UNIT CELL AND SPACE GROUP OF MONAZITE, $(La,Ce,Y)PO_4$

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Gordon has recently described monazite from Llallagua, Bolivia[1] and he supplied the writer with crystals for an equi-inclination Weissenberg study.[2] During the preparation of this manuscript Gliszczynski[3] published data on monazite which he obtained from oscillation and rotation photographs; he apparently used the data listed in Klockmann's Lehrbuch[2] to aid him in indexing the photographs. The writer's results agree with those of Gliszczynski and are summarized below.

A description of the crystals used in this study is given by Gordon.[1] They are "translucent, and pink-flesh (Ridgway) in color. . . . The indices of refraction as determined by the oil immersion method are: $\alpha = 1.785$, $\beta = 1.787$, $\gamma = 1.840$; all ± 0.005." A chemical analysis is given below (Table 2).

Using unfiltered CuK radiation, rotation, 0-, 1st-, and 2nd-layer photographs around the *b*-axis, and rotation and 0-layer photographs around the *c*-axis were taken. A study of these photographs showed that monazite has a primitive monoclinic cell and that the space group is $P2_1/n$ (C_{2h}^5). The crystal class is therefore uniquely determined as C_{2h}.

Refined measurements of the lattice constants were not attempted because the crystal used was rather large and gave intense Weissenberg background patterns.[4] In addition, there were only a few pinacoid reflections in the high-θ regions. The lattice constants listed below (Table 1) are based on measurements of four high-θ axial zone reflections; a and c were computed from the calculated β angle.

[1] Gordon, Samuel G., Thorium-free monazite from Llallagua, Bolivia: *Notulae Naturae, Acad. Nat. Sci. Phila.*, No. **2**, May 17, 1939.

[2] No *x*-ray data on monazite appears in *Strukturbericht.* The writer was not aware of the data listed in Klockmann's *Lehrbuch der Mineralogie*, 11th ed. by P. Ramdohr, Stuttgart, **1936,** p. 460. No reference to the original paper is given.

[3] Gliszczynski, S. von, Beitrag zur "Isomorphie" von Monazit und Krokoit: *Zeits. Krist.* (A), **101,** 1–16 (1939).

[4] Buerger, M. J., *X*-ray surface reflection fields and their application to absorption corrections and to background patterns: *Zeits. Krist.*, (A), **99,** 189–204 (1938).

TABLE 1

Gliszczynski		Parrish
6.782	a	6.76
6.993	b	7.00
6.445	c	6.42
76°22′	β	76°50′
0.9698:1:0.9231	$a:b:c$	0.9660:1:0.9167
	Sp. gr., meas.	5.173
5.217	Sp. gr., calc.	5.06
	Cell volume	296

TABLE 2

	1.	2.	3.	4.
P_2O_5	29.29	29.59	0.208	9.04
SiO_2	0.27			
Ce_2O_3, etc.,	31.41	31.74	0.097	4.22
La_2O_3, etc.,	33.19	33.54	0.094	4.09
Y_2O_3, etc.,	5.08	5.13	0.023	1.00
CaO	0.34			
MgO	0.22			
	99.80	100.00		

1. Chemical analysis by Samuel G. Gordon (1). A spectrographic analysis showed no thorium.

2. Analysis recalculated to 100% after deducting SiO_2, CaO, MgO.

3. Molecular ratio.

4. Molecular ratio on basis of $Y_2O_3=1.00$.

This data yields the formula $4La_2O_3 \cdot 4Ce_2O_3 \cdot Y_2O_3 \cdot 9P_2O_5$ which is equivalent to $La_4Ce_4YPO_4$ or $(La_{4/9}, Ce_{4/9}, Y_{1/9})PO_4$ which agrees with the general monazite formula (La, Ce, Y)PO_4. There are four molecules of $(La_{4/9}, Ce_{4/9}, Y_{1/9})PO_4$ per unit cell.

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