sample analyzed was not quite pure, for small amounts of impurities were plainly visible before the sample was ground. It was necessary to determine the boric acid content by difference. The analysis and ratios follow:

Analysis and ratios of axinite from Amador County.

	Analysis.	Ratios.
SiO_2	42.79	8.00
Al_2O_3	16.38	1.81
FeO	4.22	}
MnO	8.76	} 2.05
MgO	0.09	}
CaO	19.21	3.85
H_2O	1.85	1.16
B_2O_3 (by difference)	6.70	1.02
	100.00	

The ratios approximate those proposed in the first part of this paper, but the material was of too poor quality and of too slight amount to admit of accurate deductions from the analysis. It may be noted that in the Amador County axinite the manganese predominates over the iron, whereas in the axinite from San Diego County the reverse is true.

In a recent number of Tschermak's Mineralogische und Petrographische Mitteilungen Fromme [1] gives, in connection with a description of several minerals from the Radautale, an analysis of axinite. The formula derived from that analysis and Fromme's discussion of the composition of axinite require some comment. The analysis given is as follows:

Analysis of axinite from Radautale (by Fromme).

SiO_2	41.73
B_2O_3	6.30
Al_2O_3	17.08
Fe_2O_3	1.87
FeO	1.35
CaO	18.65
MnO	11.54
MgO	0.34
H_2O	1.81
	100.67

[1] Fromme, J., Chemisch-mineralogische Notizen aus dem Radautale: Min. pet. Mitt., vol. 28, 1909, pp. 305–328.

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places the manganese and magne
from the analysis. His view that
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and CaO do not isomorphously r
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bergite and ilvaite. The fact tha
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The proportion of CaO + FeO to
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available, much less than that of

Fromme rightly combines the ferric iron with the alumina, and also places the manganese and magnesia together in deducing the formula from the analysis. His view that the ferrous iron and calcium replace each other is, however, open to serious question, for in general FeO and CaO do not isomorphously replace each other in silicates, as is shown, for example, by the behavior of these compounds in hedenbergite and ilvaite. The fact that FeO and CaO are not isomorphous in axinite is made clear by the table of analyses given on p. 40. The proportion of CaO + FeO to SiO_2, for instance, is variable, and depends on the amount of FeO present, for both the SiO_2 and CaO are fairly constant.

Curiously enough, Fromme deduces from his analysis the formula of a *magnesium* axinite, which he regards as the primary type or "Grundtypus," even though his analysis shows only 0.34 per cent MgO and despite the fact that an analysis of axinite in which MgO predominates has never been published. Fromme calls his axinite a relatively pure manganese axinite, even though in the same sentence he speaks of the magnesium axinite as the type.

The formula proposed by Fromme for manganese axinite, namely, $HMnCa_2BAl_2Si_4O_{16}$, is identical with that advanced by the writer; the isomorphous relation of the FeO + MnO + MgO seems, however, to have escaped Fromme's notice. The general formula $HR''R_2''BAl_2Si_4O_{16}$ was long ago proposed by Rammelsberg, though Ford grouped the bivalent bases together rather than consider them present in fixed amount. It is the writer's belief that the evidence shows that the CaO is beyond question definite in amount and that the H_2O and the FeO + MnO + MgO are probably in definite proportion. Among the many other writers who have accepted calcium as constant is Tschermak, who, however, writes the formula for axinite $HMgCa_2BAl_2Si_4O_{16}$ with admixture of the related iron and manganese oxides. Whitfield proposed the isomorphous relation of the FeO and the MnO, but otherwise his formulas do not accord with more recent data. Therefore the view here proposed that axinite consists essentially of the two minerals, ferroaxinite ($HFeCa_2BAl_2Si_4O_{16}$) and manganoaxinite ($HMnCa_2BAl_2Si_4O_{16}$) although by no means new, puts forward clearly the evidence as it rests to-day. The existence of the corresponding magnesium axinite in a pure state is strongly indicated, but has not yet been demonstrated, for the ratio of MgO is, in all the analyses available, much less than that of FeO + MnO.