Pigeonite $(Mg, Fe^{2+}, Ca)(Mg, Fe^{2+})Si_2O_6$

Crystal Data: Monoclinic. *Point Group:* $2/m$. Prismatic crystals, to 1 cm; granular, massive. *Twinning:* Commonly twinned simply or multiply on {100} or {001}.

Physical Properties: *Cleavage:* Good on {110}, (110) $\wedge$ $(1\bar{1}0)$ ~87°; partings on {100}, {010}, and {001}. *Fracture:* [Uneven] (by analogy to the pyroxene group). *Tenacity:* [Brittle.] Hardness = 6 D(meas.) = 3.17–3.46 D(calc.) = [3.53]

Optical Properties: Semitransparent. *Color:* Brown, greenish brown-black; in thin section, colorless, pale yellow-green, brownish green. *Luster:* [Vitreous.]
Optical Class: Biaxial (+). *Pleochroism:* Weak to moderate; X = colorless, pale green, brown; Y = pale brown, pale brownish green, brownish pink; Z = colorless, pale green, pale yellow. *Orientation:* $X = a$; $Z \wedge c = 32°–44°$. *Dispersion:* $r < v$ or $r > v$, moderate. $\alpha = 1.682–1.732$ $\beta = 1.684–1.732$ $\gamma = 1.705–1.757$ 2V(meas.) = 0°–30°

Cell Data: *Space Group:* $P2_1/c$. $a = 9.706(2)$ $b = 8.950(1)$ $c = 5.246(1)$ $\beta = 108.59(1)°$ Z = 4

X-ray Powder Pattern: Yumoto, Hakone volcano, Japan.
3.021 (100), 2.903 (100), 3.210 (80), 2.908 (80), 2.578 (60), 1.6265 (60), 1.4935 (60)

Chemistry:

	(1)	(2)		(1)	(2)
SiO_2	50.56	51.47	MgO	16.10	21.68
TiO_2	0.58	0.29	CaO	7.05	1.45
Al_2O_3	1.41	1.56	Na_2O	0.26	0.07
Fe_2O_3	0.12	1.42	K_2O	0.23	0.03
FeO	23.17	21.72	H_2O^-	0.07	0.02
MnO	0.54	0.52	Total	100.09	100.23

(1) Hakone volcano, Japan; corresponds to $(Mg_{0.92}Fe^{2+}_{0.73}Ca_{0.29}Ti_{0.02}Mn_{0.02}Na_{0.02}K_{0.01})_{\Sigma=2.01}(Si_{1.94}Al_{0.06})_{\Sigma=2.00}O_6$. (2) Bushveld complex, South Africa; corresponds to $(Mg_{1.21}Fe^{2+}_{0.68}Ca_{0.06}Fe^{3+}_{0.03}Mn_{0.02}Ti_{0.01})_{\Sigma=2.01}(Si_{1.93}Al_{0.07})_{\Sigma=2.00}O_6$.

Mineral Group: Pyroxene group.

Occurrence: Common in rapidly cooled siliceous volcanic rocks. Inverted varieties with exsolved augite are found in layered mafic intrusives. From metamorphosed iron formations. Also in meteorites.

Association: Augite, olivine.

Distribution: Many localities worldwide. Studied material from: in the USA, at Pigeon Point, Cook Co., Minnesota; in the Goose Creek quarry, Leesburg, Loudoun Co., Virginia. From the Cobalt area, Ontario, Canada. In the Skaergaard intrusion, Kangerdlugssuaq Fjord, Greenland. From the Bushveld complex, Transvaal, South Africa. At the Hakone volcano, Iwate Prefecture, Japan. On the Isles of Mull and Rhum, and at Ardnamurchan, Argyllshire, Scotland. From the Vogelsberg area, Hesse, Germany.

Name: For the occurrence at Pigeon Point, Minnesota, USA.

References: (1) Dana, E.S. and W.E. Ford (1909) Dana's system of mineralogy, (6th edition), app. II, 86. (2) Deer, W.A., R.A. Howie, and J. Zussman (1978) Rock-forming minerals, (2nd edition), v. 2A, single-chain silicates, 162–196. (3) Kuno, H. and H.H. Hess (1953) Unit cell dimensions of clinoenstatite and pigeonite in relation to other common clinopyroxenes. Amer. J. Sci., 251, 741–752. (4) Morimoto, N. and N. Güven (1970) Refinement of the crystal structure of pigeonite. Amer. Mineral., 55, 1195–1209.