The ZrO_2, HfO_2, and ZrO_2-HfO_2 crystals are colorless and appear to be of good optical quality.

The authors wish to express appreciation to G. M. Wolten who identified and characterized the crystals by x-ray techniques.

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CACOXENITE FROM ARKANSAS

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While A. L. Kidwell[1] was a graduate student at the University of Chicago he added to my phosphate collection samples of cacoxenite obtained by him from Arkansas in August 1948. Since this material is not listed in the A.S.T.M. index, and few data appear in the abstract by Gordon (1950), and these are in conflict with what appears in Danas' System (II 997), I have recently subjected Kidwell's material to x-ray and optical study.

According to Kidwell the material came from the Isom Avants prospect pit in the bed of a dry branch in the NW. $\frac{1}{4}$, SE. $\frac{1}{4}$, sec. 1, T.4S., R. 30W., in Polk County about 2 miles southwest of the old Shady postoffice (abandoned now for some years). This is in the Ouachita Mountains near the middle of the west boundary of the state. The mineral occurs as fracture fillings in the novaculite; associated species in this area include strengite, beraunite, rockbridgeite, laubmannite, turquois, and possibly diadochite, as well as iron and manganese oxides. The geology of the area has been described by Miser and Purdue (1929). In an earlier report Miser (1918) mentions the occurrence of "dufrenite" (rockbridgeite ?) associated with the manganese deposits as green globular aggregates with a radiating structure. Penrose (1891) gave a brief description of the C. C. Avant (iron) claim in sec. 1.

The Arkansas specimens consist of brecciated limonite-stained novaculite with fracture fillings of limonite. The cacoxenite occurs lining cavities in the limonite. It consists of radiating globular masses up to about

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TABLE 1. POWDER DATA FOR CACOXENITE

Line No.	d_c	d_m	I	hk.l	d_c	hk.l	d_c	hk.l
1	23.962	22.02	8	100				
2	13.830	13.773	½	110				
3	11.981	11.940	10	200				
4	9.736	9.832	2−	101				
5	9.057	9.065	2	210				
6	7.987	7.988	1	300				
7	6.901	6.921	3	211				
8	4.863	4.897	4	202				
9	4.592	4.603	½	212				
10	4.221	4.245	1	222				
11	4.157	4.142	1	312				
12	3.9897	3.9873	1−	511				
13	3.8344	3.8479	1−	520				
14	3.7293	3.7242	1−	412				
15	3.3456	3.3452	5	512				
16	3.1933	3.1838	2−	602	3.1717	710		
17	3.1281	3.1008	1+	522				
18	3.0169	3.0200	¼	630				
19	2.9255	2.9287	1	720				
20	2.7928	2.7868	2	423				
21	2.7375	2.7303	1	513	2.7248	712		
22	2.0903	2.0928	½+	10.1.2				
23	2.0380	2.0388	½+	11.1.1, 941				
24	1.9735	1.9780	½+	762				
25	1.9345	1.9360	½+	11.1.2, 942	1.9328	663		
26	1.8128	1.8175	1	853	1.8230	763		
27	1.7628	1.7640	1−	10.3.3	1.7657	924	1.7681	715
28	1.7259	1.7243	½+	11.2.3, 773	1.7218	863	1.7286	10.1.4
29	1.5411	1.5431	1	14.0.3, 10.6.3	1.5487	716		
30	1.3828	1.3817	1−	10.7.4	1.3790	16.0.3		
31	1.3755	1.3760	1−	11.0.6	1.3751	13.6.2	1.3792	10.5.5

Measured from film 114 mm diameter Straumanis (Philips) camera, Fe/Mn radiation.
d_c = calculated spacing ($a = 27.669$, $c = 10.655$ Å).
d_m = measured spacing.
I = uncorrected visual intensity.

6 mm in diameter of very narrow acicular golden-yellow needles; in part these globules show a concentric structure. Under the microscope at ×360 magnification only a few of these are wide enough to be useful in observing the Becke fringe. The indices are $\omega = 1.600$ and $\epsilon = 1.680$, but the central parts of the needles are slightly lower in refractive index than their ends, so these figures are not better than $\pm .003$.

A sample consisting of a few needles with their c-axes in sub-parallel position was used to make an x-ray rotation picture (c-axis the rotation axis). The result was a photograph in which the layer lines were broad, the "spots" consisting of streaks of the powder-picture type normal to the layer lines. The very large number of zero-level powder lines thus produced (Table 2) was surprising. Indexing these served to give a good value of $a = 27.669$ Å. The less-reliable figure obtained for c was 10.655 Å.

TABLE 2. CACOXENITE REFLECTIONS FROM PLANES PARALLEL THE c-AXIS

I	d_m	hk.O	I	d_m	hk.O	I	d_m	hk.O
4	13.894	11	6	2.8047	81	½	1.7687	13.1
6	11.966	20	10	2.7640	55	1	1.7250	88
5	9.0944	21	8	2.6974	64	2	1.7099	14.0, 10.6
5	8.0111	30	5	2.6612	90	½	1.6891	13.2
1	6.9166	22	5	2.6122	82	1	1.6490	14.1
2	6.6617	31	7	2.5094	65, 91	1	1.6243	13.3, 98
4	6.0027	40	½	2.4819	74	2	1.5806	12.5
5	5.4929	32	7	2.4305	83	2−	1.5332	10.8
½	5.2280	41	2	2.3949	10.0	2−	1.4861	15.2, 13.5
1	4.7870	50	3	2.3595	92	1+	1.4610	14.4
2	4.6122	33	9	2.3012	66	2	1.4536	10.9
½	4.5348	42	5	2.2638	10.1	4	1.4474	16.1, 11.8
¾	4.2998	51	¾	2.1759	11.0	2	1.4360	12.7
3	3.9915	60	6	2.1491	10.2	1	1.4223	13.6
3	3.9392	43	2	2.1253	76	1	1.4015	16.2
6	2.8337	52	2	2.1080	85	2	1.3793	15.4, 11.9
4	3.6509	61	1	2.0762	11.1, 94	2	1.3624	13.7
7	3.4213	70, 53	2	2.0303	10.3	2	1.3282	15.5
8	3.3212	62	6	1.9694	11.2, 77	2−	1.2910	18.1, 14.7
10	3.1751	71	1	1.9120	10.4	2−	1.2528	13.9
7	3.0699	54	1	1.8724	11.3	2−	1.2382	17.4
1	3.0192	63	3	1.8408	13.0, 87	2−	1.2148	16.6
1	2.9937	80	2	1.8085	10.5			
7	2.9287	72	1	1.7776	11.4			

Measured from the zero level of a rotation film (57 mm diam.) exposed 5 days Fe/Mn radiation.
I = uncorrected visual intensity.
d_m = measured spacing.

A long-exposure Weissenberg yielded a series of streaks parallel the reference line. These were only slightly spotty, indicating a near-random orientation of the *a*-axes of the crystals. The results of indexing a standard-type powder picture appear in Table 1. No convincing data were obtained in conflict with Gordon's determination of the space group as $P6/mmm$?

NOTE

After the above paper had been accepted for publication an article entitled "An *X*-ray Study of the Phosphate Minerals from the Alkaline Rock Area of Songo, Sierra Leone" by Atso Vorma came to my attention. This appeared in *Bull. Com. Géol. Finlande*, **31** (196), 405–416, 1961. It contains a table showing unindexed powder *x*-ray data for cacoxenite from this locality. Vorma's results are in excellent agreement with the

data of Table 1 of my paper, though he shows lines of medium intensity at d=3.27, 2.44, 2.19, and 1.580 and lines of weak intensity at d=6.3, 5.75, 3.56, 2.63–2.24 (5 lines) and 1.680, 1.629, 1.606, 1.507 and 1.473. His paper also contains an excellent color photograph of cacoxenite sunbursts.

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