**Supplementary material 3: Description of samples listed in Supplementary material 2**

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# Leucosyenite samples

The three leucosyenite samples F2, SRA-1 and T-2 come from the main deposit (blue zone in Fig. 2). F2 sample is an alternation of mafic (20 %) and felsic ribbons (75 %). Felsic ribbons are composed of subhedral millimetric microcline (40 %) and albite (20 %), and anhedral millimetric quartz (15 %), and mafic ribbons consist to a mix of anhedral moderately grained riebeckite and hornblende. Zirconosilicates (5 %) are subhedral millimetric vlasovite, gittinsite and zircon crystals concentrated in two band in felsic ribbons. Gittinsite and zircon are the product of vlasovite alteration. SRA-1 is richer in mafic minerals (≃ 35 %), plurimillimetric elongated subhedral to anhedral crystals of richterite and aegirine-augite. Felsic minerals are composed of millimetric subhedral elongated crystals of microcline (45 %) and albite (15 %). Mosandrite-(Ce) crystals (2 %) are anhedral to subhedral curved or elongated and millimetric. Eudialyte are also present (3 %, anhedral) but not analyzed. T-2 is an altered sample of leucosyenite. Subhedral quartz crystals represent 8 % of the sample. Microcline and albite crystals represent ≃ 60 % of the sample. These crystals are subhedral to anhedral, altered, and finely to moderately grained, like quartz crystals. Rinkite Group mineral (RGM) are present (2 %). They are altered, elongated and millimetric. Mafic minerals (30 %) are also altered, plurimmilimetric, elongated. These are amphibole and pyroxene, probably aegirine-augite.

# Mesosyenite samples

Three of the four mesosyenite samples come from the main deposit (F6, SRA-6, SRA-9), and the last sample come from the “Couleuvre” site (JR279A). Respectively, SRA-6 and SRA-9 are composed of 42 % and 51 % of mafic minerals, two amphiboles (arfvedsonite and/or riebeckite) and 57 % and 48 % of felsic minerals (dominated by Na-feldspar, microcline are not higher than 10 %). Felsic minerals are in bands/patch between mafic minerals. Amphibole crystals are subhedral to anhedral and finely to moderately grained. Crystals of Na-felspar for the two samples are finely grained and subhedral to, in majority, anhedral. In SRA-6, 1 % of brown millimetric euhedral to subhedral fractured crystals of a Th-host mineral is present, identified as ekanite, and traces of anhedral fractured vlasovite (< 1 mm), with of anhedral altered crystals of gittinsite (< 1 mm) and traces of anhedral fractured fluorapatite (< 1 mm). These are the same minor phase in SRA-9, with trace of euhedral to subhedral ekanite (< 1 mm), trace of micrometric to millimetric subhedral vlasovite altered in gittinsite, and traces of anhedral fractured fluorapatite (< 1 mm), but also trace of micrometric to millimetric anhedral crystal of britholite and fluorite. F6 is a sample of a mesosyenite marked by an alteration of massive zones and foliated zones. This sample is composed of 45 % of eudialyte, 30 % of mafic minerals (Katophorite, pargasite and /or hastingsite for amphibole, aegirine-augite), 18 % of felsic mineral (microcline, albite, trace of quartz), 5 % of brown mineral (chocolate brown = britholite, other brown = richterite/mosandrite), 2 % of vlasovite and traces of fluorapatite. Amphibole and aegirine-augite crystals are moderately grained and subhedral. Eudialyte crystals and RGM are subhedral, finely to moderately grained, in heaps. Fluorapatite are founded in theses heaps. Britholite group mineral (BGM) crystals are finely grained, anhedral, and surrounded RGM and eudialyte crystals. Felsic minerals are in patches, finely to moderately grained and anhedral to subhedral. Subhedral moderately grained vlasovite are founded in these felsic patches. The example of eudialyte bearing patch in the supplementary material 5 is an example of the foliated zone near F6. This sample is an alteration of felsic bands (microcline, albite, quartz, 40 %) and mafic bands (Na-Ca amphibole and aegirine-augite, 55 %). Eudialyte (5 %) are concentrated in a felsic band, are finely grained and subhedral to anhedral, such as felsic minerals, or disseminated in bands of moderately grained and subhedral mafic minerals. The last sample, JR279A, is composed of 50 % of coarse grained subhedral to anhedral microcline with exsolution of albite, with 1 % of anhedral quartz, and 50 of mafic minerals, composed of amphibole, chevkinite group minerals, bastnaesite, britholite, cheralite and unidentified Ti-REE-F host mineral. Amphiboles are coarse grained subhedral riebeckite and ferro-richterite. Chevkinite group minerals are represented by chevkinite-(Ce) and perrierite-(Ce). Crystals of chevkinite-(Ce) are moderately to coarse grained, euhedral to subhedral, fractured and altered, with an alteration crown in contact with amphiboles. The crown is composed of anhedral finely grained crystals of perrierite-(Ce), bastnaesite and unidentified Ti-REE-F mineral host minerals. Other crystals of chevkinite-(Ce) are surrounded by anhedral finely to moderately grained crystals of britholite, cheralite, bastnaesite, felspar, fluorite and calcite. In another part of the sample, bastnaesite is a crown-shaped around chevkinite-(Ce), quartz, fluorite, and calcite. Amphibole crystals have inclusions of quartz, feldspar, chevkinite-(Ce), carbonates and fluorite, and bastnaesite in their fractures.

# Mafic syenite samples

Six samples are mafic syenite samples: Al-01, JR14, SRA-3, 5, 7 and 11. Al-01 is composed of a coarse grained euhedral monomineralic ekanite surrounded by a mix of finely to moderately grained subhedral feldspar (albite + microcline), pyroxene, amphibole, and elongate moderately grained anhedral crystal of rinkite and mosandrite. An anhedral moderately grained unidentified zirconosilicate is also present, with inclusion of feldspars. JR14 is composed of 25 % of felsic minerals (feldspars, quartz), 75 % of mafic minerals (allanite, amphibole, REE-Nb host minerals) and trace of fluorite. Allanite crystals are finely to coarse grained, euhedral to subhedral and have altered border. These borders contain inclusions of feldspar, amphibole, and REE-host minerals. Feldspars and REE-Nb host minerals (chivruaaite, maoniupingite-(Ce), and two crystals of seidozerite supergroup minerals or murmanite group mineral) crystallize next. Feldspars are anhedral, finely (microcline), or anhedral moderately to coarse grained (albite). REE- Nb host minerals are subhedral to anhedral moderately grained. Zircons, amphiboles, and quartz crystallize at the same time to anhedral REE-Nb host minerals, Zircons and quartz are finely grained and subhedral to anhedral. Amphibole, probably kataphorite and hastingsite, are anhedral and moderately grained. Perrierite-(Ce) are identified as inclusions in allanite crystals.

SRA-5 is composed of 65 % of moderately to coarse grained subhedral crystals of richterite, arfvedsonite and/or kataphorite, with a band of finely to moderately grained subhedral crystal of albite and microcline (34 %). The last 1 % consist of finely grained subhedral to anhedral crystals of BGM, RGM and eudialyte. SRA-7 consist of a mafic syenite with 20 of felsic minerals (albite and microcline), 55 % of mafic minerals (micas and amphiboles), and 25 of BGM and fluorapatite. Microcline and albite are finely grained and anhedral. Amphibole and mica are finely to moderately grained, but amphibole is anhedral, and micas are subhedral. BGM, crystals are finely to moderately grained, and subhedral to anhedral. Parasite and fluorapatite are subhedral to anhedral finely grained. For SRA-11, richterite represent 65 % of the sample. Crystals are coarse grained and subhedral. This sample have 15 % of finely to moderately grained anhedral felsic mineral (albite, microcline), and 20 % of brown minerals (zircon, titanite, BGM, bastnaesite, euxenite). Euxenite, titanite, bastnaesite and BGM are finely grained and anhedral to subhedral, while zircon crystals are subhedral moderately to coarse grained.

SRA-3 is a felsic patch in a mafic syenite rich in amphibole and diopside. SRA-3 is composed principally of Th-Ca host mineral (probably ekanite, 15 %), RGM (9 %), eudialyte (40 %), feldspar (albite and microcline, 20 %), pectolite (5 %), diopside (5 %), richterite (5%) and britholite (1 %). Th-Ca host minerals are moderately to coarse grained, fractured and subhedral to euhedral. Eudialyte and RGM crystals are finely to moderately grained, subhedral, and fractured. Felspar, pectolite, richterite, diopside and britholite are finely to moderately grained, and anhedral.

# Amphibole-syenite samples

Ten samples come from amphibole-syenite, while three are felsic patch samples included in amphibole-syenite. For the drill core 12-KM-127, eudialyte crystals were extracted. For 12-KM-127 42.00 to 43.10 m, mafic minerals (80 %) are amphibole (same as other syenite, but richterite > 50 %), pyroxenes, and felsic minerals are albite and microcline (10 %). Felsic minerals are finely grained, and anhedral to subhedral, while mafic minerals are moderately to coarse grained and subhedral. Eudialyte crystals (9 %) are disseminated in patches. Crystals are anhedral to subhedral, and finely to moderately grained. Vlasovite, and brown crystals (1 %) are present in traces, are finely to moderately grained, and subhedral. Brown crystals are probably ekanite, thorite, mosandrite and BGM. 12-KM-127 44.10 to 44.90 m have three differences with the previous samples: 1) felsic minerals represent 15 % of sample, REE-HFSE host mineral 2 %, and amphibole 83 %, 2) eudialyte crystals are anhedral and 3) amphiboles crystals are subhedral to euhedral. 12-KM-127 30.58 to 31.47 m eudialytes crystals come from bands of amphibole-syenite intercalated between mesosyenites. The size of mafic, felsic, and REE-HFSE host minerals are finely to moderately grained. Amphibole crystals (60 %) are anhedral to subhedral, while microcline, albite (feldspar = 30 %) and eudialyte (10 %). Eudialyte crystals are organized in bands, in patches or are disseminated.

F-7 is an amphibole-syenite composed of 80 % fluororichterite and diopside (95-5), 10 % of feldspar (in majority albite, trace of microcline), 4 % of RGM, 4 % of fluorite and 2 % of BGM. Diopside and fluorichterite are coarse to moderately grained (in majority, some crystals are finely grained) and subhedral. Some crystals of diopside are euhedral. Other minerals are anhedral and finely to moderately grained. Mafic minerals and feldspars contain inclusions of fluorite. Some crystals of RGM are altered in and/or have inclusions of BGM. F-11 is an example of amphibole-syenite with a level of miserite-pectolite. 55 % of sample is represented by richterite. Crystals are moderately to coarse grained, subhedral, fractured. Eudialyte and miserite represent 30 % of sample (15 and 15 %). Eudialyte are subhedral to euhedral, moderately grained, unaltered, with very rarely inclusion of miserite. Inclusions of finely grained eudialyte are founded in richterite. Miserite crystals are finely to moderately grained and subhedral to anhedral, and locally altered. Finely grained subhedral calcite/fluorite are also founded (3 %). RGM (2 %) and BGM (1 %) are also founded. RGM are subhedral to anhedral, finely to moderately grained, and BGM are euhedral to anhedral, and finely to moderate grained. RGM crystals seem co-crystalline with eudialyte and miserite. REE-HFSE oxide/carbonates (euxenite/parasite) are present, as subhedral moderately grained crystals (2 %). These minerals, as eudialyte, miserite, rinkite, and calcite/fluorite, are surrounded by interstitial anhedral finely grained pectolite (2 %). The last 5 % are composed of albite and trace of microcline. Albite crystals are finely to moderately grained, anhedral, and surrounded eudialyte, pectolite, and calcite/fluorite. SRA-12 is dominated by mafic minerals (95 %, 35 % of aegirine-augite, and 60% of fluororichterite). Fluororichterite crystals are euhedral to subhedral, moderately to coarse grained and fractured. Aegirine-augite are finely to moderately grained and subhedral. 4 % of the sample are finely to moderately grained subhedral to anhedral feldspar (3 % of albite and 1 % of microcline). RGM crystals represent the last 1 %. They are finely to moderately grained, subhedral, elongated, and have little inclusions of pyroxene/amphibole/feldspar. BGM are present in traces.

F4 and F5 are two felsic patches founded in amphibole-syenite. F4 is composed of 50 % of coarse grained subhedral amphibole (kataphorite and richterite), 10 % coarse grained euhedral altered thorite, 15 % of finely to moderately grained anhedral to subhedral fractured fluorapatite, 10 % of finely to moderately anhedral fractured eudialyte, 15 % of anhedral to subhedral finely to moderately grained feldspar. BGM, vlasovite and gittinsite are present in traces, and are finely grained. BGM and gittinsite crystals are anhedral, and vlasovite crystals are anhedral to subhedral. Vlasovite is the main mineral of F5 (80 %). Vlasovite crystals are very coarse grained to moderately grained, euhedral to subhedral, and fractured. Fractures are filled y finely grained anhedral gittinsite (5 %). Microcline crystals are present (3 %, anhedral, finely grained). Eudialyte and albite surround vlasovite crystals (8 %). Eudialyte and albite crystals are moderately grained and anhedral. Albite crystals have inclusions of eudialyte and microcline. Kataphorite represent 3 % of the sample. Theses minerals crystals are moderately grained, subhedral and have inclusions of albite and microcline. Fluorapatite represent the last 1 %. These crystals are anhedral and finely to moderated grained.

# Marbles-skarn samples

Five samples of skarn/marbles were used for this study. Marbles have not deformation or trace od recrystallization and are finely to moderately grained. Skarn show mineral lineation and recrystallization, with moderately and coarse grained subhedral crystals. F19, SRA-4 and SRA-10 are three samples of marbles, and PB01 and SRA-8 are two examples of skarn.

F19 is a sample divided in three lithologies, a marble, an amphibole-syenite and a fenite in contact of the two first lithologies. The mafic syenite is essentially composed of 97 % of amphibole and 3 % of phlogopite. Trace of zircon are present in amphibole. This part of the syenite have been metasomatized. The fenite part is a diopside-phlogopite-calcite fenite and show marks of recrystallization and metasomatization. The marble is essentially composed of 70 % of finely to moderately subhedral calcite with 28 % of finely grained diopside. The last 2 % are BGM. BGM are finely to moderately grained, subhedral to anhedral, elongated, and fractured. Traces of subhedral zirconolite, zircon and phlogopite are founded. SRA-4 is a homogenous moderately grained marble composed of calcite, phlogopite, BGM, chondrodite, and trace of amphibole and muscovite. Calcite crystals (90 %, 1-3 mm) are subhedral, rarely euhedral and anhedral, rarely fractured and/or elongated. Phlogopite crystals (6 %, 1-2 mm) are anhedral, fractured, and elongated, such as several crystals of BGM (2 %, 0.1 to 1 mm). BGM are not imperatively elongated. Chondrodite crystals (2 %, 1 mm) are euhedral to subhedral and fractured. Amphibole and muscovite crystals are fractured and anhedral. SRA-10 is a diopside and phlogopite marble. Phlogopite crystals represent 15 % of the sample, and diopside 55 %. Calcite and BGM represent 30 % of the sample (respectively 25 and 5 %), and zircon and parasite-(Ce) are present in traces. Phlogopite crystals are moderately to coarse grained, subhedral and rarely fractured, and diopside crystals are moderately grained and subhedral. Calcite crystals are finely to moderately grained, anhedral, and fractured. BGM are subhedral to anhedral, rarely euhedral, and finely to moderately grained.

Pb-01 is a sample with the contact between a richterite-phlogopite skarn and a chondrodite-skarn. The first is composed of coarse grained euhedral phlogopite (20 %), of coarse grained subhedral to anhedral richterite (45 %), and moderately to coarse grained anhedral to subhedral calcite (35 %). The second skarn is composed of 50 % of moderately grained subhedral calcite and 50 % of moderately grained euhedral to subhedral chondrodite, with trace of phlogopite (moderately grained, euhedral to subhedral) and richterite (finely grained, anhedral). Traces of BGM, zirconolite and baddeleyite are founded. Baddeleyite (finely grained, elongated, euhedral) and BGM (finely grained, anhedral) are founded in the chondrodite-skarn. Zirconolite (finely grained, subhedral to anhedral) is particularly founded in the richterite-phlogopite skarn, but also in the chondrodite-skarn. SRA-8 is a skarn composed essentially of calcite (15 %), BGM (15 %), phlogopite (45 %), diopside (15 %) and traces of pyrochlore, aeschynite and/or euxenite minerals. Diopside and BGM crystals are moderately grained (rarely coarse grained), subhedral to euhedral, and fractured for BGM, subhedral for diopside. Calcite crystals are moderately grained and subhedral to anhedral. Phlogopite crystals are moderately grained (rarely coarse grained), fractured, and anhedral to euhedral, with inclusions of calcite and BGM. Pyrochlore, aeschynite and/or euxenite minerals are anhedral and finely grained.

# Fenites and metamorphic rock samples

Fenite samples are essentially of diopside, feldspar, phlogopite, amphibole, quartz, and calcite. In this study, minerals from six samples of fenites, namely F18, FF15A, FF15C, SRA-2, Surp01 and T8S, from Kipawa were analyzed.

F18 come from a level of amphibole-phlogopite-feldspar-calcite fenite. This fenite level is heterogenous, because F18 is an amphibole-phlogopite-calcite fenite without feldspar. F18 is composed of 35 % of finely to moderately grained anhedral to euhedral calcite. Amphibole crystals (richterite, kataphorite) and phlogopite represent respectively 50 and 15 % of the sample. Crystals are moderately grained and subhedral to euhedral. Inclusions of calcite are founded in phlogopite and amphibole. Traces of zircon and quartz were founded, also BGM crystals finely grained and subhedral-anhedral. FF15A and FF15C come from the "Falaise" mineral prospect. FF15A is a muscovite-feldspar fenite, and FF15C a quartz-feldspar-phlogopite fenite. FF15A is dominated by moderately to coarse grained subhedral-euhedral muscovite (90 %), 5 % of anhedral moderately grained microcline, 2 % of unidentified mineral, and a coarse grained subhedral fractured bastnaesite crystal (2 %). Zircon, parasite, monazite and xenotine crystals are generally anhedral to subhedral, finely grained, and sometimes in inclusions. FF15C is essentially composed of 80 % of subhedral coarse grained quartz (80 %), anhedral, fractured and moderately grained microcline and albite (10 %), coarse grained subhedral altered and fractured ankerite (4 %), moderately grained anhedral to subhedral monazite (2), finely grained euhedral zircon (1 %). The last 2 % is composed of BGM, phlogopite, euxenite and bastnaesite. Euxenite crystals (finely to moderately grained) are founded anhedral in cluster with bastnaesite, BGM and monazite (all minerals are finely to moderately grained and anhedral to subhedral), or subhedral with a crown of phlogopite (finely grained, subhedral). Bastnaesite crystals frequently contains inclusions, and are in contact with carbonates, BGM, zircon and euxenite. Monazite also are anhedral to subhedral finely grained and fractured. SRA-2 is a diopside-feldspar fenite. 80 % of the sample is composed of diopside, 15 of microcline and 5 % of BGM and RGM. Diopside crystals are anhedral to subhedral and moderately to rarely coarse grained and fractured. Microcline crystals are anhedral and finely to moderately grained. RGM are moderately to coarse grained, anhedral in majority and BGM are finely to moderately grained and anhedral. T8S is a mica-quartz fenite. 70 % of sample are phlogopite and biotite crystals with 5 % of muscovite. These crystals are moderately to coarse grained and euhedral. A band of coarse grained subhedral quartz crystals represent 20 % of the sample. The last 5 % is composed of monazite and xenotime crystals. Preferentially in the micas part, these crystals are finely grained and anhedral to euhedral. Apatite, sulfides, oxides and garnet are present in traces.

Surp01 sample is a metamorphic rock composed by quartz, garnet, allanite, phlogopite, zircon, apatite, and microcline. Quartz, allanite, and garnet are dominant (respectively 15, 15 and 55 % of the sample) and are moderately to coarse grained. Quartz and garnet crystals are anhedral and fractured, while allanite crystals are subhedral, rich in inclusions of REE and/or Th host minerals and altered. Phlogopite crystals (1 %) are moderately grained and euhedral to subhedral. Microcline crystals (2 %) are moderately grained and anhedral. Zircon (3 %) and apatite (4 %) crystals are finely grained and anhedral to euhedral. The last 5 % correspond to Nb, Yb and Th host minerals, probably euxenite, pyrochlore, or thorite.