# PROGRESS REPORT ON DRILL CORE EXAMINATION FROM LACKNER LAKE ALKALIC COMPLEX

Lackner and McNaught townships, Sudbury Mining District

Report for International Explorers and Prospectors Limited

Frederick W. Breaks, Ph.D,. P.Geo

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# INTRODUCTION

This report provides progress on a detailed mineralogical and geochemical investigation of drill core from holes completed in 2011 within the south-central part of the Lackner Lake alkalic complex in the Sudbury mining district situated near the town of Chapleau. Drill holes 66-11-01 and 66-11-02 were initially examined by Corstorphine (2012) in a report that contains 20 whole rock analyses (Acme Analytic Laboratories) which documented the following maximum levels for metals of economic interest: Total REE (5398 ppm), Y (218 ppm), Nb (5212 ppm), Ta (417 ppm) and U (835 ppm).

The purpose of the present study is to provide a more detailed assessment of lithological and geochemical variation and its relation to controls on Nb-Ta-REE-Th-U mineralization within one of the drill holes (66-11-01). It should be stated that no modern mineralogical work has been undertaken on the complex with exception of electron microprobe work on one sample from the Pole Lake REE-Th-Nb-Ba occurrence (Breaks 2016), situated 4.25 km north of the two drill holes examined in this report.

The drill core was examined by the author at the facilities of International Explorers and Prospectors in Timmins, Ontario between December 13 and 18, 2016. Focus was directed towards drill hole 66-11-01 that had previous defined anomalous values for ΣREE, Nb, Ta and U (Corstorphine 2012). A lithochemistry suite encompassing all rock types and recognized mineralized zones was selected from the drill core and 43 samples were submitted to ALS Global preparation lab in Sudbury on December 29, 2016.

This report focuses upon petrographic variation amongst rock types identified in the drill core. A follow-up report will present results from the lithochemistry coupled with electron microprobe verification of mineral chemistry in selected rock types that involve REE-Nb-Ta-Th-U-Sc mineralization. Petrographic examination of 30 thin sections with a Nikon Labophot Pol microscope is currently in progress.

It is recommended that electron microprobe mineral verification be undertaken from selected lithologies and mineralization in drill hole 66-11-01 in addition to two mineralized samples from the Zone 6 Fe-P-Ti-Nb deposit and the NE Camp Lake Fe-Th-Nb-Sc occurrence for comparison.

# REGIONAL AND DETAILED GEOLOGICAL SETTING

The drill holes are located at GPS coordinates Zone 17T, NAD 83 at 342905E, 5293235N and 342720E, 5293280N respectively on claim 4214383 (Figure 1). Both holes have azimuths of 180 degrees and an inclination of -50 degrees. General and detailed locations on various maps are shown in Figures 1, 2 3 and 4. These holes are located just southeast of historic drill holes SM1, 2 and 3 on the former Silverman claims and are depicted on the geologic map of Parsons (1961b). These historic holes encountered disseminated pyrrhotite, chalcopyrite and pyrite within hematite altered zones but no assay data are given (Silverman 1959).

The holes situated adjacent to a N-S lineament evident on the digital elevation model maps of Figures 1 and 4 that appears part of a major N-S system of interconnected lineaments possibly representing fault zones.

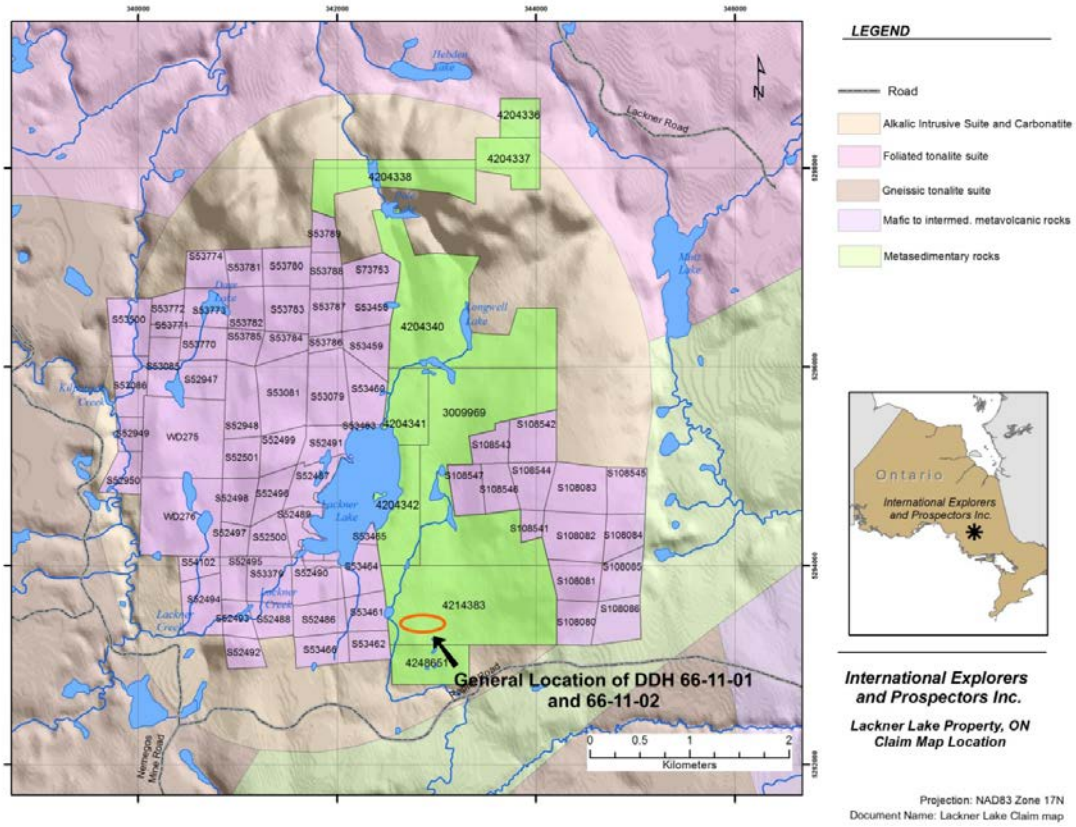


Figure 1. General location of drill holes 11-66-01 and 11-66-02 on digital elevation model claim map for the Lackner Lake area, Sudbury mining district.

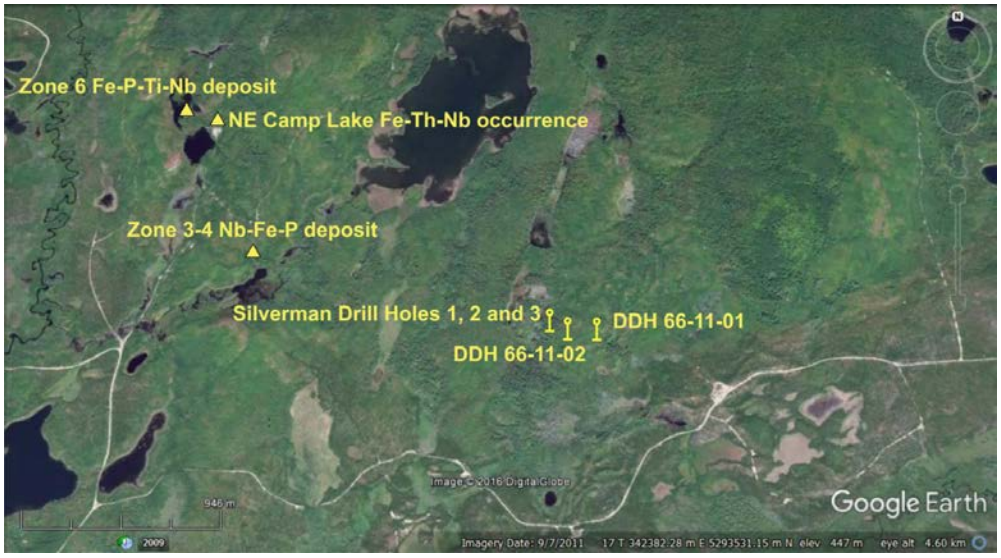


Figure 2. Detailed location of drill holes 66-11-01 and 66-11-02 in relation to historic drill holes SM1, 2 and 3 on the former Silverman claims (Parsons 1961b) and historic mineralization at Zone 3-4, Zone 6 Fe-P-Ti-Nb deposit and the NE Camp Lake Fe-Th-Nb-Sc occurrence.

## GEOPHYSICS

The Lackner Lake alkalic complex has been covered by airborne magnetic and radiometric surveys at several scales: 1:50 000 (GSC 2001) and 1: 20 000 by Fugro Geophysics (2010).

Small ovoid magnetic anomalies, that lie above 3 nT/m, are evident in Figure 3 of the first derivative of the magnetic field with Keating coefficients (GSC 2001). The magnetic anomalies occur internal and external to the main Lackner Lake alkalic complex and correlate with late magnetite masses and vein systems.

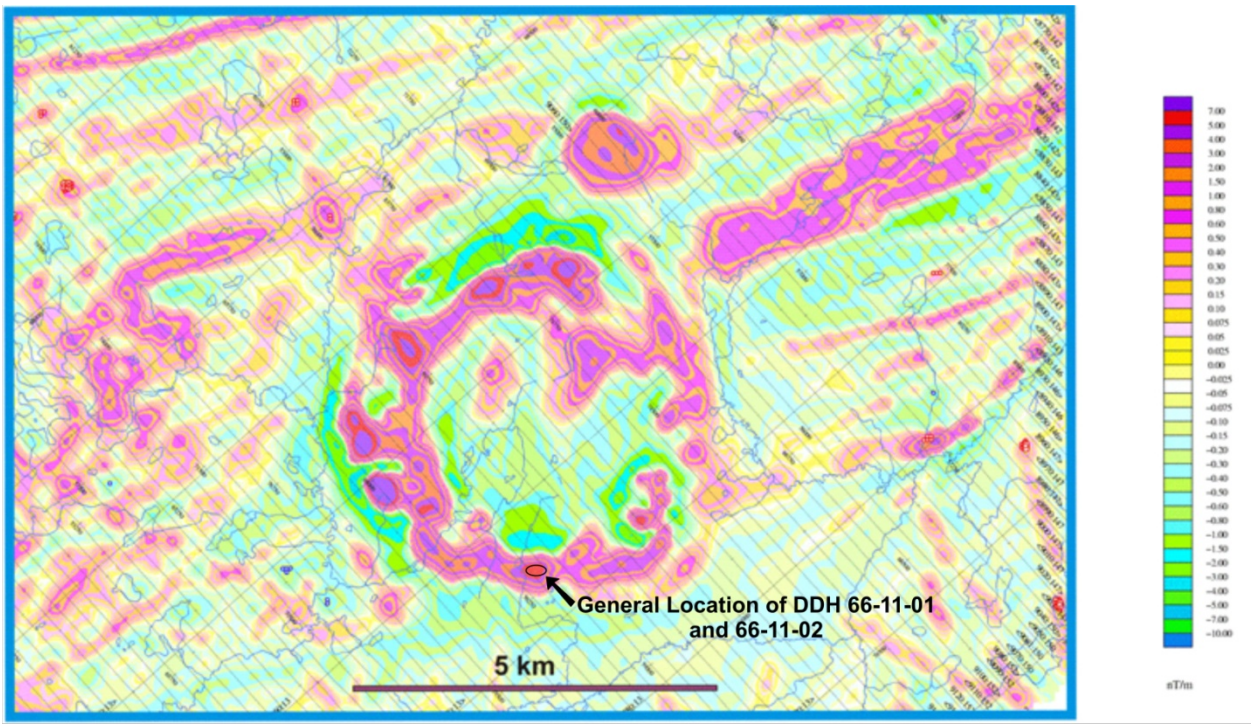


Figure 1. General location of drill holes 66-11-01 and 66-11-02 in relation to first derivative airborne magnetic survey over Lackner Lake complex. Source: GSC 2001.

Within the complex, seven anomalies are associated with the inner ijolite ring as at the Zone 6 deposit, the McVittie pit, Daer (Rock) Lake and east and west of Pole Lake.

In the southern part of the complex on claim 4214383, drill holes 66-11-01 and 66-11-02 occur within a 0.2 by 0.5 km ovoid magnetic anomaly (Figure 3).

## LITHOLOGICAL VARIATION IN DRILL HOLE 66-11-01

This 176 m inclined hole @50 degrees and 180 degree azimuth attained a vertical depth of 112 m. The hole bottomed in nepheline syenite and broadly transected two lithologic packages:

- mafic and intermediate alkalic rocks (ijolite, malignite, melteigite and pyroxenite), and,
- nepheline syenite and related pegmatite.

The drill hole conceivably cuts across a major internal geological contact at depth in the Lackner Lake complex as mapped by Parsons (1961b) that involves an inner partial ring of ijolite and foliated ijolite (units 4 in Figure 4) and an adjacent nepheline syenite core zone (unit 5 in Figure 4). A detailed photographic record of all rock types and alteration is given in this section. In particular, the mafic to intermediate alkalic lithologic unit contains a complex assortment of at least seven different rock types as described below.

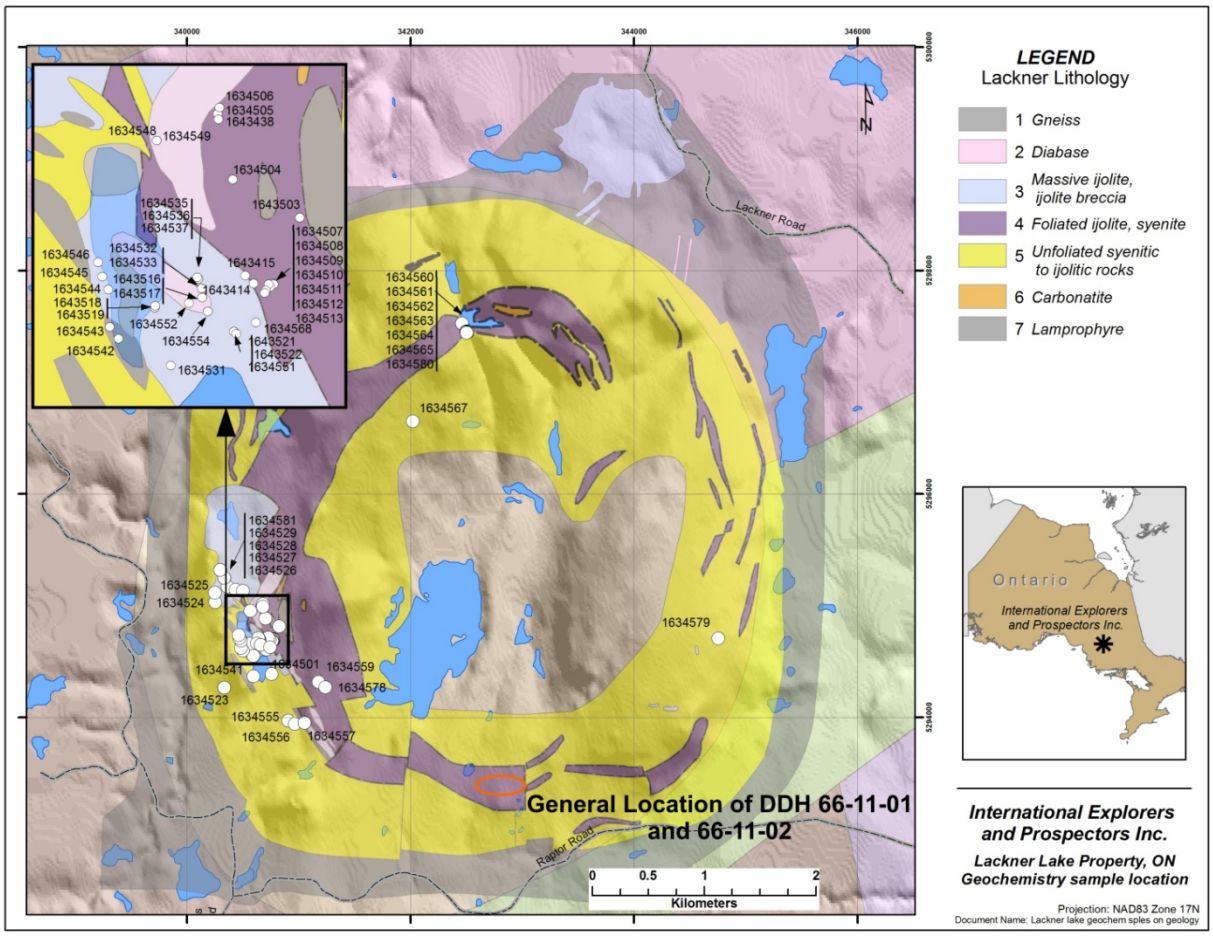


Figure 2. General location of drill holes 66-11-01 and 66-11-02 in relation to geology of the Lackner Lake complex after Parsons (1961b). White circles represent locations of geochemical samples selected in 2014 survey (Breaks 2016).

## Diabase

This rock type was only found in the first 3 m of the drill hole and is likely part of a diabase dyke although contact was not seen as the core was broken and poorly recovered at this interval. The rock is mesocratic, fine-grained, massive, modestly magnetic and consists of approx 50% each of diopside-hedenbergite, and slender laths of plagioclase. Trace amounts of aegirine, Fe-oxide and biotite were noted.

## Mafic to Intermediate Alkalic Group

This group of rocks occurs between 3.5 m and 100.1 m in drill interval and hosts carbonatite mineralization at several intervals. There is considerable petrographic variation which will be summarized below for each rock type identified. The most striking example of carbonatite formation via segregation from an host ijolite occurs at the 74.47 to 74.84 m drill interval. Here, pods of silicocarbonatite have gradational boundaries with the ijolite host and display mineralogical zonation characterized by calcite cores mantled by a nepheline-rich rim (*see* Photo 11). Such petrographic observations support evolution of the carbonatite pods from its ijolite parent.

### Inequigranular Ijolite

This rock type is typically mesocratic, massive, inequigranular, fine- to medium-grained, and is dominated by black to dark green black aegirine (Photo 1). Local sections of drill core reveal a ductile planar fabric evident by the preferred orientation of platy aggregates of phlogopite likely induced by magmatic flow . The rock unit grades into nepheline-porphyritic ijolite.

Nepheline commonly alters to sodalite, cancrinite, zeolite minerals, and muscovite. Aphanitic alteration, marked by a turbid appearance in nepheline in plane polarized light, was observed in many thin sections and no attempt was made to characterize the alteration phases in nepheline. The alteration imparts a pink, deep orange or blood red colouration in nepheline megacrysts (*see* Photos 3, 5 and 16). Sodalite and cancrinite associated with nepheline were observed by previous workers (Hodder 1961 and Sage 1988).


Photo 1. Inequigranular ijolite at 74.3 to 74.47 m drill interval that is dominated by fine to medium-grained green aegirine with subordinate black phlogopite and pink nepheline.

## Ijolite Breccia

Ijolite breccia locally occurs and consists of a fine-to medium-grained, green-black rock with 10% subrounded, felsic lithic fragments of an unknown rock type up to 2 by 3 cm and angular white mineral crystal fragments up to 2 by 4 mm (Photo 2).


Photo 2. Ijolite breccia from 65.53 to 65.77 m drill interval showing white crystal and felsic lithic fragments.

## Nepheline-Porphyritic Ijolite

This Fine to coarse-grained rock type is a major unit in the drill hole and consists of 5 to 40%, light pink nepheline phenocrysts, up to 6 by 15 mm, that range from euhedral shapes to those strongly flattened by magmatic flow (Photo 3).

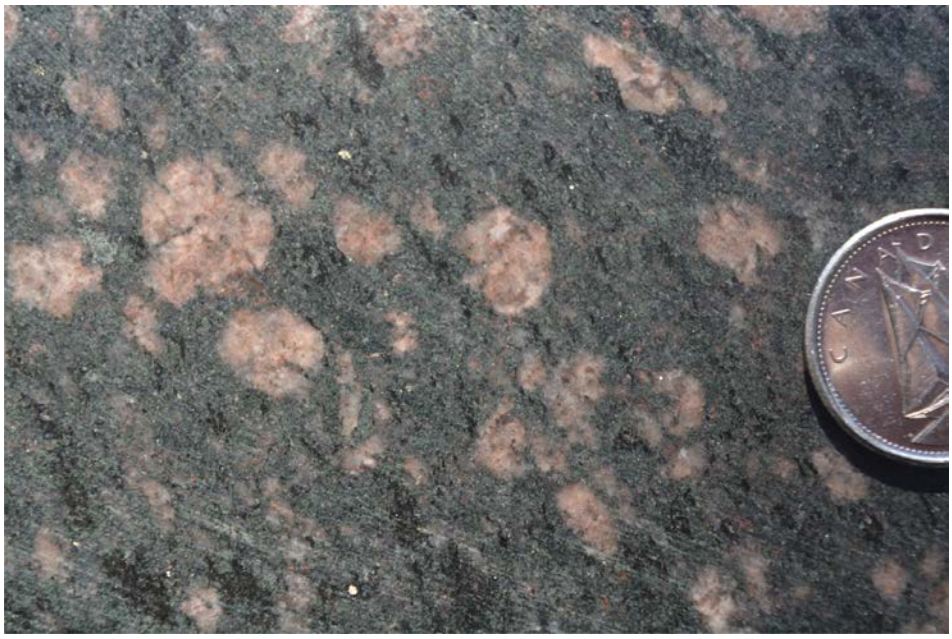

Photo 3. Example of nepheline-porphyritic ijolite with bright pink altered nepheline that locally have hexagonal shapes. Matrix is dominantly fg green aegirine and accompanied by black grains of phlogopite that define a magmatic flow foliation. Drill interval 16.63 to 15.84 m.

Photo 4. Ductile magmatic flow foliation in nepheline-porphyritic ijolite marked by strongly distended, pancake-shaped nepheline phenocrysts at drill interval 49.82 m.

The magmatic flow imparted a flattened distortion of nepheline megacrysts (Photo 4) that are coplanar with platy black phlogopite grain aggregates, up to 2 by 7 mm.

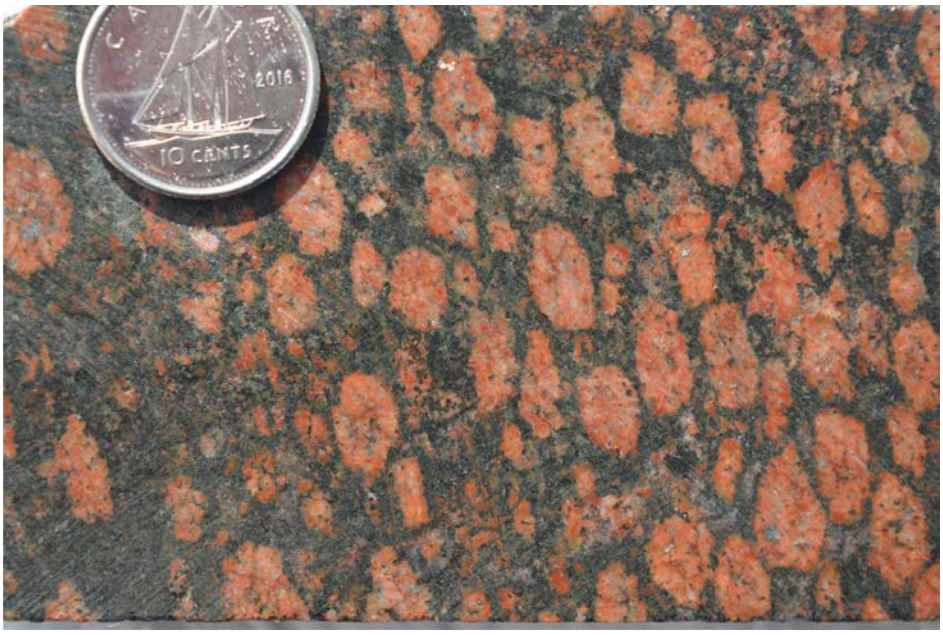


Photo 5. High concentration of orange altered nepheline megacrysts at 80 m in drill hole that reveal typical blocky to hexagonal crystal shapes.

Photo 6. Magmatic layering in nepheline-porphyritic ijolite at drill interval 23.65 to 23.78 m that shows thin layers of fine-grained ijolite virtually free of nepheline megacrysts.

At the 33m interval core interval, nepheline-porphyritic ijolite, there is a commencement of alteration in (Photo 5) that was possibly generated by late carbonatite-generated fluids (carbothermal fluids of Mitchell 2005). This is evident as a deep brown stain and a profusion of calcite veinlets described in section below (see "Alteration").

## Mesocratic and Leucocratic Segregations in Ijolite

These coarse grained segregations occur throughout in the nepheline-porphyritic and inequigranular ijolite as pods and layers up to 30 cm across that comprise up to 20% of the host rock. The segregations appear genetically linked with its host rocks as gradational contacts were observed. Nb-U-Ta mineralization was recognized in one of the mesocratic segregations in lithochemistry sample 19151 of Corstorphine (2012).

Photo 7. Ijolite with abundant exsolved white calcite segregations that is a possible precursor to carbonatite.

Thus, these segregations are viewed with importance in this study due to a potential linkage with mineralization. Some core intervals, as at 86.3 to 87.63 m, reveal a possible transition into carbonatite where the ijoite host has abundant calcite-rich segregations (Photo 7).

The calcite-rich ijolite in Photo 7 may be similar to the calcitic ijolite of Sage (1987) documented in the Prairie Lake carbonatite near Thunder Bay.

There are two general petrographic types of the segregations hosted in ijolite:

- leucocratic segregations of phlogopite, nepheline,K-feldspar and calcite, and,
- mafic to intermediate segregations with aegirine, brown amphibole, phlogopite and magnetite.

These segregations are coarser grained compared to its host and typically there are no sharp intrusive contacts supporting the inference that these domains represent *in situ* segregation of melt from the ijolite host.

### *Mesocratic Segregations*

Mafic to intermediate compositions predominate in this type of segregation and involve pyroxenite, melteigite and malignite rock types (Photo 8). Mafic minerals typically comprise dark green aegirine and phlogopite with occasional appearance of brown amphibole. Felsic minerals comprise calcite, nepheline and K-feldspar. Phlogopite occurs as late poikilitic megacrysts up to 3 cm diameter and are commonly riddled with inclusions of nepheline, aegirine, and sparse pyrochlore, apatite and brown amphibole. The segregations commonly have internal mineral zonation and gradational boundaries with its ijolite host that implies exsolution of a volatile-rich, late magmatic phase.

Photo 8. Mesocratic segregation at 72.2 m drill interval , which consists of coarse-grained dark-green aegirine, black phlogopite, grey nepheline and white calcite core zone, with gradation into a medium-grained ijolite host rock (upper left).

### *Leucocratic Segregations*

Leucocratic segregations consist of K-feldspar, nepheline, calcite and phlogopite and may also contain core zones rich in calcite (Photo 9).

Photo 9. Leucocratic segregation of pink-grey nepheline, black phlogopite, unknown pink mineral, and white calcite in a dark green fine-to medium-grained ijolite host at 74 m drill interval. Several bronze grains of pyrrhotite occur within the segregation core area.

## Silicocarbonatite

Silicocarbonatite zones, 50 cm to 85 cm in width, were identified at 3 different intervals (Photos 10, 11 and 12) in drill hole 66-11-01 (lithochemical analysis numbers in brackets).

- 56.86 to 57.4 m (26373),
- 74.47 to 74.84 m (26376), and,
- 81.15 to 82 m (19152 and 26380).

These mineralized systems, hosted in the inequigranular and nepheline-porphyritic ijoite, are distinctive by the elevated Sr, Ba, Total REE, Nb, Ta, and U. Silica contents lie between 20 and 30% and thus these rocks are provisionally classified as silicocarbonatite (Krestens 1983).

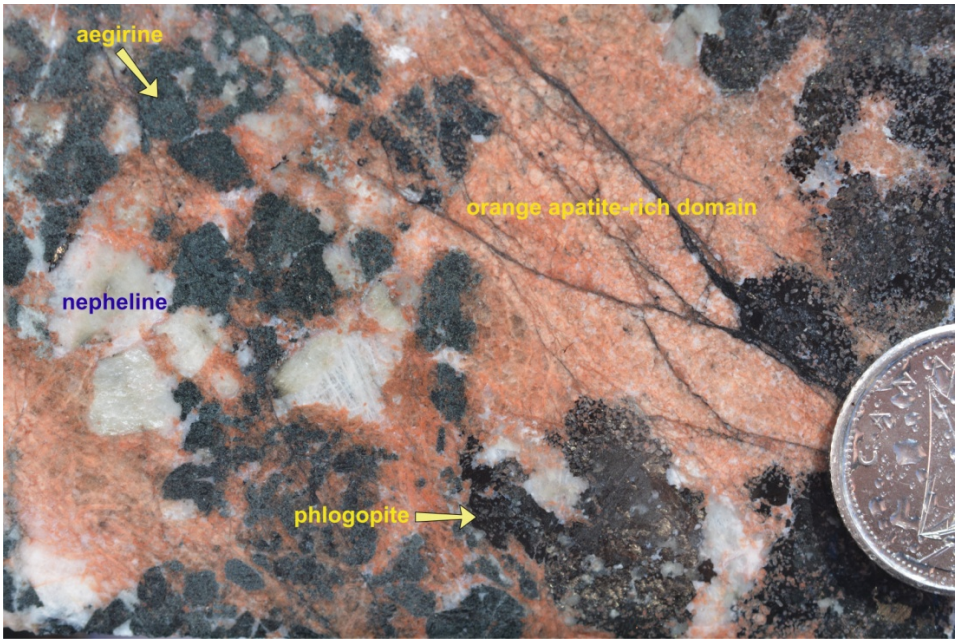


Photo 10. Part of a silicocarbonatite zone at 81.15 to 82m drill interval that consists of aegrine, altered nepheline, phlogopite, calcite and masses of fine-grained orange apatite. Sample 19152 from Corstorphine (2012) that assayed 6.4 % $P_2O_5$, 1.6% Sr, 9114 ppm Ba, 0.5% total REE, 1635 ppm Nb, 85 ppm Ta and 227 ppm U.

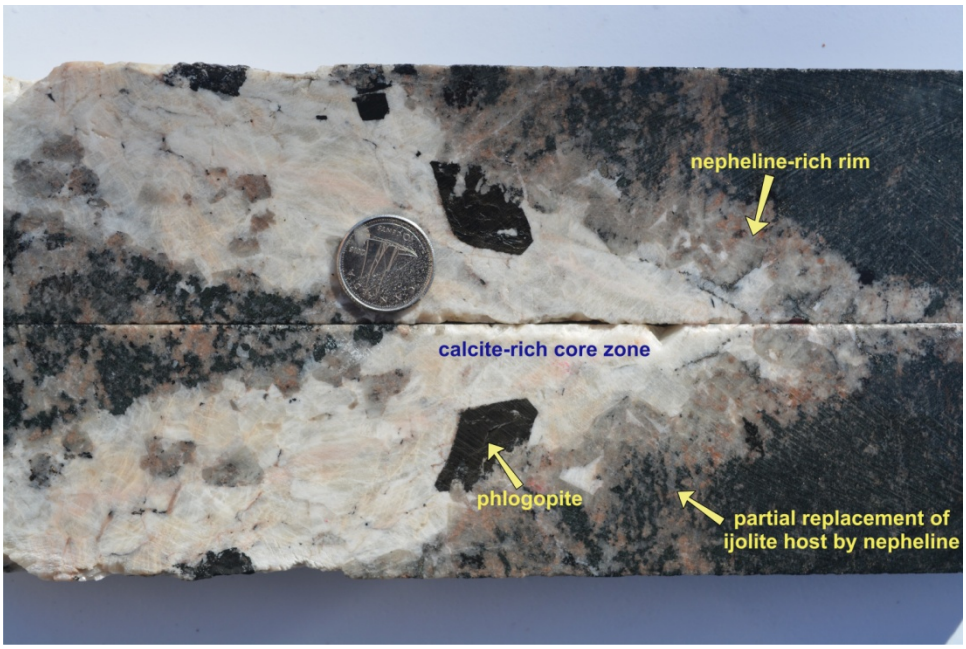


Photo 11. Zoned carbonatite pod hosted in ijolite at drill interval 74.47 to 74.84 m that shows progressive inward crystallization marked by a pink nepheline border, followed by sparse phlogopite crystals (black) and finally by white, coarse-grained calcite that dominantly comprises the core zone.

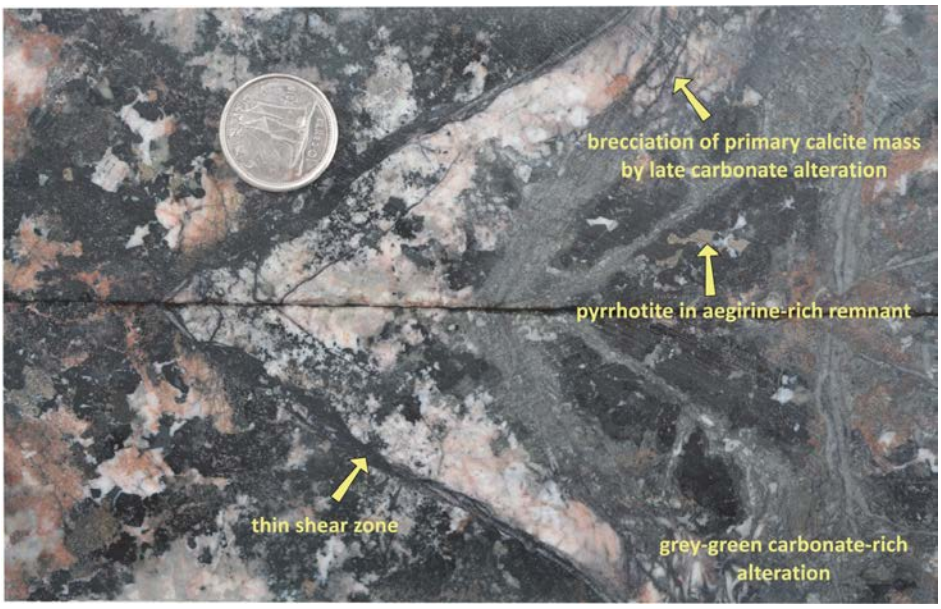


Photo 12. Silicocarbonatite marked by coin with black aegirine, white calcite, orange apatite and phlogopite that is partly overprinted by late carbonate-rich alteration (fine-grained grey-green masses) in right half of photo. Drill interval 81.15 to 82 m.

Sample 19152 from Corstorphine (2012) provides an excellent example of apatite-rich mineralization associated with silicocarbonatite (Photo 10).

## Pulaskite

This rock type is essentially a holo-leucocratic, mono-mineralic rock consisting of Ba-K-feldspar with minor nepheline that was only encountered at the 71.4 to 71.53 m drill interval.

## Phlogopite-Nepheline-K-feldspar-Diopside Syenite Pegmatite

This lithology occurs at 33.33m to 33.95 m within a 4 m wide zone of strongly altered rock that has a deep brown colouration and renders rock type identification difficult. The alteration is inferred to be related to the diopside-bearing syenite pegmatite dyke**.** Masses of fine- to coarse-grained phlogopite-diopside alteration are hosted in ijolite with sparse orange altered nepheline megacrysts. Rock is non-magnetic with 1-2% of a medium-grained, brick orange unknown mineral that occurs in the alteration mass and may represent altered nepheline.

## Nepheline Syenite Group

This group contains phlogopite-aegirine- and aegirine-phlogopite-brown amphibole nepheline syenite. This rock is massive, pink to grey pink, coarse-grained and has a mafic content up to 20% that comprises aegirine, phlogopite and brown amphibole (Photo 13). Calcite is an accessory mineral and may reach up 5% as in sample 26392. REE and niobium mineralization was not identified in this lithologic group.

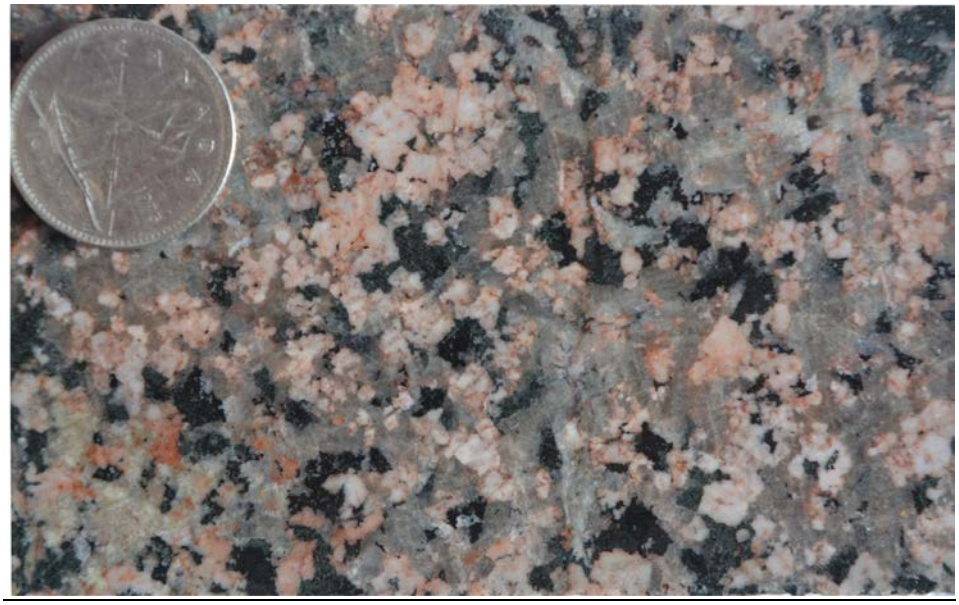

Photo 13. Typical nepheline syenite, at 152 m, that shows light orange, altered, euhedral to subhedral nepheline enveloped by dark grey K-feldspar. Mafics comprise phlogopite and brown amphibole, possibly arfvedsonite.

## Alteration

Several alteration types were encountered in the drill core:

- early alteration of nepheline marked by varied intensity of pink colouration and due to fine-grained white mica,
- alteration in ijolite host rocks associated with silicocarbonatite pods as in sample 26376, and,

- late dark brown alteration associated with calcite and natrolite veinlets.

### Carbonatite-Associated Alteration

This type of alteration was recognized at drill interval 74.47 to 74.84 m where green ijolite host rocks have been converted into irregular masses of fine-grained nepheline-rich rock along the contact with zoned silicocarbonatite pods (Photo 14).

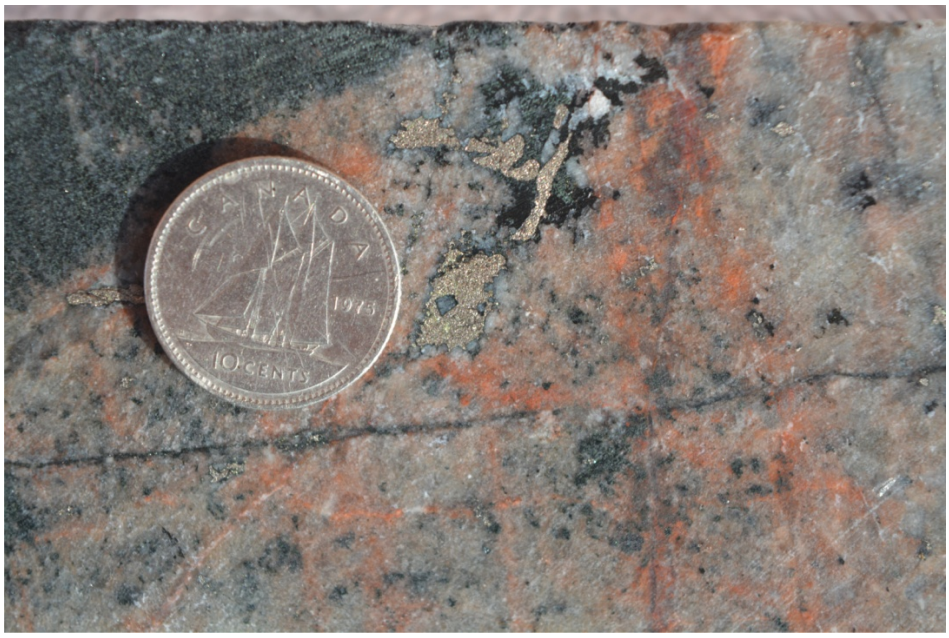


Photo 14. Light pink nepheline alteration in ijolite host near carbonatite pod at 74.47 to 74.84 m drill interval (sample 26376). Remnants of green ijolite host are exemplified in upper left corner. Note cluster of pyrrhotite associated with this type of alteration.

### Alteration Associated with Late Calcite and Natrolite Veinlets

These veins mainly occur in a 4 m wide zone of intense deep brown alteration at the 48 m drill interval and possibly reflect influence of late carbothermal fluids (Mitchell 2005). Metasomatic selvedges of deep brown colour, 2-3 cm thickness lie symmetrically envelop calcite veinlets (Photo 15) that occur in nepheline-porphyritic ijolite. The natrolite veins have a striking deep red colouration and mostly post-date the calcite veinlets. Alteration of nepheline megacrysts to a deep red colour locally occur ( Photo 16).

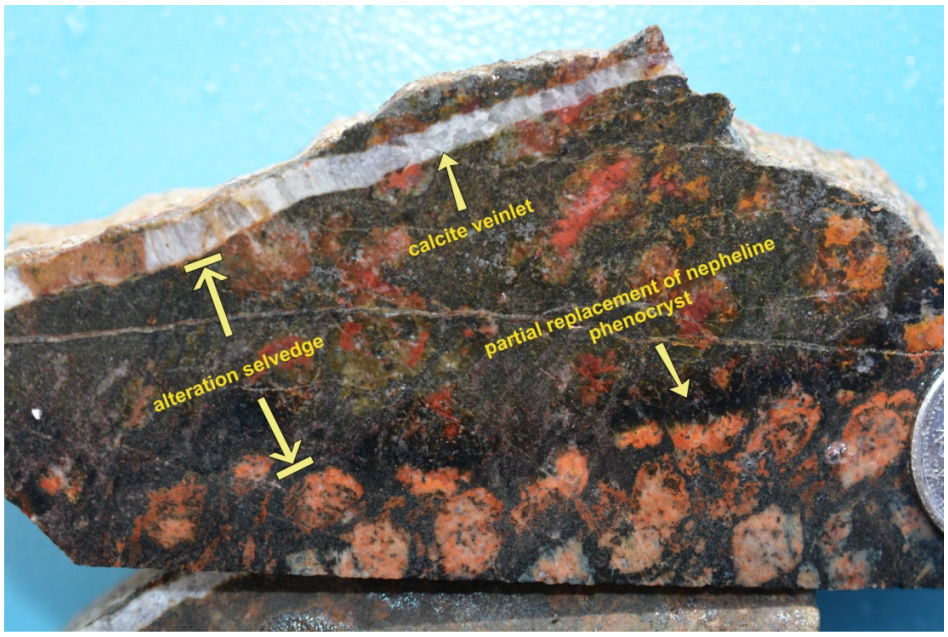


Photo 15. Detail of brown alteration selvedge in nepheline-porphyritic ijolite which contain ragged remnants of nepheline phenocrysts. Alteration possibly due to carbothermal fluids associated with the calcite veinlet.


Photo 16. Late red fracture, possibly filled with natrolite, cross-cuts nepheline phenocrysts in nepheline-porphyritic ijolite that were previously altered to a deep orange colour.

## ELECTRON MICROPROBE INVESTIGATION

An electron microprobe investigation of eight samples, which also have been chemically analyzed, is currently in progress by Dr. A.G. Tindle at the Dept of Earth Sciences of The Open University, UK. Two of these samples are from niobium-rich ijolite breccia at the Zone 6 deposit and possible phoscorite at the

NE Camp Lake Fe-Th-Nb-Sc occurrence in order to determine mineralogical character of the mineralization.

## CONCLUSIONS

A number of conclusions derive from this preliminary examination of drill core from hole 66-11-01 in the Lackner Lake complex:

- two major lithologic groups were intersected in the drill hole: 100 m interval of mafic to intermediate alkalic rocks and nepheline syenite of unknown total thickness as the hole bottomed in this rock type at 179 m
- mafic to intermediate alkalic rock group is petrographically diverse and comprises at least 7 different rock types and variants: inequigranular ijolite, ijolite breccia, nepheline-porphyritic ijolite, pyroxenite, genetically-related, coarse-grained segregations of two types, silicocarbonatite zones
- nepheline syenite group is relatively uniform in petrographic features and does not appear to host mineralization
- phlogopite-nepheline-K-feldspar-diopside syenite pegmatite dykes locally intrude the mafic to intermediate alkalic group
- magmatic segregations, coarse-grained, locally zoned, are widespread in the mafic to intermediate alkalic group and reveal gradational boundaries against its ijolite host
- leucocratic and mesocratic segregations, up to 30 cm across, were classified and both contain various combinations of nepheline, aegirine, brown amphibole, phlogopite, magnetite, K-feldspar, calcite and local pyrochlore and pyrrhotite
- these segregations are viewed with importance due to a potential linkage with mineralization as exemplified by analysis 19151 (Corstorphine 2012) where the highest Nb and Ta values in the two drill holes were documented in a radioactive, aegirine-rich mass: Nb ( 5211 ppm), Ta (417 ppm), U (835 ppm), Th (90 ppm), ΣREE (585 ppm), Ba (5434 ppm), Sr (3606 ppm) and $P_2O_5$ (0.82%)
- scale range of these segregations is currently not known beyond the drill holes. Larger scale bodies of similar exsolved magmatic material could conceivably occur
- transition into a zoned silicocarbonatite pod was identified at interval 86.3m to 87.63 m, in which the adjacent calcite ijoite host has abundant calcite-rich segregations
- further field and laboratory work are needed to assess the mineral potential of the Lackner lake complex. The laboratory component has involved thin section work with a polarizing microscope and electron microprobe work on selected sample in progress

## RECOMMENDATIONS

A number of recommendations will enhance progress of exploration in the assessment of the mineral potential of the Lackner Lake alkalic complex:

1. Upgrading of road system - culvert needed at Lackner Creek needed plus clearing out of bushed-in roads.

2. Detailed graphical analysis and discussion of rock chemistry data recently sampled for drill hole 66-11-01 received on January 21, 2017.

3. Electron microprobe investigation of mineralized zones in drill hole 66-11-01 and also at Zone 6 and the NE Camp Lake Fe-Th-Nb-Sc occurrence to verify mineralogy. Virtually no modern mineral chemistry work has been undertaken on the complex. In particular, one thin section from the NE Camp Lake occurrence will attempt to verify the presence of phoscorite. This rare rock type can be associated with giant ore deposits as at Phalaborwa, RSA and Kovdor, Russia. The NE Camp Lake showing is situated near the Multi-Minerals Zone 8 deposit where a historic resource of 80 mT of 0.25% Nb2O5 was delineated in "a body of carbonate rock 650 feet long and 50 feet wide and proven to a depth of 500 feet (Hodder 1961).

4. NE Camp Fe-Th-Nb-Sc occurrence - labour needed to clean out of old blast pits found in 2014 field work to better assess the scandium and niobium mineral potential. These pits have been heavily overgrown perhaps from the 1950s.

5. Ground magnetic survey over the NE Camp Lake Fe-Th-Nb-Sc occurrence. Elevated scandium (mean 85 ppm, range 53 to 114 ppm) was documented by Breaks (2016) in old blast pits of this zone. A ground magnetic survey would accurately define extent of the magnetite-rich rocks that could conceivably consist of phoscorite.

6. Drill program: vertical holes within airborne magnetic low near Lackner Lake in order to test for possible carbonatite core zone in area of no rock exposure

7. Drill testing of carbonatite zones originally defined by Multi-Minerals at Zone 8 and Zones 3-4. No historic core of the mineralization has survived for any of the zones. Zone 8 has a historic resource of 80 million tonnes of 0.25% Nb2O5 (Sage 1988) but there are no data for other metals of economic interest (eg. Sc, Y, and REE). A few drill holes across each zone could provide important data especially for Zones 3-4 and 8 that are not well exposed on surface.

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