

The unknown mineral $(\text{Ca}_{0.2}\text{Mg}_{1.3}\text{Fe}^{2+}_{0.3})\text{Si}_3(\text{Ti}_{0.3}\text{Zr}_{1.7})\text{O}_{12}$ from the Kostomuksha lamproites/kimberlites2: paragenesis and chemistry

Anton Antonov

VSEGEI, Centre for Isotope Research, St.-Petersburg, Russia

Lamproite/kimberlite2 rocks from Kostomuksha iron open pit mine is host to a diversity of accessory minerals, the most common of which are apatite, perovskite, barite, Fe-Ni sulfides, Cu-Fe-Ni sulfides, strontianite, ilmenite, rutile, titanite, spinel (Al & Cr), titaniferous magnetite and monazite. There are no typical for lamproite/orangeite rocks clan potassium zirconium silicates (like wadeite and dalyite) as well as “complex” titanium oxides (jeppite and armalcolite) and hollandites (priderite). At routine thin sections scanning (with the SEM by bright spots) an unknown mineral – silicate of Zr and Mg was found. There are multitude of unidentified Zr-Ca silicates descriptions from the matrix of kimberlite/lamproite clan rocks in a works of their petrology and mineralogy (Hammond, 2002; Mitchell, 1995).

The uncovered mineral of Zirconium in Kostomuksha lamproite/kimberlite2 occurs is very rare groundmass accessory phase ($< 40 \mu\text{m}$). It forms the anhedral grains set in a serpentine-calcite matrix (fig. 1) as detached grains as well as an intergrowth with ilmenite and rutile. In stand alone position in the phyllosilicate-carbonate matrix this mineral was observed as solid (fig.2) as well as spongy (fig. 3) grains.

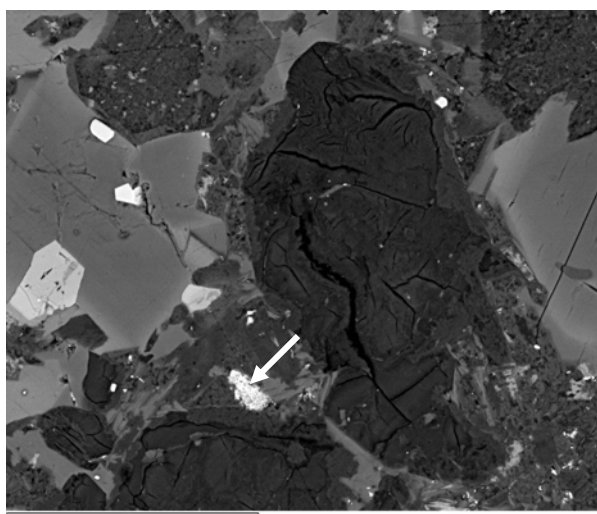


Fig. 1 Microphotograph of the Kostomuksha lamproite thin section in BSE mode (dark-grey – serpentine, middle-grey with the rim – phlogopite, bright-grey – apatite, white – chromite, magnetite and Zr silicate)

Compositional data were obtained by energy-dispersive (at 20 kV of EHT and 1 nA beam current on Faraday cup) and wave-length dispersion (20 kV, 8.7 nA) spectrometry using tungsten and field emission scanning electron microscopes. X-ray spectra were acquired for 100 seconds. Spectra were collected and processed with INCA Energy and INCA Wave software packages. XPP correction was applied to the raw data. The approved natural minerals were used as standards. At analysis with wave-length dispersion spectra acquisition LiF (for Fe Ka line), PET (for Ce La, Ti Ka, Zr La, Sr Ka and Si Ka lines) and TAP (for Al Ka and Mg Ka lines) crystals were used.

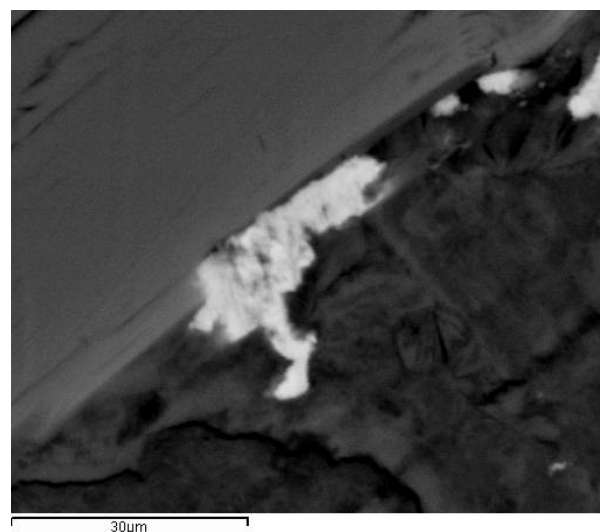


Fig. 2 Photomicrograph showing solid grain of Zr silicate onto phlogopite phenocrysts contact with carbonate-phyllosilicate matrix (BSE image)

Because of imperfection of analyzed surfaces (e.g. sponginess (fig. 3), hypsometric level of quite soft interstitial material, etc) all collected data were reduced and improper analysis was refused. Our statistical data is based on selected 30 cases (with good repeatability of analytical data (e.g. analytical totals) and stoichiometric fitness). The principal components of this multiple oxide are: zirconium, silicon, magnesium and oxygen. The electron-microprobe analysis gave ranges of ZrO_2 varying from 42.2 to 45.2 wt. %, SiO_2 – from 34.5 to 38.4 wt. %, MgO – from 9.5 to 11.3 wt. % (Tab. 1), minor amounts of Al, Ca, Ti and Fe (the total

of listed is about 8-9 wt. %) and analytical totals are varying from 97.86 to 100.01 wt.% (for selected measurements). Entire set of data gave much more wide range of components variation (Fig. 4)

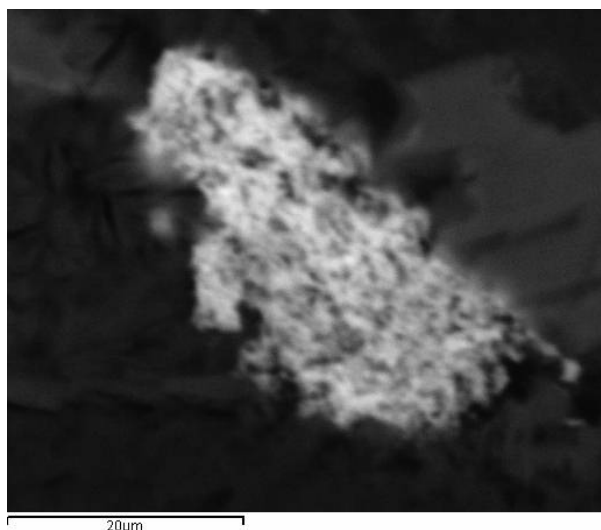


Fig. 3 Photomicrograph showing spongy grain of Zr silicate in a carbonate-phylllosilicate matrix (BSE image)

The cation-anion ratio 7/12 is well matching for empirical (with simplification) formula: $Mg_2Si_3Zr_2O_{12}$. The real formula of the mineral is well corresponding to $(Ca_{0.2}Mg_{1.3}Fe^{2+}_{0.3})Si_3(Ti_{0.3}Zr_{1.7})O_{12}$ formula record.

The multiple oxide with the similar kind of stoichiometry was described as hexagonal **mongshanite** $((Mg,Cr,Fe^{2+})_2(Ti,Zr)_5O_{12})$ (not approved by IMA) from Chinese kimberlite dike (not exactly specified) groundmass ilmenite intergrowth (Jianxiong, 1988).

The whole rocks geochemistry demonstrates the content of Zr (by ICPMS) is varying from 450 up to 1100 ppm (Nikitina, 1999). The described mineral it seems the principal concentrator of Zr responsible for bulk geochemistry (along with rare xenogenic zircon).

References

- Hammond A., Mitchell R., 2002, Accessory mineralogy of orangeite from Swartuggens, South Africa, *Mineralogy and Petrology*, 76, 1-19
- Jianxiong Z., Kezi Z., Yelong F., Guojie Y., 1988, New Names American Mineralogist, 73, 439-445.
- Mitchell R., 1995, Kimberlites, orangeites and related rocks, Plenum Press, New York, 410 pp.
- Nikitina, L., Levsky, L., Lohkov, K., Belyatsky, B., Zhuravlev, V., Lepekhina, E. & Antontov, A., 1999. Proterozoic alkaline-ultramafic magmatism in the eastern part of the Baltic Shield. *Petrology* 7, 246-266.

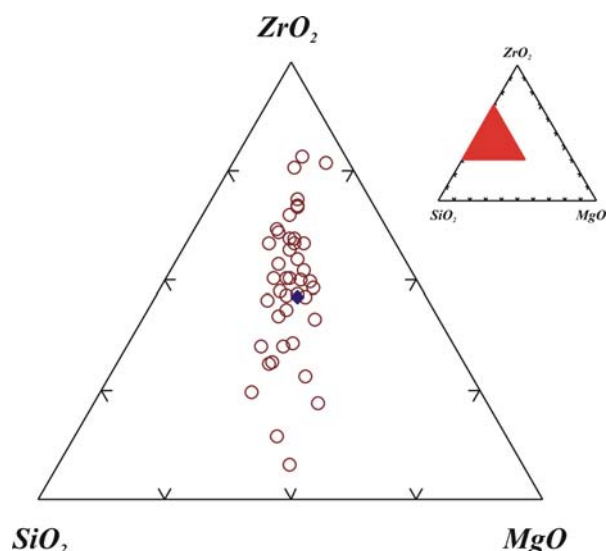


Fig. 4 Diagram showing a compositional variation of investigated mineral principal components (without any rejections (full data set)). Dark blue rhomb – averaged meaning for utilized data.

Table 1 Representative chemical data for unknown Zr silicate (wt. %)

Sample	13	16	17	27	5	9	aver
MgO	9.64	11.11	10.46	11.31	10.36	9.53	10.45
Al ₂ O ₃	0.77	0.68	0.45	0.99	1.05	0.82	0.79
SiO ₂	38.43	36.86	34.51	35.85	37.02	37.8	36.88
CaO	1.90	2.15	4.41	2.23	1.75	1.95	2.39
TiO ₂	0.78	0.84	2.7	0.94	1.3	1.77	1.36
FeO _{tot}	4.18	3.14	2.74	2.66	2.83	3.33	3.14
ZrO ₂	42.16	45.22	44.74	45.87	45.13	44.8	44.47
Total	97.86	100	100.01	99.85	99.44	100	99.48
Mg	1.228	1.402	1.335	1.434	1.309	1.197	1.323
Al	0.077	0.068	0.045	0.099	0.105	0.081	0.079
Si	3.284	3.120	2.955	3.049	3.138	3.183	3.131
Ca	0.174	0.195	0.405	0.203	0.159	0.176	0.217
Ti	0.05	0.053	0.174	0.06	0.083	0.112	0.087
Fe ²⁺	0.299	0.222	0.196	0.189	0.201	0.235	0.223
Zr	1.757	1.866	1.868	1.903	1.866	1.84	1.841
Cations	6.869	6.926	6.978	6.937	6.861	6.824	6.901
O	12	12	12	12	12	12	12