

THE AMERICAN MINERALOGIST, VOL. 54, JANUARY-FEBRUARY, 1969

CHEMICAL COMPOSITION AND OPTICAL PROPERTIES OF
YUGAWARALITE FROM THE TYPE LOCALITY

KAZUO HARADA, *Section of Geology, Chichibu Museum of Natural History, Nogami-machi, Saitama Prefecture, Japan*, KOZO NAGASHIMA, *Chemical Institute, Faculty of Science, Tokyo University of Education, Otsuka, Tokyo, Japan*,

AND KIN-ICHI SAKURAI, *Department of Geology, National Science Museum, Ueno Park, Tokyo, Japan*.

ABSTRACT

Pure crystals of yugawaralite from the type locality analyzed SiO_2 59.58, Al_2O_3 18.54, Fe_2O_3 0.19, MgO tr, CaO 8.96, Na_2O 0.19, K_2O 0.05, total H_2O 13.00, total 100.51, corresponding to a formula proposed by Barrer. Cell dimensions and optical data are given.

Yugawaralite was first described by Sakurai and Hayashi (1952) as a new zeolite with $\text{CaAl}_2\text{Si}_5\text{O}_{14} \cdot 4\text{H}_2\text{O}$, on the sample from Hudō-no-taki (a fall) near Yugawara Hot Spring, Kanagawa Prefecture, Japan. At the locality, it occurs as veinlets (2–5 cm wide), closely associated with laumontite and quartz, in andesitic tuff breccia. Yugawaralite seems to be classified into a metamorphic mineral belonging to the laumontite stage proposed by Coombs *et al.* (1959) and, recently, a regional occurrence was confirmed by Seki and Okumura (1968).

Sakurai and Hayashi (1952) gave morphological, physical, optical, chemical and thermal (DTA and TGA) data for this new zeolite. Recently, Barrer and Marshall (1965) made X-ray and chemical studies on yugawaralite from Heinabergsjökull in Southern Iceland and the crystal structure of the same specimen was determined by Kerr and Williams (1967). Seki and Haramura (1966) also advocated the same formula for yugawaralite after considering the packing index, the specific gravity and a new chemical analyses of yugawaralite from the type locality. However, as mentioned by Seki and Haramura (1966) the sample of yugawaralite analyzed contained small amounts of calcite, wairakite and laumontite. Now, the reexamination of yugawaralite from the type locality was intended to confirm the chemical formula and X-ray data given by Barrer and Marshall (1965) and Seki and Haramura (1966). The optical orientation of yugawaralite, which has not been presented, was also studied. The presentation of detailed chemical and optical data for yugawaralite from the type locality thus seems warranted because of the frequent occurrences of this species *e.g.*, Erd *et al.* (1968).

MINERALOGY

Crystals of yugawaralite are colorless and transparent with a strong

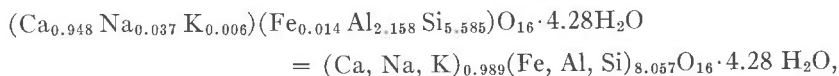
TABLE 1. VARIOUS ANALYSES OF YUGAWARALITE FROM THE TYPE LOCALITY

	1	2	3
SiO ₂	57.94	59.29	59.58
Al ₂ O ₃	17.65	17.43	18.54
Fe ₂ O ₃	0.35	0.05	0.19
FeO	none	0.25	none
MgO	0.86	0.11	trace
CaO	9.79	9.90	8.96
Na ₂ O	0.38	0.26	0.19
K ₂ O	0.41	trace	0.05
H ₂ O ⁺	10.70	12.85	13.00
H ₂ O ⁻	1.80	0.10	
Total	99.80	100.24	100.51

1. Analyst, A. Hayashi (quoted from Sakurai and Hayashi, 1952).
2. Analyst, H. Haramura (quoted from Seki and Haramura, 1966).
3. Analyst, K. Nagashima and K. Nakao (present study).

fully analysed by K. Nagashima and K. Nakao. Various analyses of yugawaralite from the type locality including the present study are shown in Table 1.

The writers' analysis corresponds to:



and agree quite well with the chemical formula of $\text{CaAl}_2\text{Si}_6\text{O}_{16} \cdot 4 \text{H}_2\text{O}$ proposed by Barrer *et al* (1965) and further advocated by Seki and Haramura (1966). A considerable replacement of Si for Al was recognized. The specific gravity calculated adopting the analysis and the cell parameter is 2.26. This agrees well with the measured value 2.23.

ACKNOWLEDGMENTS

The writers wish to express their thanks to Emeritus Prof. H. Shibata of Geol. and Min. Inst., Tokyo University of Education for his helpful comments on the optical study. Thanks are also due to Drs. A. Kato, Y. Seki and T. Sameshima for helpful comments. Thanks are also due to Mr. K. Nakao of Tokyo University of Education who gave much help in the chemical analysis. Special thanks are also due to Prof. R. M. Barrer who read the manuscript.

REFERENCES

- BARRER, R. M., AND D. J. MARSHALL (1965) Synthetic zeolite related to ferrierite and yugawaralite. *Amer. Mineral.*, **50**, 484-489.
- COOMBS, D. S., A. J. ELLIS, W. S. FYFE AND A. M. TAYLOR (1959) The zeolite facies, with

- comments on the interpretation of hydrothermal syntheses. *Geochim. Cosmochim. Acta*, **17**, 53-107.
- ERD, R. C., G. D. EBERLEIN, AND A. PABST (1968) Stellerite: A valid orthorhombic end member of a continuous series with monoclinic stilbite. (abstr.) *Geol. Soc. Amer. Spec. Pap.*, **115**, 58-59.
- KERR, I. S., AND D. J. WILLIAMS (1967) The crystal structure of yugawaralite. *Z. Kristallogr.*, **125**, 220-225.
- SAKURAI, K., AND A. HAYASHI (1952) Yugawaralite, a new zeolite. *Sci. Rep., Yokohama Nat. Univ., Sec. 2* **1**, 69-77.
- SEKI, Y., AND H. HARAMURA (1966) On chemical composition of yugawaralite. *J. Jap. Ass. Mineral. Petrology Econ. Geol.*, **59**, 107-111 [in Japanese with English abstr.].
- , AND K. OKUMURA (1968) Yugawaralite from Onikobe active geothermal area, northeast Japan. *J. Jap. Ass. Mineral. Petrology Econ. Geol.*, **60**, 27-33.

THE AMERICAN MINERALOGIST, VOL. 54, JANUARY-FEBRUARY, 1969

CRYSTALLOGRAPHIC NOMENCLATURE AND TWINNING
IN THE HUMITE MINERALS

NORRIS W. JONES, *Department of Geological Sciences, Virginia Polytechnic Institute, Blacksburg, Virginia*¹ 24061.

ABSTRACT

The several crystallographic settings previously used for the humite minerals have led to mistakes and confusion in space group, cleavage and twinning descriptions. The Taylor and West setting is preferred because it allows ready comparison of humites and structurally analogous olivines. Twinning on (001) in chondrodite yields single crystal diffraction patterns consistent with orthorhombic rather than monoclinic symmetry.

The humite minerals (norbergite, $Mg_2SiO_4 \cdot Mg(OH,F)_2$; chondrodite, $2Mg_2SiO_4 \cdot Mg(OH,F)_2$; humite, $3Mg_2SiO_4 \cdot Mg(OH,F)_2$; and clinohumite, $4Mg_2SiO_4 \cdot Mg(OH,F)_2$) are structurally similar to the olivine group minerals in that they consist of a hexagonal closest-packed array of anions, zig-zag chains of edge-sharing, M-filled octahedra and isolated tetrahedra (Ribbe, Gibbs and Jones, 1968). Norbergite and humite are orthorhombic and chondrodite and clinohumite are monoclinic with interaxial angles of approximately 109° and 101° , respectively.

During the course of a microprobe and single-crystal study of these minerals (Jones, 1968) it was noted that there is considerable confusion in the literature regarding the choice of crystallographic axes and space groups. Some of the choices which have been made are shown in Table 1. Apparently this profusion of axial choices has led to some of the mistakes found in descriptions of the humite minerals. Thus, as noted in Table 1, certain of the space groups adopted by Sahama (1953; after Strunz,

¹ Present address: Department of Geology, Wisconsin State University, Oshkosh, Wisconsin 54901.