Franklinite $ZnFe^{3+}_2O_4$

Crystal Data: Cubic. *Point Group*: 4/*m* $\bar{3}$ 2/*m*. Typically, as octahedra, commonly with rounded edges, to 22 cm; may be modified by {011}, {001}, rare {013}, {051}, others. Also exsolved within other minerals; coarse to fine granular, massive. *Twinning*: On {111} as both twin and composition plane, the spinel law, common.

Physical Properties: *Cleavage*: Parting on {111}, fair. *Fracture*: Uneven to subconchoidal. *Tenacity*: Brittle. Hardness = ~6 VHN = 852-882 (100 g load). D(meas.) = 5.05-5.22 D(calc.) = 5.163 Strongly to weakly magnetic.

Optical Properties: Opaque, translucent in fine fragments. *Color*: Iron-black, brown, red, may be tarnished; in reflected light, white to gray, with dark red internal reflections. *Streak*: Reddish brown to black. *Luster*: Metallic to semimetallic; may be dull.
Optical Class: Isotropic. *n* = 2.36(2) (Li).
R: (400) 19.2, (420) 19.2, (440) 19.2, (460) 19.2, (480) 19.2, (500) 19.1, (520) 19.0, (540) 18.6, (560) 18.2, (580) 17.8, (600) 17.4, (620) 17.1, (640) 16.8, (660) 16.6, (680) 16.4, (700) 16.3

Cell Data: *Space Group*: *Fd*3*m*. *a* = 8.43-8.474 Z = 8

X-ray Powder Pattern: Franklin, New Jersey, USA.
2.55 (100), 1.499 (80), 2.99 (70), 1.632 (70), 1.104 (50), 0.978 (50), 2.12 (40)

Chemistry:

	(1)	(2)	(3)		(1)	(2)	(3)
SiO_2	0.72			MnO	9.96	6.6	0.6
TiO_2			0.7	ZnO	20.77	26.2	30.25
Al_2O_3		0.3	1.25	MgO	0.34	0.3	
Fe_2O_3	66.58	66.7	63.9	CaO	0.43		
FeO			3.6	H_2O	0.71		
				Total	99.51	100.1	100.3

(1) New Jersey, USA; total Fe as Fe^{3+}. (2) Do.; by electron microprobe, average of five analyses, total Fe as Fe_2O_3. (3) Långban, Sweden; by electron microprobe, average of four analyses, Fe^{2+}:Fe^{3+} calculated from stoichiometry; corresponds to $(Zn_{0.88}Fe^{2+}_{0.12})_{\Sigma=1.00}(Fe^{3+}_{1.90}Al_{0.06}Mn^{2+}_{0.02}Ti_{0.02})_{\Sigma=2.00}O_4$.

Mineral Group: Spinel group.

Occurrence: In beds and veins formed by high-temperature metamorphism of Fe, Zn, Mn-rich marine carbonate sediments. As a minor mineral in some manganese and iron deposits.

Association: Zincite, willemite, calcite, andradite, manganosite, rhodochrosite, gahnite, magnetite, rhodonite, hausmannite, hetaerolite, jacobsite, braunite, sarkinite, berzeliite, hematite.

Distribution: From Franklin and at Sterling Hill, Ogdensburg, Sussex Co., New Jersey, USA. Found at Långban, Värmland, Sweden. Occurs at Hraničná, Czech Republic. In Kazakhstan, from Nayzatas, Dzhumart, and in the Ushkatyn deposits, Atasui area. At the Pereval marble quarry, near Slyudyanka, Sayan Mountains, Siberia, Russia. From the Koduru manganese mine, Srikakulam district, Andhra Pradesh, India. At the Bonnie prospect, near Mukinbudin, Western Australia.

Name: Named for *Franklin* Furnace (now Franklin), New Jersey, USA; and in honor of the American statesman, philosopher, and inventor Benjamin Franklin (1706-1790).

References: (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 698-707. (2) Berry, L.G. and R.M. Thompson (1962) X-ray powder data for the ore minerals. Geol. Soc. Amer. Mem. 85, 193. (3) Burke, E.A.J. and C. Kieft (1972) Franklinite from Langban, Sweden: a new occurrence. Lithos, 5, 69-72. (4) Shirakashi, T. and T. Kubo (1979) Cation distribution in franklinite by nuclear magnetic resonance. Amer. Mineral., 64, 599-603. (5) O'Neill, H.St.C. (1992) Temperature dependence of the cation distribution in zinc ferrite ($ZnFe_2O_4$) from powder XRD structural refinements. Eur. J. Mineral., 4, 571-580. (6) Dunn, P.J. (1995) Franklin and Sterling Hill, New Jersey. No publisher, n.p., 566-578. (7) Lucchesi, S., U. Russo, and A. Della Giusta (1999) Cation distribution in natural Zn-spinels: franklinite. Eur. J. Mineral., 11, 501-511.