Thaumasite $Ca_3Si(SO_4)(CO_3)(OH)_6 \cdot 12H_2O$

Crystal Data: Hexagonal. *Point Group:* 6. Crystals prismatic, to 5 cm; typically acicular, radiating; powdery, compact, massive.

Physical Properties: *Cleavage:* Traces observed. *Fracture:* Subconchoidal. *Tenacity:* Brittle. Hardness = 3.5 D(meas.) = 1.877 D(calc.) = [1.90]

Optical Properties: Transparent to translucent. *Color:* Colorless, white, pale yellow. *Luster:* Vitreous to dull, greasy, silky.
Optical Class: Uniaxial (–). ω = 1.498–1.507 ϵ = 1.458–1.470

Cell Data: *Space Group:* $P6_3$. a = 11.030(7) c = 10.396(6) Z = 2

X-ray Powder Pattern: Ballyalton, Ireland.
9.56 (100), 5.51 (40), 3.41 (20), 3.78 (16), 3.18 (16), 2.713 (14), 2.155 (13b)

Chemistry:

	(1)	(2)
SiO_2	10.00	10.20
Al_2O_3	0.08	
Fe_2O_3	0.14	
MgO	0.50	
CaO	27.38	27.85
H_2O	42.61	42.57
CO_2	6.73	6.99
SO_3	12.61	12.80
Total	100.05	100.41

(1) Hatrurim, Israel; corresponds to $(Ca_{2.96}Mg_{0.08})_{\Sigma=3.04}Si_{1.01}(SO_4)_{0.96}(CO_3)_{0.93}(OH)_{6.00} \cdot 12.3H_2O$. (2) N'Chwaning mine, South Africa; by AA, CO_3 volumetrically, H_2O by TGA; corresponds to $Ca_{3.10}Si_{1.06}(SO_4)_{1.00}(CO_3)_{0.99}(OH)_{6.37} \cdot 11.60H_2O$.

Occurrence: A very late-stage mineral in some sulfide ore deposits. In contact metamorphic zones and from the reaction of geothermal waters or seawaters with basalts and tuffs.

Association: Zeolites, apophyllite, analcime, calcite, gypsum, pyrite.

Distribution: In the Bjelke mine, near Åreskuta, and at Kjölland, Jämtland, and at Långban, Värmland, Sweden. From Sulitjelma, Norway. At Ballyalton, Co. Down, Ireland. From the Bellerberg volcano and at the Schellkopf, Eifel district; and on the Zeilberg, near Maroldsweisach, Bavaria, Germany. At Klöch, Styria, Austria. In the Hatrurim Formation, Israel. Large crystals from the Wessels and N'Chwaning mines, Kuruman, Cape Province, South Africa. In the USA, at Paterson and Great Notch, Passaic Co., New Jersey; in the Goose Creek quarry, Leesburg, Loudoun Co., and the Fairfax quarry, Centreville, Fairfax Co., Virginia; from Crestmore, Riverside Co., California. From Concepción del Oro, Zacatecas, Mexico. In the Basalt quarry, Prospect, New South Wales, Australia. A number of other occurrences are known.

Name: From the Greek *to be surprised*, because of its remarkable composition, without parallel at the time of its discovery.

Type Material: Wroclaw University, Wroclaw, Poland, II–18500.

References: (1) Dana, E.S. (1892) Dana's system of mineralogy, (6th edition), 698. (2) Knill, D.C. and B.R. Young (1960) Thaumasite from Co. Down, Northern Ireland. Mineral. Mag., 32, 416–418. (3) Gross, S. (1977) The mineralogy of the Hatrurim Formation, Israel. Geol. Sur. Israel Bull. 70, 37–38. (4) Effenberger, H., A. Kirfel, G. Will, and E. Zobetz (1983) A further refinement of the crystal structure of thaumasite, $Ca_3Si(OH)_6CO_3SO_4 \cdot 12H_2O$. Neues Jahrb. Mineral., Monatsh., 60–68. (5) Grubessi, O., A. Mottana, and E. Paris (1986) Thaumasite from the Tschwinning [N'Chwaning] mine, South Africa. Tschermaks Mineral. Petrog. Mitt., 35, 149–156.