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References

Connolly, Joseph P. (1930) The sand-calcite crystals of Devils Hill. *Black Hills Engineer*, **18**, 64–73.

Nichols, Henry Windsor (1906), New forms of concretions; Sand-barite crystals from Oklahoma. *Field Columbian Mus. Geol. Ser.*, **III**, 31–35.

Pogue, Joseph E. (1911) On sand-barites from Kharga, Egypt. *Proc. U. S. Natl. Mus.* **38**, 17–24.

Rogers, A. F. and R. D. Reed, (1926) Sand-calcite crystals from Monterey County, California. *Am. Mineral.* **11**, 23–28.

Wanless, H. R. (1922) Notes on sand-calcite crystals from South Dakota. *Am. Mineral.* **7**, 83–86.

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A NEW YTTRIAN APATITE ENCLOSED IN QUARTZ FROM NAEGI, GIFU PREFECTURE, JAPAN

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During an investigation of the minor elements contained in quartz of a pegmatite from Naegi, Gifu Prefecture, Japan (Omori and Konno, 1961), the writers found an apatite which contained a remarkable amount of yttrium, an element not heretofore reported as prominent in apatite. The present mineral differs its color, specific gravity, refractive indices, *x*-ray powder diffraction and chemical composition from abukumalite studied by Omori and Hasegawa (1953).

The mineral was discovered in quartz by observations on an artificially etched crystal (Fig. 1). This occurrence differs from the ordinary occurrence of pegmatitic apatite. The mineral measures 10–32 mm long and 2–5 mm wide. The larger crystals usually have a slender druse in their center (Fig. 2). The crystal form is hexagonal prismatic.

The mineral is pale greenish-white with a vitreous luster. Careful measurement of the specific gravity was made using a pycnometer, with the result recalculated to 4° C.; G 3.188.

Under the microscope a thin section of this mineral is colorless, transparent and uniaxial negative. The indices of refraction measured with a total refractometer; $\epsilon=1.6389$, $\omega=1.6452$, $\epsilon-\omega=(-)0.0063$.

X-ray powder diffraction data were obtained by the Geigerflex dif-

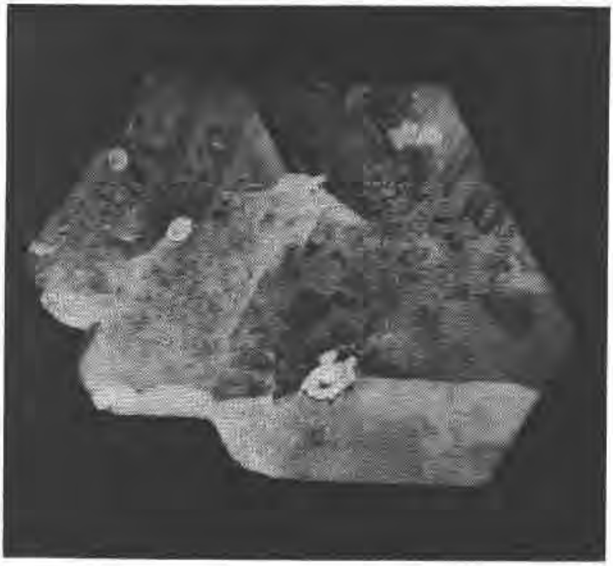

FIG. 1. Photograph of yttrian apatite enclosed in etched quartz, on which Dauphine and Brazil twins can be observed. Ordinary light, magnification ×1.3.

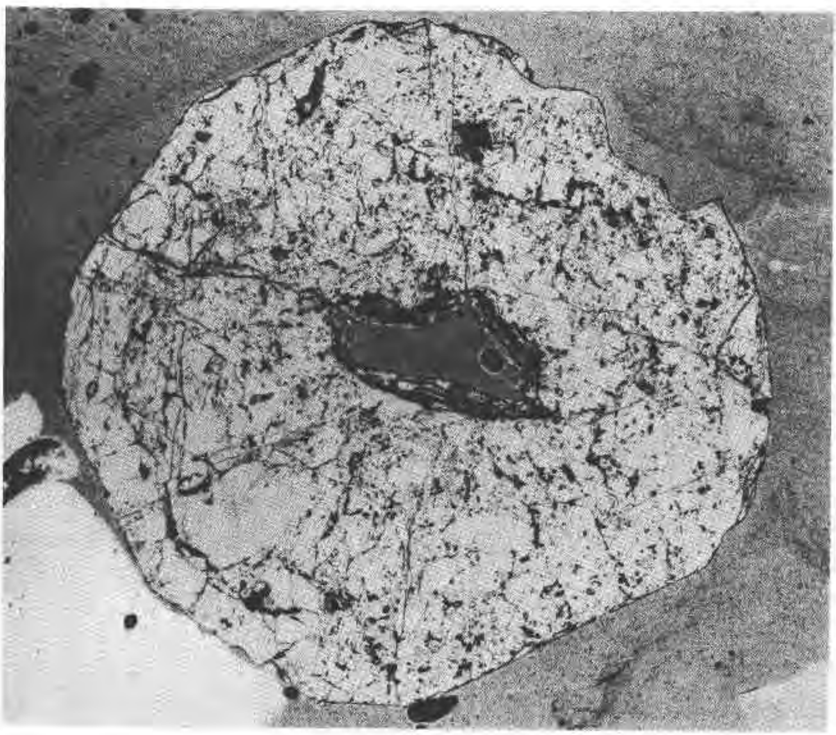

FIG. 2. Photomicrograph of yttrian apatite. Ordinary light, magnification ×20

Table 1. *X*-Ray Diffraction Data for Yttrian Apatite and Apatite

Yttrian apatite, Naegi, Japan (Fe radiation, Mn filter)			Apatite (Cu radiation, Ni filter) Kurokura, Japan	
d(Å)	I/I_0	hkl	d(Å)	I/I_0
3.439	55	002	3.453	37
3.167	12	102	3.164	12
3.075	15	120, 210	3.089	14
2.803	100	121, 211	2.840	100
2.771	45	112	2.780	60
2.714	65	300	2.722	28
2.624	25	202	2.637	40
2.290	5	122, 212	2.292	40
2.257	25	130, 310	2.265	10
1.939	25	222	1.957	28
1.885	12	132, 312	1.903	11
1.837	25	123, 213	1.841	43
1.802	9	231, 321	1.804	14
1.770	15	140, 410	1.779	5
1.749	9	402	1.752	7
1.720	12	004	—	—
1.639	6	232, 322	—	—
1.470	6	502	—	—
1.452	6	304	1.455	14
1.429	5	151	—	—

fractometer with Mn-filtered Fe radiation ($\lambda = 1.9360$ Å). The interplanar spacings and intensities for all curves are given in Table 1 and compared with apatite from Kurokura, Japan. The lattice constants of the hexagonal unit cell, $a = 9.397$Å and $c = 6.860$ and the axial ratio $c:a = 0.730$, are similar to the apatite studied by Gruner and McConnell (1937), McConnell (1937, 1938) and Naray-Szabo (1930).

The calculated specific gravity using the lattice constants and chemical formula derived below is G = 3.296, which is close to the measured value.

Infrared absorption spectra were obtained for wave lengths 2 to 15 microns with a split beam spectrophotometer; Perkin-Elmer Model 21 with a NaCl prism. The specimen was ground to a fine powder in an agate mortar and 1–2 mg of material mixed with *ca.* 400 mg of KBr.

The infrared spectra have two strong bands at 9.2 and 9.6 microns, one medium band at 10.5 microns and two weak bands at 2.95 and 6.15 microns as shown in Fig. 3, which are similar to the two apatites studied by Omori (1961).

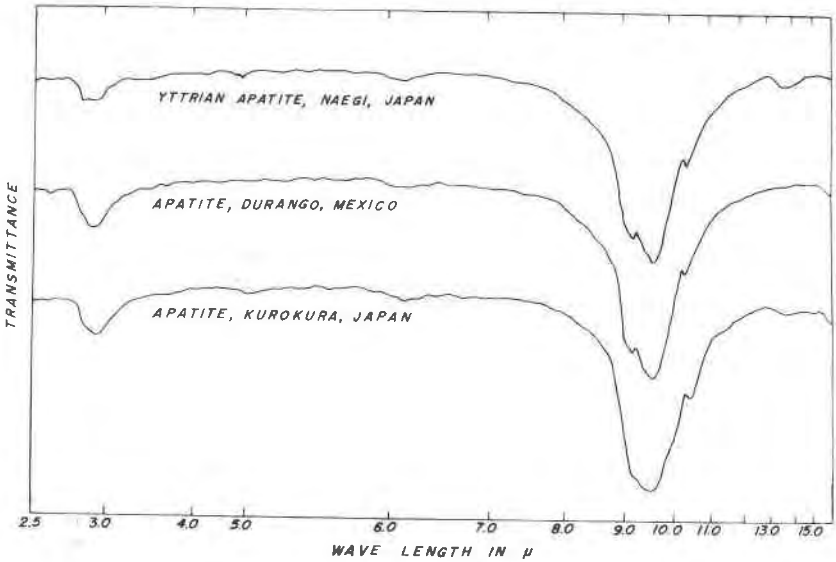

FIG. 3. Infrared absorption spectra of yttrian apatite and apatites.

TABLE 2. CHEMICAL COMPOSITION OF YTTRIAN APATITE, NAEGI, JAPAN

	Wt. %	Mol. prop.	Atomic proportion				
SiO_2	2.63	43	Si (quartz)		43	0 (quartz)	86
Al_2O_3	0.36	3	Al	6		0	9
Fe_2O_3	0.41	2	Fe	4			6
MnO	0.17	2	Mn	2			2
TiO_2	None				867		
MgO	None						
CaO	43.32	773	Ca	773			773
$(Ce)_2O_3$	0.32	1	Ce	2			3
$(Y)_2O_3$	10.65	40	Y	80			120
ThO_2	None						
P_2O_5	40.29	284	P	568			1420
Cl	0.12	3	Cl	3			(−)1
F	2.82	148	F	148	187		(−)74
$H_2O(+)$	0.32	18	H	36			18
$H_2O(-)$	0.28						
Total	101.69						2362
Less O for F	1.19					Less O for OH	36
Less O for Cl	0.03					Less O for quartz	86
Total	100.47					Total	2240

The chemical analysis is given in Table 2. The most noticeable difference from normal apatite is the high content of Y_2O_3. The Y ion occupies the Ca position. *X*-ray fluorescence analysis also was used for determining Y. The small amount of SiO_2 may be caused by included quartz.

The formula derived from the analysis is

$$(Ca^{2+}_{773}Y^{3+}_{80}Ce^{3+}_{2}Fe^{3+}_{4}Al^{3+}_{6}Mn^{2+}_{2})_{867}P^{5+}_{568}O^{2-}_{2240}(F^{1-}_{148}Cl^{1-}_{3}OH^{1-}_{36})_{187}$$

or, simplified, $(Ca_{4.1}Y_{0.6})_{4.7}P_{3.0}O_{12.0}(F_{0.8}OH_{0.2})_{1.0}$ or even more simply $(Ca,Y)_{4.7}(PO_4)_3(F,OH)$. The molecular amounts of yttrian apatite and included quartz are 96.3 per cent and 3.7 per cent respectively. The totals of the recalculated univalent cations and anions of yttrian apatite are 4666 and 4667 respectively.

The above formula may be represented as $(Ca_{5-x}Y_{2/3x})(PO_4)_3(F,OH)$. When $x=1$, the formula is that of the present mineral and when $x=5$, the end member become yttroapatite.

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References

Gruner, J. W. and D. McConell (1937), The problem of the carbonate apatites. *Zeit. Krist.* **97,** 208–215.

McConnell, D. (1937), The substitution of SiO_4- and SO_4-groups for PO_4-groups in the apatite structure; ellstadite, the end-member. *Am. Mineral.* **22,** 977–986.

——— (1938), A structural investigation of the isomorphism of the apatite group. *Am. Mineral* **23,** 1–19.

Naray-Szabo, St. (1930), The structure of apatite $(CaF)Ca_4(PO_4)_3$. *Zeit Krist.* **75,** 323–331, 387–396.

Omori, K. (1961), Infrared absorption spectra of some essential minerals. *Sci. Rep. Tohoku Univ.* (3) **7,** 101–130.

——— and S. Hasegawa, (1953), Yttrialite and abukumalite from Iizaka Village, Fukushima Prefecture. *Sci. Rep. Tokohu Univ.* (3) **4,** 151–155.

——— and H. Konno, (1961), Minor composition in quartz from Naegi, Gifu Prefecture. *Jour. Jap. Asso. Min. Petro. Econ. Geol.* **46,** 1–10 (in Japanese).

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ETCHING OF SYNTHETIC FLUORPHLOGOPITE

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Introduction

Considerable work has been reported on the etch patterns produced on cleavage faces of natural muscovite and other types of micas. It seems that no etching work has been reported so far on synthetic mica. In