MINERALOGY OF ALKALINE IGNEOUS AND ASSOCIATED HYDROTHERMAL AND METASOMATIC ROCKS, MURUN COMPLEX, EASTERN SIBERIA, RUSSIA

The list presented below is a summary of published (1-6) and authors' own unpublished data. Nikolay V. Vladykin is gratefully acknowledged for his comments on this list. Minerals given in **bold** contain essential K, Sr or Ba in their composition. Note, however, that many other minerals on this list contain elevated levels of these elements (e.g., Sr in calcite, fluorapatite and eudialyte, Ba in microcline, etc.). The underlined minerals were discovered at Murun; only key references are given for these entries.

Mineral name	Mineral formula	References (type material only)
Aegirine	$NaFeSi_2O_6$	
Aegirine-augite	$(Na,Ca)(Fe,Mg)Si_2O_6$	
Actinolite	$Ca_2(Mg,Fe)_5(Si_4O_{11})_2(OH,F)_2$	
Agrellite	$NaCa_2Si_4O_{10}F$	
Albite	$NaAlSi_3O_8$	
Analcime	$NaAlSi_2O_6 \cdot H_2O$	
Anatase	TiO_2	
Ancylite-(Ce)	$\mathbf{(Sr,Ca)Ce(CO_3)_2(OH)\bullet(H_2O)}$	
Andradite	$Ca_3Fe_2Si_3O_{12}$	
Anilite	Cu_7S_4	
Annite	$\mathbf{K(Fe,Mg)_3AlSi_3O_{10}(OH,F)_2}$	
Anorthite	$(Ca,Na)Al(Al,Si)Si_2O_8$	
Apophyllite-(KOH)	$\mathbf{KCa_4(Si_8O_{20})(OH,F)\bullet 8H_2O}$	
Augite	$(Ca,Na)(Mg,Fe,Ti)(Al,Si)_2O_6$	
Autunite	$Ca(UO_2)_2(PO_4)_2 \cdot 10\text{-}12H_2O$	
Azurite	$Cu_3(CO_3)_2(OH)_2$	
Baddeleyite	ZrO_2	
Banalsite	$\mathbf{BaNa_2Al_4Si_4O_{16}}$	
Barite	$\mathbf{BaSO_4}$	
Barytocalcite	$\mathbf{CaBa(CO_3)_2}$	
Barytolamprophyllite	$\mathbf{Ba_2Na_3(Fe^{3+},Ti)_3(Si_2O_7)_2(O,OH,F)_4}$	
Benstonite *(decomposed)*	$\mathbf{(Ba,Sr)_6(Ca,Mn)_6Mg(CO_3)_{13}}$	
Bornite	Cu_5FeS_4	
Brannerite	UTi_2O_6	
Brochantite	$Cu_4(SO_4)(OH)_6$	
Brookite	TiO_2	
Brucite	$Mg(OH)_2$	
Burbankite	$\mathbf{(Na,Ca)_3(Sr,Ca,Ba,REE)_3(CO_3)_5}$	
Calcite	$CaCO_3$	
Celadonite	$\mathbf{K(Mg,Fe^{2+})(Fe^{3+},Al)(Si_4O_{10})(OH)_2}$	
Chalcocite	Cu_2S	
Chalcopyrite	$CuFeS_2$	
Charoite	$\mathbf{(K,Sr,Ba,Mn)_{15\text{-}16}(Ca,Na)_{32}[(Si_{70}(O,OH)_{180})](OH,F)_{4.0}\bullet 3H_2O}$	**1–2, 6–12**

Mineral name	Mineral formula	References (type material only)
Chromite	$Fe(Cr,Fe^{3+})_2O_4$	
Chrysocolla	$Cu_2H_2Si_2O_5(OH)_4 \cdot nH_2O$	
Clinohumite	$(Mg,Fe)_9(SiO_4)_4(F,OH)_2$	
Copper	Cu	
Corundum	Al_2O_3	
Dalyite	**$K_2ZrSi_6O_{15}$**	
Davanite	**$K_2TiSi_6O_{15}$**	**1, 13–15**
Denisovite	**$(K,Na)Ca_2Si_3O_8(F,OH)$**	
Digenite	Cu_9S_5	
Diopside	$Ca(Mg,Fe)Si_2O_6$	
Djerfisherite	**$K_6(Fe,Cu)_{25}S_{26}Cl$**	
Dolomite	$CaMg(CO_3)_2$	
Elpidite	$Na_2ZrSi_6O_{15} \cdot 3H_2O$	
Epididymite	$Na_2Be_2Si_6O_{15} \cdot H_2O$	
Eudialyte	$Na_{15-x}Ca_6(Fe,Mn)_3Zr_3Si(Si_{25}O_{73})(O,OH,H_2O)_3Cl_2$	
Fedorite	$(Na,K)_2(Ca,Na)_7(Si_{16}O_{38})F_2 \cdot 3.5H_2O$	
Ferripyrophylite	$Fe_2(Si_4O_{10})(OH)_2$	
Fluorapatite	$Ca_5(PO_4)_3(F,OH)$	
Fluorite	CaF_2	
Fluoro-sodic-pedrizite (?)	$NaLi_2(Mg,Al,Li)_5(Si_4O_{11})_2(F,OH)_2$	
Fluorstrophite	**$Sr_3Ca_2(PO_4)_3F$**	
Forsterite	$(Mg,Fe)_2SiO_4$	
Francevillite	**$Ba(UO_2)_2(VO_4)_2 \cdot 5H_2O$**	
Frankamenite	**$K_3Na_3Ca_5(Si_{12}O_{30})(OH,F)_4 \bullet H_2O$**	**16–19**
Fresnoite	**$Ba_2TiSi_2O_8$**	
Froodite	$PdBi_2$	
Galena	PbS	
Geikielite	$(Mg,Fe)TiO_3$	
Gold	Au	
Graphite	C	
Grossular	$Ca_3Al_2Si_3O_{12}$	
Henrymeyerite	**$BaFe^{2+}Ti_7O_{16}$**	
Humite	$(Mg,Fe)_7(SiO_4)_3(F,OH)_2$	
Huttonite	$ThSiO_4$	
Idaite	Cu_5FeS_6	
Jarosite	**$KFe^{3+}{}_3(SO_4)_2(OH)_6$**	
Ilmenite	$(Fe,Mn)TiO_3$	
Kalsilite	**$KAlSiO_4$**	
Kilchoanite	$Ca_3Si_2O_7$	
Kukharenkoite-(Ce)	**$Ba_2REE(CO_3)_3F$**	

Mineral name	Mineral formula	References (type material only)
Labuntsovite-Mg	**$Na_4K_4(Mg,Fe)_2Ti_8[Si_4O_{12}]_4(O,OH)_8$•10-12($H_2O$)**	
Lamprophyllite	**$Na_2(Sr,Ba)_2Ti_3(SiO_4)_4(OH,F)_2$**	
Lemmleinite-K	**$Na_4K_4(K,Ba)_{4-x}Ti_8(Si_4O_{12})_4(O,OH)_8$•8($H_2O$)**	
Leucite	**$KAlSi_2O_6$**	
Leucophanite	$(Na,Ca)_2BeSi_2(O,OH)_7$	
Leucosphenite	$Na_4BaTi_2O_2(B_2Si_{10}O_{28})$	
Lorenzenite	$Na_2Ti_2Si_2O_9$	
Magnesio-arfvedsonite	$Na_3(Mg_4Fe^{3+})(Si_8O_{22})(OH,F)_2$	
Magnesioriebeckite	$Na_2(Mg_4Fe^{3+}{}_2)(Si_8O_{22})(OH,F)_2$	
Magnetite	$Fe^{2+}Fe^{3+}{}_2O_4$	
Malachite	$Cu_2(CO_3)(OH)_2$	
Meionite	$Ca_4Al_6Si_6O_{24}(CO_3)$	
Melilite	$(Ca,Na)_2(Mg,Al,Fe)(Si,Al)_2O_7$	
Meta-uranocircite	**$Ba(UO_2)_2(PO_4)_2$•6-8H_2O**	
Microcline	**$KAlSi_3O_8$**	
Miserite	**$K_{1.5-x}(Ca,REE)_5(Si_6O_{15})(Si_2O_7)(OH,F)_2$•n$H_2O$**	
Molybdenite	MoS_2	
Monazite	$REEPO_4$	
Monticellite	$Ca(Mg,Fe)SiO_4$	
Mosandrite	$Na_2Ca_4REETi(Si_2O_7)_2OF_3$	
Mottramite	$PbCu(VO_4)(OH)$	
Murunskite	**$K_2(Cu,Fe)_4S_4$**	**20, 21**
Muscovite	**$KAl_2(Si_3Al)O_{10}(OH,F)_2$**	
Narsarsukite	$Na_4(Ti,Fe)(Si_8O_{20})(O,OH,F)_2$	
Natrolite	$Na_2Al_2Si_3O_{10}\cdot 2H_2O$	
Neotocite	$(Mn,Fe)SiO_3\cdot H_2O$	
Nepheline	**$Na_3K(AlSiO_4)_4$**	
Noonkanbahite	**$BaKNaTi_2(Si_4O_{12})O_2$**	**1, 2, 22**
Odintsovite	**$K_2Na_4Ca_3Ti_2Be_4Si_{12}O_{38}$**	**23, 24**
Olekminskite	**$Sr(Sr,Ca,Ba)(CO_3)_2$**	**1, 25**
Orthoclase	**$KAlSi_3O_8$**	
Paralstonite	**$BaCa(CO_3)_2$**	
Pectolite	$NaCa_2(Si_3O_8OH)$	
Periclase	MgO	
Perlialite	**$K_8Tl_4Al_{12}Si_{24}O_{72}$•20($H_2O$)**	
Perovskite	$CaTiO_3$	
Phlogopite	**$K(Mg,Fe)_3(AlSi_3O_{10})(OH,F)_2$**	
Potassic-magnesio-arfvedsonite	**$KNa_2(Mg_4Fe^{3+})(Si_8O_{22})(OH,F)_2$**	
Potassic-richterite	**$(K,Na)(CaNa)_2Mg_5(Si_8O_{22})(OH,F)_2$**	
Priderite	**$(K,Ba)(Ti,Fe^{3+})_8O_{16}$**	

Mineral name	Mineral formula	References (type material only)
Pyrite	FeS_2	
Pyromorphite	$Pb_5(PO_4)_3Cl$	
Pyrrhotite	$Fe_{1-x}S$	
Quartz	SiO_2	
Richterite	$Na_2Ca(Mg,Fe)_5(Si_8O_{22})(OH,F)_2$	
Rosenbuschite	$Na_2Ca_6(Na,Ca)_4Zr_3Ti(Si_2O_7)_4F_4O_4$	
Rutile	TiO_2	
Sanidine	$\mathbf{KAlSi_3O_8}$	
Serandite	$Na(Mn,Ca)_2(Si_3O_8OH)$	
Silver	Ag	
Smithsonite	$ZnCO_3$	
Sobolevskite	PdBi	
Sodalite	$Na_8Al_6Si_6O_{24}Cl_2$	
Sperrylite	$PtAs_2$	
Sphalerite	ZnS	
Spinel	$MgAl_2O_4$	
Steacyite	$\mathbf{K_{1-x}(Na,Ca)_2ThSi_8O_{20}}$	
Strontianite	$\mathbf{SrCO_3}$	
Sudburyite	(Pd,Ni)Sb	
Tainiolite	$\mathbf{KLiMgSi_4O_{10}(F,OH)_2}$	
Tausonite	$\mathbf{SrTiO_3}$	**1, 26–28**
Tetra-ferriphlogopite	$\mathbf{K(Mg,Fe)_3Fe^{3+}Si_3O_{10}(OH)_2}$	
Thalcusite	$TlCu_3FeS_4$	
Thorianite	ThO_2	
Thorite	$ThSiO_4$	
Thorosteenstrupine	$(Ca,Th,Mn)_3Si_4O_{11}F{\cdot}6H_2O$	
Tinaksite	$\mathbf{K_2Na(Ca,Mn)_2(Ti,Fe)[Si_7O_{18}(OH)]O}$	**1, 2, 29–31**
Titanite	$CaTiSiO_4O$	
Tokkoite	$\mathbf{K_2Ca_4[Si_7O_{18}(OH)](F,OH)}$	**31, 32**
Tremolite	$Ca_2(Mg,Fe)_5(Si_4O_{11})_2(OH,F)_2$	
Turkestanite	$\mathbf{K_{1-x}(Ca,Na)_2ThSi_8O_{20}{\bullet}nH_2O}$	
Uraninite	UO_2	
Vanadinite	$Pb_5(VO_4)_3Cl$	
Vesivianite	$Ca_{10}Mg_4Al_4(SiO_4)_5(Si_2O_7)_2(OH)_4$	
Vishnevite	$\mathbf{Na_6K_2Si_6Al_6O_{24}(SO_4){\bullet}2H_2O}$	
Vladykinite	$\mathbf{Na_3Sr_4(Fe^{2+}Fe^{3+})Si_8O_{24}}$	**This work**
Wadeite	$\mathbf{K_2ZrSi_3O_9}$	
Witherite	$\mathbf{BaCO_3}$	
Wollastonite	$Ca_3Si_3O_9$	
Wulfenite	$PbMoO_4$	
Xonotlite	$Ca_6(Si_6O_{17})(OH)_2$	

Mineral name	Mineral formula	References (type material only)
Yuksporite	**$(Sr,Ba)_2K_4(Ca,Na)_{14}([\ ],Mn,Fe)\{(Ti,Nb)_4(O,OH)_4[Si_6O_{17}]_2[Si_2O_7]_3\}(H_2O,OH)_{\sim 3}$**	
Zircon	$ZrSiO_4$	
Zirconolite	$CaZrTi_2O_7$	

REFERENCES CITED

1. Konev, A.A., Vorob'ev, E.I., and Lazebnik, K.A. (1996) Mineralogy of the Murun Alkaline Massif. Siberian Branch RAS press, Novosibirsk, Russia, 221 pp. (in Russian).
2. Reguir, E.P. (2001) Aspects of the Mineralogy of the Murun Alkaline Complex, Yakutia, Russia. MSc Thesis, Lakehead University, Thunder Bay, Canada, 193 pp. Published online at: http://www.collectionscanada.gc.ca/obj/s4/f2/dsk3/ftp04/MQ60867.pdf
3. Chukanov, N.V., Pekov, I.V., Zadov, A.E., Voloshin, A.V., Subbotin, V.V., Sorokhtina, N.V., Rastsvetaeva, R.K., and Krivovichev, S.V. (2003) Mineals of the Labuntsovite Group. Nauka, Moscow, 323 pp. (in Russian).
4. Dobrovol'skaya, M.G., Malov, V.S., and Vladykin, N.V. (1985) Minerals of platinum and palladium in charoite rocks. Doklady AN SSSR, 284, 438-442 (in Russian).
5. Mitchell, R.H. and Vladykin, N.V. (1996) Compositional variation of pyroxene and mica from the Little Murun ultrapotassic complex, Aldan Shield, Russia. Mineralogical Magazine, 60, 907-925.
6. Vorob'ev, E.I. (2008) Charoite. Geo, Novosibirsk, 140 pp. (in Russian).
7. Rogova, V.P., Rogov, Yu.G., Drits, V.A., and Kuznetsova, N.I.(1978) Charoite- a new mineral and gemstone. Zapiski Vsesoyuznogo Mineralogicheskogo Obshchestva, 107(1), 94–100 (in Russian).
8. Rogova, V.P. (1979) Charoite, a new mineral and a new jewelry stone. International Geology Review, 21, 615–620.
9. Vladykin, N.V., Matveeva, L.N., Bogacheva, N.G., and Alekseev, Yu.A. (1983) New data on charoite and charoite rocks. In Minerals and Genesis of Gemstones of Eastern Siberia. Nauka, Leningrad, 41–56 (in Russian).
10. Evdokimov, M.D. (1995) Charoite: a unique mineral from a unique occurrence. World of Stones, 1995 (7), 3–11.
11. Rozhdestvenskaya, I.V., Kogure, T., Abe, E., and Drits, V.A. (2009) A structural model for charoite. Mineralogical Magazine, 73, 883–890.
12. Rozhdestvenskaya, I., Mugnaioli, E., Czank, M., Depmeier, W., Kolb, U., Reinholdt, A., and Weirich, T. (2010) The structure of charoite, $(K,Sr,Ba,Mn)_{15\text{-}16}(Ca,Na)_{32}[(Si_{70}(O,OH)_{180})](OH,F)_{4.0}\bullet nH_2O$, solved by conventional and automated electron diffraction. Mineralogical Magazine, 74, 159–177.
13. Lazebnik, K.A., Lazebnik, Yu.D., and Makhotko, V.F. (1984) Davanite $K_2TiSi_6O_{15}$ – a new alkali titanosilicate. Zapiski Vsesoyuznogo Mineralogicheskogo Obshchestva, 113, 95–97 (in Russian).
14. Gebert, W., Medenbach, O., and Flörke, O.W. (1983) Darstellung und Kristallographie von $K_2TiSi_6O_{15}$ – isotyp mit Dalyit $K_2ZrSi_6O_{15}$. Tschermaks Mineralogische und Petrographische Mitteilungen, 31, 69–79
15. Raade, G. (1987) Davanite, $K_2TiSi_6O_{15}$, in the Smoky Butte (Montana) lamproites: discussion of X-ray powder data. American Mineralogist, 72, 1014–1015.

16. Nikishova, L.V., Lazebnik, K.A., Rozhdestvenskaya, I.V., Lazebnik, Yu.D. and Emel'yanova, N.N. (1992) Triclinic canasite from charoitites of Yakutia. Mineralogicheskii Zhurnal, 14(1), 71–77 (in Russian).
17. Evdokimov, M.D. and Reguir, E.P. (1994) Canasite in charoitites of the Murun alkaline complex (Lilac Rock deposit). Zapiski Vserossiiskogo Mineralogicheskogo Obshchestva, 123(1), 104–118 (in Russian).
18. Nikishova, L.V., Lazebnik, K.A., Rozhdestvenskaya, I.V., Emel'yanova, N.N., and Lazebnik, Yu.D. (1996) Frankamenite $K_3Na_3Ca_5(Si_{12}O_{30})F_3(OH)\cdot H_2O$ – a new minerals, triclinic analogue of canasite from charoitites. Zapiski Vserossiiskogo Mineralogicheskogo Obshchestva, 125(2), 106–108 (in Russian).
19. Rozhdestvenskaya, I.V., Nikishova, L.V., and Lazebnik, K.A. (1996) The crystal structure of frankamenite. Mineralogical Magazine, 60, 897–905.
20. Dobrovolskaya, M.G., Tsepin, A.I., Evstigneeva, T.L., Vyal'sov, L.N., and Zaozerina, A.O. (1981) Murunskite, $K_2Cu_3FeS_4$, a new sulfide of potassium, copper, and iron. Zapiski Vsesoyuznogo Mineralogicheskogo Obshchestva, 110, 468–473 (in Russian).
21. Pekov, I. V., Zubkova, N. V., Lisitsyn, D. V., and Pushcharovsky, D.Yu. (2009) Crystal chemistry of murunskite. Doklady Earth Sciences, 424, 139–141.
22. Uvarova, Y. A., Sokolova, E., Hawthorne, F.C., Liferovich, R.P., Mitchell, R.H., Pekov, I.V., and Zadov, A.E. (2010) Noonkanbahite, $BaKNaTi_2(Si_4O_{12})O_2$, a new mineral species: description and crystal structure. Mineralogical Magazine, 74, 441–450.
23. Konev, A.A., Vorob'ev, E.I., Sapozhnikov, A.N., Piskunova, L.F., and Ushchapovskaya, Z.F. (1995) Odintsovite – $K_2Na_4Ca_3Ti_2Be_4Si_{12}O_{38}$ – a new mineral from the Murunsky massif. Zapiski Vserossiiskogo Mineralogicheskogo Obshchestva, 124(5), 92–96 (in Russian).
24. Rastsvetaeva, R.K., Evsyunin, V.G., and Kashaev, A.A. (1995) Crystal structure of a new representative of ring silicates. Doklady Chemistry, 340, 49–51.
25. Konev, A.A., Vorob'ev, E.I., Piskunova, L.F., Ushchapovskaya, Z.F. and Tichonova, G.A. (1991) Olekminskite $Sr(Sr,Ca,Ba)(CO_3)_2$ – a new mineral and the new isomorphous series olekminskite-paralstonite. Zapiski Vsesoyuznogo Mineralogicheskogo Obshchestva, 120(3), 89–96 (in Russian).
26. Vorob'ev, E.I., Konev, A.A., Malyshonok, Yu.V., Afonina, G.G., and Sapozhnikov, A.N. (1984) Tausonite, $SrTiO_3$, a new mineral of the perovskite group. Zapiski Vsesoyuznogo Mineralogicheskogo Obshchestva, 113(1), 86–89 (in Russian).
27. Vorob'ev, E.I., Konev, A.A., Malyshonok, Yu.V., Afonina, G.G., and Paradina, L.F. (1987) Tausonite: Geological Conditions of Formation and Mineral Parageneses. Nauka, Novosibirsk, 143 pp. (in Russian).
28. Mitchell R.H. and Vladykin N.V. (1993) Rare-earth element-bearing tausonite and potassium barium titanates from the Little Murun potassic alkaline complex. Mineralogical Magazine, 57, 651–668.
29. Rogov, Yu.G., Rogova, V.P., Voronkov, A.A., and Moleva, V.A. (1965) Tinaksite, $NaK_2Ca_2TiSi_7O_{19}(OH)$ – a new mineral. Doklady AN SSSR, 162, 658-661 (in Russian).
30. Rozhdestvenskaya, I.V., Nikishova, L.V., and Lazebnik, K.A. (1991) Pecularities of the crystal structure of minerals from tinaksite group. Mineralogicheskii Zhurnal, 13, 3–12 (in Russian).
31. Rozhdestvenskaya, I.V., Nikishova, L.V., Lazebnik, Yu.D. and Lazebnik, K.A. (1989) The crystal structure of tokkoite and its relation to the structure of tinaksite. Zeitschrift für Kristallographie – Crystalline Materials, 189, 195–204.
32. Lazebnik, K.A., Nikishova, L.V. and Lazebnik, Yu.D. (1986) Tokkoite – a new mineral of charoitites. Mineralogicheskii Zhurnal, 8(3), 85–89 (in Russian).