## Yugawaralite $CaAl_2Si_6O_{16}\cdot 4H_2O$



**Crystal Data:** Monoclinic. *Point Group:* $m$. Crystals flat tabular ‖ {010}, to 8 cm; in groups of nearly parallel crystals.

**Physical Properties:** *Cleavage:* $\{40\bar{1}\}$, {100} distinct, $\{10\bar{1}\}$ imperfect; parting on {010}. *Fracture:* Conchoidal. *Tenacity:* Very brittle. Hardness = 4.5–5 D(meas.) = 2.20–2.23 D(calc.) = 2.26 Piezoelectric and pyroelectric.

**Optical Properties:** Transparent to translucent. *Color:* Colorless to white; colorless in thin section. *Luster:* Vitreous to pearly, iridescent on {010}. *Streak:* White.
*Optical Class:* Biaxial (–) or (+). *Orientation:* $Z = b$; $X \wedge c = -9°$; $Y \wedge c = 6°$–$9°$.
*Dispersion:* $r < v$, weak to distinct. $\alpha = 1.492$–$1.496$ $\beta = 1.497$–$1.499$ $\gamma = 1.502$–$1.504$
2V(meas.) = 48°–89°

**Cell Data:** *Space Group:* $Pc$. $a = 6.72(2)$ $b = 13.98(2)$ $c = 10.05(2)$ $\beta = 111°31'$
Z = 2

**X-ray Powder Pattern:** Yugawara Hot Spring, Japan.
3.057 (100), 4.672 (70), 4.652 (67), 5.81 (52), 7.01 (31), 3.237 (29), 4.295 (26)

**Chemistry:**

| | (1) | (2) | | (1) | (2) |
|---|---|---|---|---|---|
| $SiO_2$ | 57.94 | 61.81 | $Na_2O$ | 0.38 | 0.05 |
| $Al_2O_3$ | 17.65 | 16.85 | $K_2O$ | 0.41 | 0.00 |
| $Fe_2O_3$ | 0.35 | 0.00 | $H_2O^+$ | 10.70 | |
| MgO | 0.86 | 0.00 | $H_2O^-$ | 1.80 | |
| CaO | 9.79 | 9.28 | $H_2O$ | | [12.01] |
| | | | Total | 99.88 | [100.00] |

(1) Yugawara Hot Spring, Japan. (2) Khandivali quarry, India; by electron microprobe, $H_2O$ by difference; corresponds to $(Ca_{0.97}Na_{0.01})_{\Sigma=0.98}Al_{1.95}Si_{6.05}O_{16}\cdot 4H_2O$.

**Mineral Group:** Zeolite group.

**Occurrence:** As crystals lining cavities, and veinlets, typically deposited in active geothermal areas.

**Association:** Zeolites, gyrolite, okenite, prehnite, quartz, calcite.

**Distribution:** In Japan, from the Yugawara Hot Spring, Kanagawa Prefecture; at Shimoda, and in the Toi and Seikoshi mines, Shizuoka Prefecture; and at Takinoue, Kakkonda Hot Springs, Iwate Prefecture; several other localities are known. In the Khandivali and Malad quarries, near Bombay, Maharashtra, India. At Heinabergsjökull and Hvalsgod (Klif), Hvalfjord, and elsewhere in Iceland. From Osilo, near Sassari, Sardinia, Italy. In the USA, from Yellowstone National Park, Wyoming, and the Chena Hot Springs area, about 65 km east of Fairbanks, Alaska. From Yellow Lake, near Olalla, British Columbia, Canada.

**Name:** For the locality where first found, Yugawara Hot Spring, Japan.

**Type Material:** National Science Museum, Tokyo, Japan; National School of Mines, Paris, France; National Museum of Natural History, Washington, D.C., USA, 106164, 106931.

**References:** (1) Sakurai, K. and A. Hayashi (1952) "Yugawaralite," a new zeolite. Sci. Reports, Yokohama National Univ., Sec. II, no. 1, 69–77. (2) (1953) Amer. Mineral., 38, 426 (abs. ref. 1). (3) Eberlein, G.D., R.C. Erd, F. Weber, and L.B. Beatty (1971) New occurrence of yugawaralite from the Chena Hot Springs area, Alaska. Amer. Mineral., 56, 1699–1717. (4) Wise, W.S. (1978) Yugawaralite from Bombay, India. Mineral. Record, 9, 296. (5) Akizuki, M. (1987) An explanation of the optical variation in yugawaralite. Mineral. Mag., 51, 615–620. (6) Kvick, Å (1986) Neutron diffraction study of the zeolite yugawaralite at 13 K. Zeits. Krist., 174, 265–281.