Hydroxylellestadite $Ca_5(SiO_4)_{1.5}(SO_4)_{1.5}OH$

Crystal Data: Hexagonal. *Point Group*: 6/*m*. As prismatic crystals, massive, granular.

Physical Properties: *Cleavage*: Indistinct. *Fracture*: Irregular. *Tenacity*: Brittle.
Hardness = 4.5 VHN = 590(30) (50 g load). D(meas.) = 3.068 D(calc.) = 3.046

Optical Properties: Translucent to transparent. *Color*: Pale rose, rose-pink, orange.
Streak: White. *Luster*: Vitreous.
Optical Class: Uniaxial (-). ω = 1.655(2) ε = 1.650(2)

Cell Data: Space Group: $P6_3/m$. a = 9.496(2) c = 6.920(2) Z = 2

X-ray Powder Pattern: Crestmore, California, USA.
2.843 (100), 2.751 (70), 3.458 (50), 2.800 (40), 1.964 (40), 1.855 (40), 2.651 (30)

Chemistry:

	(1)	(2)	(3)		(1)	(2)	(3)
CaO	55.18	55.84	54.51	P_2O_5	3.06	8.73	0.66
SrO			0.28	Cl	1.64	0.54	0.91
SO_3	20.69	16.85	21.56	F	0.57	0.39	0.28
Na_2O			0.34	CO_2			1.65
SiO_2	17.31	14.73	17.30	H_2O^+	0.53		2.04
Al_2O_3	0.13		trace	H_2O^-	0.10		0.72
Fe_2O_3	0.22		0.21	H_2O		[1.45]	
MnO	0.01		0.04	$-O = (F, Cl)_2$	0.61	0.29	0.32
MgO	0.47		trace	Total	99.91	98.24	100.25

(1) Crestmore, California, USA. (2) Cioclovina Cave, Romania; average of 8 electron microprobe analyses supplemented by FTIR and Raman spectroscopy, H_2O calculated for charge balance; corresponds to $Ca_{5.14}[(SiO_4)_{1.26}(SO_4)_{1.08}(PO_4)_{0.64}]_{\Sigma=2.98}[(OH)_{0.83}F_{0.10}Cl_{0.08}]_{\Sigma=1.01}$. (3) Chichibu mine, Saitama prefecture, Japan; includes K_2O=0.07, corresponds to $(Ca_{4.70}Na_{0.05}Sr_{0.0135}Fe_{0.013}K_{0.007}Mn_{0.0005})_{\Sigma=4.77}(SiO_4)_{1.43}[(SO_4)_{1.338}(CO_3OH)_{0.186}(PO_4)_{0.046}]_{\Sigma=1.57}[(OH)_{0.938}Cl_{0.128}F_{0.073}]_{\Sigma=1.14}$.

Polymorphism & Series: Chlorellestadite and fluorellestadite.

Mineral Group: Apatite supergroup, ellestadite group.

Occurrence: In contact metamorphosed limestone (Crestmore). In highly phosphatized, silicate-rich, carbonate-mudstone cave sediments heavily compacted and thermally transformed by in situ combustion of bat guano (Romania). In pyrometamorphosed rocks on coal mine spoil heaps.

Association: Diopside, wollastonite, vesuvianite, monticellite, okenite, calcite (Crestmore); berlinite (Cioclovina Cave); wilkeite, apatite, magnetite, chlorite, tremolite, calcite (Chichibu).

Distribution: From Crestmore, Riverside Co., California, USA. In Cioclovina Cave, SW side of the Şureanu Mountains and in the Oraviţa skarns, about 35 km SSW of Reşita, Romania. At the Chichibu mine, Saitama prefecture, Japan. On combusted spoil heaps at the Kukla mine, Oslavany, and the Ferdinand mine, Zastávka, Rosice-Oslavany coalfield, Czech Republic.

Name: Honors Dr. Reuben B. Ellestad (1900-1993), American analytical chemist, University of Minnesota, Minneapolis, Minnesota, USA, and the *hydroxyl*-end member of the *ellestadite* group.

References: (1) McConnell, D. (1937) The substitution of SiO_4- and SO_4-groups for PO_4-groups in the apatite structure; ellestadite, the end-member. Amer. Mineral., 22, 977-986. (2) Onac, B.P., H. Effenberger, K. Ettinger, and S.C. Panzaru (2006) Hydroxylellestadite from Cioclovina Cave (Romania): microanalytical, structural, and vibrational spectroscopy data. Am. Mineral., 91, 1927-1931. (4) Sejkora, J., S. Houzar, and V. Šrein (1999) Cl-rich hydroxylellestadite from Zastávka near Brno. Acta Musei Moraviae, Scientiae Geologicae, 84, 49-59 (in Czech with English abstract). (5) Harada, K., K. Nagashima, K. Nakao, and A. Kato (1971) Hydroxylellestadite, a new apatite from Chichibu mine, Saitama prefecture, Japan. Amer. Mineral., 56, 1507-1518.