Bustamite $(Mn^{2+}, Ca)_3Si_3O_9$

Crystal Data: Triclinic. *Point Group:* $\bar{1}$. Crystals prismatic, needlelike, to 2.5 cm, or tabular on {001}; commonly fibrous, cleavable massive. *Twinning:* Composition plane {110}, simple twins, uncommon.

Physical Properties: *Cleavage:* Perfect on {100}, good on {110} and {1$\bar{1}$0}, poor on {010}. Hardness = 5.5–6.5 D(meas.) = 3.32–3.43 D(calc.) = 3.421 Pink color fades on exposure to light.

Optical Properties: Transparent to translucent. *Color:* Pale pink to brownish red; in thin section, colorless to yellowish pink. *Luster:* Vitreous.
Optical Class: Biaxial (–). *Pleochroism:* $X = Z$ = orange; Y = rose. *Orientation:* $X \wedge a \simeq 15°$; $Y \wedge b \simeq 35°$; $Z \wedge c \simeq 30°$–$35°$. *Dispersion:* $r < v$, weak, strong crossed dispersion. α = 1.640–1.695 β = 1.651–1.708 γ = 1.653–1.710 2V(meas.) = 34°–60°

Cell Data: *Space Group:* $P\bar{1}$. $a = 15.412$ $b = 7.157$ $c = 13.824$ $\alpha = 89°29'$ $\beta = 94°51'$ $\gamma = 102°56'$ Z = 12

X-ray Powder Pattern: Broken Hill, Australia.
2.880 (100), 2.989 (60), 3.19 (50), 1.776 (50), 2.227 (40), 1.665 (40), 2.711 (30)

Chemistry:

	(1)	(2)
SiO_2	48.44	48.31
FeO	0.27	1.87
MnO	25.20	33.04
ZnO	0.53	
MgO	0.65	1.90
CaO	25.20	14.93
LOI	0.34	
Total	100.63	100.05

(1) Franklin, New Jersey, USA; corresponding to $(Ca_{1.66}Mn^{2+}_{1.31}Mg_{0.06}Fe^{2+}_{0.01})_{\Sigma=3.04}Si_{2.97}O_9$.
(2) Långban, Sweden; corresponding to $(Mn^{2+}_{1.74}Ca_{0.99}Mg_{0.18}Fe^{2+}_{0.10})_{\Sigma=3.01}Si_{3.00}O_9$.

Occurrence: In manganese ores formed by metamorphism of manganese-bearing sediments with attendant metasomatism; typically associated with skarns.

Association: Rhodonite, tephroite, calcite, glaucochroite, johannsenite, wollastonite, diopside, grossular.

Distribution: "Type" material, from Tetela de Ocampo, Hidalgo, Mexico, is a mixture; well-studied material from other localities includes: in the USA, at Franklin, Sussex Co., New Jersey. At Långban and in the Harstigen mine, near Persberg, Värmland, Sweden. At the Treburland mine, Altarnun, Cornwall, and in the Railroad quarry, Meldon, near Okehampton, Devon, England. At Camas Malag, Isle of Skye, Scotland. From Băiţa (Rézbánya), Romania. At Campiglia, Tuscany, and Schio, Vicenza, Italy. From the N'Chwaning mine, near Kuruman, Cape Province, South Africa. In Australia, at Broken Hill, New South Wales. From the Obori mine, Yamagata Prefecture; the Noda-Tamagawa mine, Iwate Prefecture; the Kanoiri mine, Tochigi Prefecture; the Mikumo mine, Shiga Prefecture; and the Hijikuzu mine, Iwate Prefecture, Japan.

Name: In honor of General Anastasio Bustamente (1780–1853), of Mexico.

References: (1) Larsen, E.S. and E.V. Shannon (1922) Bustamite from Franklin Furnace, New Jersey. Amer. Mineral., 7, 95–100. (2) Deer, W.A., R.A. Howie, and J. Zussman (1978) Rock-forming minerals, (2nd edition), v. 2A, single-chain silicates, 574–585. (3) Peacor, D.R. and M.J. Buerger (1962) Determination and refinement of the crystal structure of bustamite, $CaMnSi_2O_6$. Zeits. Krist., 117, 331–343. (4) Harada, K., H. Sekino, K. Nagashima, T. Watanabe, and K. Momoi (1974) High-iron bustamite and fluorapatite from the Broken Hill mine, New South Wales, Australia. Mineral. Mag., 39, 601–604. (5) Ohashi, Y. and L.W. Finger (1978) The role of octahedral cations in pyroxenoid crystal chemistry. I. Bustamite, wollastonite, and the pectolite-schizolite-serandite series. Amer. Mineral., 63, 274–288.