Neptunite $KNa_2Li(Fe^{2+},Mn^{2+},Mg)_2Ti_2Si_8O_{24}$

Crystal Data: Monoclinic. *Point Group:* *m*. As prismatic crystals, to 7.5 cm, with {110} prominent, typically with square cross sections, may be curved or twisted. *Twinning:* Interpenetrant on {301}.

Physical Properties: *Cleavage:* Perfect on {110}. *Fracture:* Conchoidal. *Tenacity:* Brittle. Hardness = 5–6 D(meas.) = 3.19–3.23 D(calc.) = [3.24] Piezoelectric.

Optical Properties: Nearly opaque. *Color:* Black; deep red-brown in thin fragments. *Streak:* Cinnamon-brown. *Luster:* Vitreous.
Optical Class: Biaxial (+). *Pleochroism:* X = pale yellow; Y = yellow-orange; Z = red-orange to red-brown. *Orientation:* $Y = b$; $Z \wedge c = 16°–20°$. *Dispersion:* $r < v$, extreme. $\alpha = 1.692(1)$ $\beta = 1.702(1)$ $\gamma = 1.734(2)$ 2V(meas.) = ∼40°

Cell Data: *Space Group:* *Cc*. $a = 16.427(2)$ $b = 12.478(2)$ $c = 9.975(1)$ $\beta = 115.56(1)°$ Z = 4

X-ray Powder Pattern: San Benito Co., California, USA.
3.186 (100), 9.6 (60), 3.517 (45), 3.308 (35), 2.942 (32), 2.837 (32), 2.480 (32)

Chemistry:

	(1)	(2)		(1)	(2)
SiO_2	52.29	54.06	CaO	0.62	
TiO_2	17.35	17.30	Li_2O	1.63	1.54
FeO	11.92	12.45	Na_2O	6.81	6.33
MnO	2.27	1.75	K_2O	5.58	4.92
MgO	1.55	1.65	Total	100.02	100.00

(1) San Benito Co., California, USA. (2) Do.; by electron microprobe, Li by wet chemical analysis; corresponds to $K_{0.95}Na_{1.85}Li_{0.92}(Fe_{1.51}Mg_{0.35}Mn_{0.20})_{\Sigma=2.06}Ti_{1.94}Si_{8.10}O_{24}$.

Polymorphism & Series: Forms a series with mangan-neptunite.

Occurrence: In natrolite veins cutting a glaucophane schist inclusion in a serpentinite body (San Benito Co., California, USA).

Association: Eudialyte, arfvedsonite, aegirine (Narssârssuk, Greenland); natrolite, benitoite, joaquinite-(Ce) (San Benito Co., California, USA); nordite-(La), lomonosovite, sodalite, ussingite (Kola Peninsula, Russia).

Distribution: From Narssârssuk, Iglunguak, and the Ilímaussaq intrusion, Greenland. In the Inagli massif, 30 km west of Aldan, Yakutia, and in the Khibiny and Lovozero massifs, Kola Peninsula, Russia. From the Khan-Bogdinskii granitic massif, Gobi, Mongolia. In the Dara-i-Pioz massif, Alai Range, Tien Shan, Tajikistan. From Barnavave, near Carlingford, Co. Louth, Ireland. At Mont Saint-Hilaire, Quebec, and Seal Lake, Labrador, Newfoundland, Canada. In the USA, splendid crystals from the Gem mine and Mina Numero Uno, San Benito Co., California, and at Point of Rocks, Colfax Co., New Mexico. From near Woodsreef, New South Wales, Australia.

Name: For *Neptune*, sea-god of Roman mythology; so named because of its close association at the type occurrence with aegirine, the name of which derives from *Ægir*, the Scandinavian sea-god.

Type Material: University of Copenhagen, Copenhagen, Denmark.

References: (1) Dana, E.S. (1899) Dana's system of mineralogy, (6th edition), app. I, 49. (2) Berry, L.G. (1963) Neptunite: unit cell and X-ray powder data. Can. Mineral., 7, 679–681. (3) Laird, J. and A.L. Albee (1972) Chemical composition and physical, optical, and structural properties of benitoite, neptunite, and joaquinite. Amer. Mineral., 57, 85–102. (4) Kunz, M., T. Armbruster, G.A. Lager, A.J. Schultz, R.J. Goyette, W. Lottermoser, and G. Amthauer (1991) Fe, Ti ordering and octahedral distortions in acentric neptunite: temperature dependent X-ray and neutron structure refinements and Mössbauer spectroscopy. Phys. Chem. Minerals, 18, 199–213.