Quadruphite $Na_{14}CaMgTi_4(Si_2O_7)_2(PO_4)_4O_4F_2$

Crystal Data: Triclinic. *Point Group:* 1. As flakes, flattened on {001}, to 3 mm, some epitaxially overgrown on lomonosovite and sobolovite.

Physical Properties: *Cleavage:* {001}, perfect; {110} and {100}, less perfect. *Fracture:* Steplike. *Tenacity:* Brittle. Hardness = 5 D(meas.) = 3.12 D(calc.) = 3.11

Optical Properties: Translucent to transparent. *Color:* Light brown. *Luster:* Vitreous, resinous on fractures, pearly to adamantine on cleavages. *Streak:* White. *Optical Class:* Biaxial (–). *Pleochroism:* Pronounced; X = colorless; $Y = Z$ = yellowish. *Dispersion:* $r < v$, strong. *Absorption:* $Z \geq Y > X$. $\alpha = 1.630$ $\beta = 1.678$ $\gamma = 1.697$ 2V(meas.) = 62°

Cell Data: *Space Group:* $P1$. $a = 5.415(2)$ $b = 7.081(3)$ $c = 20.34(1)$ $\alpha = 86.85(4)°$ $\beta = 94.40(4)°$ $\gamma = 89.94(3)°$ Z = 1

X-ray Powder Pattern: Lovozero massif, Russia.
2.880 (10), 2.702 (8b), 2.636 (7), 2.050 (5), 1.600 (5), 1.662 (4b), 1.713 (3)

Chemistry:

	(1)		(1)
SiO_2	16.5	CaO	5.3
TiO_2	13.7	SrO	0.4
ZrO_2	4.1	BaO	1.1
Nb_2O_5	3.8	Na_2O	28.1
FeO	0.3	F	3.4
MnO	4.3	P_2O_5	19.2
MgO	1.1	$-O = (F, Cl)_2$	1.4
		Total	99.9

(1) Lovozero massif, Russia; by electron microprobe, average of three analyses; corresponds to $Na_{13.21}(Ca_{1.38}Ba_{0.10}Sr_{0.06})_{\Sigma=1.54}(Mg_{0.40}Mn_{0.28}Fe_{0.06})_{\Sigma=0.74}(Ti_{2.50}Mn_{0.60}Zr_{0.48}Nb_{0.42})_{\Sigma=4.00}(Si_2O_7)_2(P_{0.98}O_4)_4O_{3.04}F_{2.61}$.

Occurrence: In ultra-agpaitic pegmatites in a differentiated alkalic massif.

Association: Nepheline, sodalite, analcime, potassic feldspar, albite, arfvedsonite, aegirine, cancrisilite, ussingite, makatite, villiaumite, polyphite, lomonosovite, sobolovite, additional minor minerals.

Distribution: On Mt. Alluaiv, Lovozero massif, Kola Peninsula, Russia.

Name: From the Latin *quadruplex*, for *four*, and PHosphorus, for the four phosphate anions in the chemical formula.

Type Material: A.E. Fersman Mineralogical Museum, Academy of Sciences, Moscow, Russia, p545/5; The Natural History Museum, London, England, 1994,25.

References: (1) Khomyakov, A.P., G.N. Nechelyustov, E.A. Sokolova, and G.I. Dorokhova (1992) Quadruphite $Na_{14}CaMgTi_4[Si_2O_7]_2[PO_4]_4O_4F_2$ and polyphite $Na_{17}Ca_3Mg(Ti, Mn)_4[Si_2O_7]_2[PO_4]_6O_2F_6$ – new minerals of the lomonosovite group. Zap. Vses. Mineral. Obshch., 121(1), 105–112 (in Russian). (2) (1993) Amer. Mineral., 78, 1316 (abs. ref. 1). (3) (1994) Mineral. Abs., 45, 240 (abs. ref. 1).