Twenty Third Annual Meeting

Thunder Bay, Ontario

Institute on Lake Superior Geology

COLDWELL TRIP

FIELD GUIDE TO ASPECTS OF THE GEOLOGY OF THE COLDWELL ALKALINE COMPLEX

ROGER H. MITCHELL AND R. GARTH PLATT

Department of Geology

Lakehead University

Thunder Bay

Twenty Third Annual Meeting, Institute on Lake Superior Geology, Marathon, May 1977

THE COLDWELL ALKALINE COMPLEX

The Coldwell complex is located on the north shore of Lake Superior between the Pic and Little Pic Rivers. The community of Marathon is located on the eastern side of the complex. This circular complex with a diameter of 25 km. is the largest alkaline intrusion in North America and is unusual in that oversaturated, under-saturated and saturated magmatism is present.

The alkaline rocks are of Neohelikian age (1000 m.y.) and are emplaced in Archean rocks of the Superior Province of the Canadian Shield, which in this area form an essentially east-west trending greenstone belt. A north-easterly bifurcation of this belt originates in the Marathon area and it is at this point that the alkaline rocks have been emplaced. The Archean rocks, which include basic and acidic volcanics and greywackes have been metamorphosed to greenschist and amphibolite grade, subjected to at least two periods of folding and in-truded by Archean granites and syenites. Little is known of the Archean geology although some information can be found in Puskas (1967) Milne (1967), Walker (1967), Ayres et al. (1970), Thompson (1931), and Einarsson (1972).

A general geological map of the complex, together with an aeromagnetic map is given in figures 1A and 1B. The geological map is based on the work of Puskas (1967), together with our own observations and re-interpretation of the sequence of igneous events. It should be noted that figure 1A is an over simplication of the geology of the area. In detail, relationships are extremely complicated and very detailed mapping, coupled with extensive mineralogical studies, is required before anything approaching an accurate geological map can be produced.

The structure of the complex is poorly known because of insufficient geophysical and structural observations. Puskas (1967) believed that the complex was a lopolith but our recent work does not support this concept of a single differentiated intrusion. Lilley (1964) considers that the bulk of the intrusion is a funnel shaped body of gabbro and ferroaugite syenite which has been intruded by nepheline syenites. Our recent studies indicate that several centers of intrusion may be present, and that an area bounded by the Little Pic River, Redsucker Cove and Geordie Lake may be a downfaulted block. Rocks within this area are characterized by the occurrence of multiple breccias and metasomatism and may represent rocks which were originally close to the roof of the complex. Rocks of the eastern portion of the intrusion are in contrast less complex and relatively xenolith free.

Petrologically we have recognized three distinct intrusive magmatic episodes, each being characterized by a distinct differentiation trend. In order of intrusion these are:

CENTER 1 - Saturated alkaline rocks with peralkaline oversaturated residua.

CENTER 2 - Miascitic alkaline rocks with undersaturated residua.

CENTER 3 - Alkaline rocks with oversaturated residua.

CENTER 1 - Gabbro, ferroaugite syenite

The oldest unit of the complex is represented by the eastern border gabbros (figure 1A). These rocks are intruded by ferroaugite syenites. Igneous layering is characteristic of both units. Several centers of intrusion may be present in the ferroaugite syenites

which typically exhibit extreme iron enrichment and differentiate to quartz bearing residua. Characteristic minerals of the ferroaugite syenite are fayalite, ferroaugite, ferrorichterite, ferroedenite and aenigmatite.

CENTER 2 - Biotite gabbro, nepheline and natrolite syenites

Alkaline biotite gabbro outcrops is an arcuate ring pattern on the Coldwell Penninsula and we believe that this together with nepheline syenite defines an undersaturated intrusive center (figure 1A). A second intrusion of nepheline syenite may be located on Pic Island. Nepheline syenites are characterised by moderate iron enrichment, aluminous amphiboles and acmitic pyroxenes. Titanium in these rocks enters amphibole and pyroxenes rather than forming aenigmatite as in Center 1.

The distinctly differentiation trends of Centers 1 and 2 are well illustrated by the trends in pyroxene compositions illustrated below. (Mitchell and Platt, 1977)

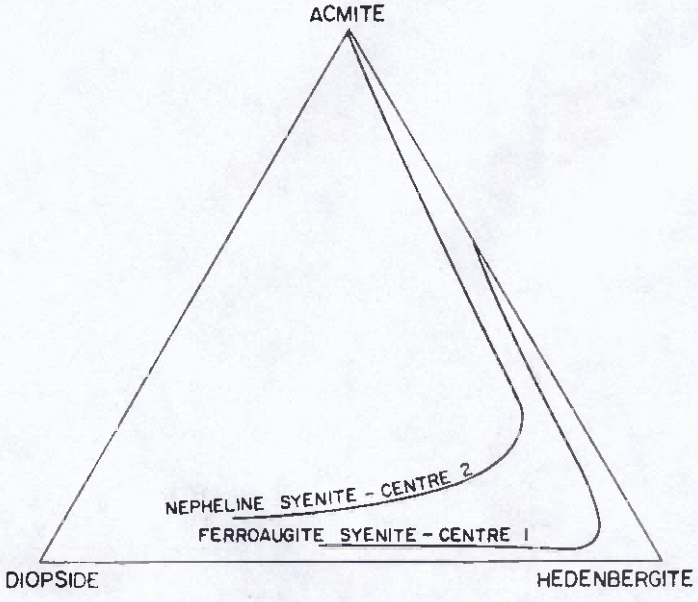
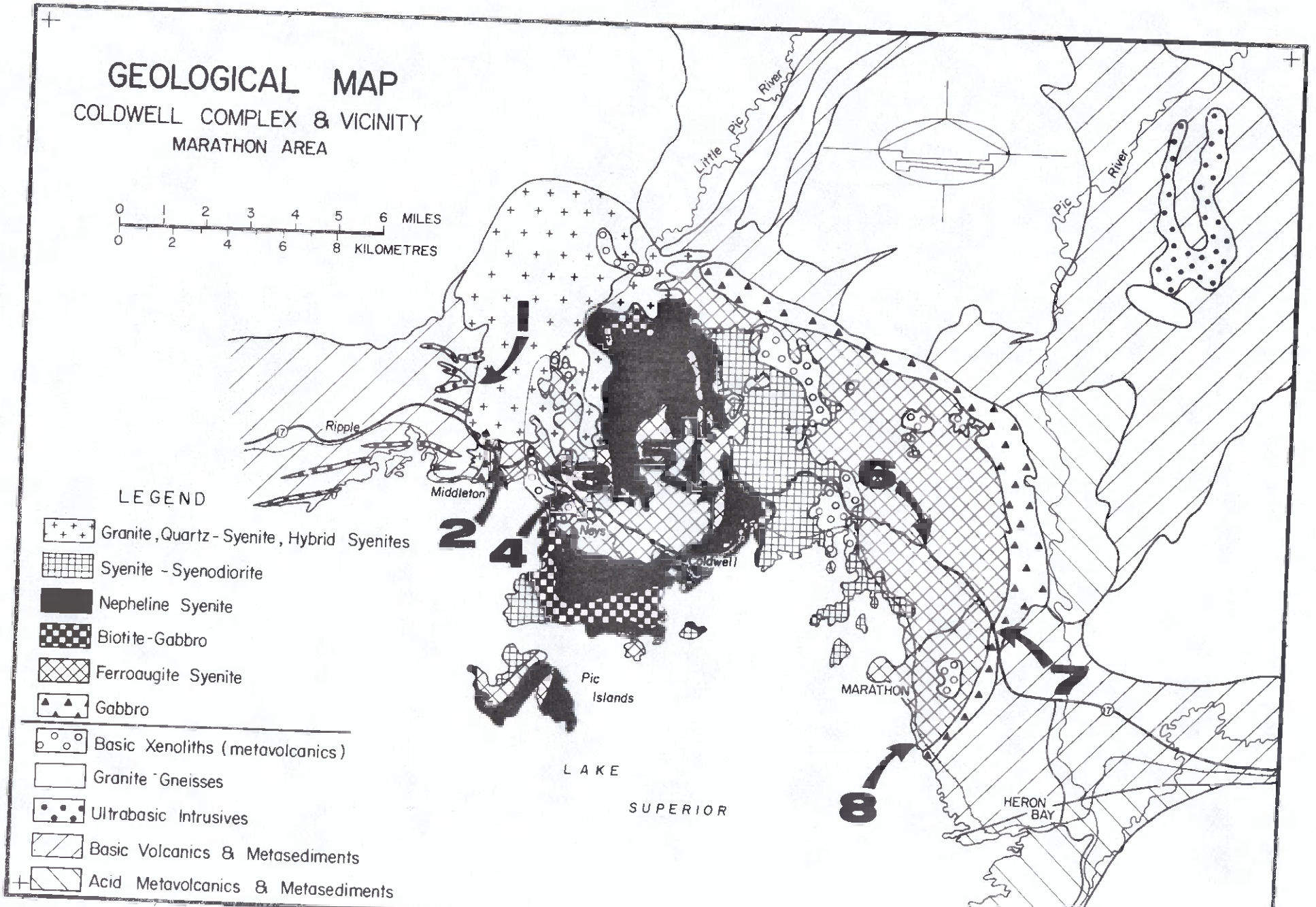


Figure 1A - Geological map of the Coldwell alkaline complex based upon Ontario Department of Mines Preliminary Map P114 (Puskas 1967) together with our own observations and re-interpretation of the sequence of igneous events.

Figure 1B - Magnetic expression of the Coldwell alkaline complex. Based upon Ontario Department of Mines Aeromagnetic Maps 2146G, 2147G, 2156G, 2157G.

AEROMAGNETIC MAP

CONTOUR INTERVAL: 100


GEOLOGICAL MAP
COLDWELL COMPLEX & VICINITY
MARATHON AREA
0 1 2 3 4 5 6 MILES
0 2 4 6 8 KILOMETRES
LEGEND
Granite, Quartz-Syenite, Hybrid Syenites
Syenite - Syenodiorite
Nepheline Syenite
Biotite-Gabbro
Ferroaugite Syenite
Gabbro
Basic Xenoliths (metavolcanics)
Granite Gneisses
Ultrabasic Intrusives
Basic Volcanics & Metasediments
Acid Metavolcanics & Metasediments
Little Pic River
Pic River
Ripple
Middleton
Neys
Coldwell
Pic Islands
MARATHON
HERON BAY
LAKE SUPERIOR
1
2
4
6
7
8

CENTER 3 - Syenite, quartz syenites

In the western portion of the complex are found a wide variety of syenites, quartz syenites and granitic rocks whose petrology is poorly known. The quartz syenites have been found to intrude all earlier rocks of Center 2. These rocks are characterized by an abundance of zircon, paucity of pyroxene, arfvedsonitic amphiboles, fluorite and quartz.

MINOR INTRUSIONS

The plutonic rocks are cut by two groups of minor intrusions. (a) diatremes (b) dikes

DIATREMES

Three diatremes are known in the Coldwell region, only one of which cuts the intrusive rocks of the complex. This diatreme located on the west side of the Coldwell Penninsula contains hornfelsed metasediments and inclusions of Center 2 rocks as xenoliths (Balint 1977). Diatremes in the Archean rocks, such as the Deadhorse and McKellar Creek diatremes, may be contemporaneous, but no Coldwell rocks have yet been found among their xenolith suites.

DIKE ROCKS

A wide variety of dike rocks cut the complex and surrounding country rocks. These dikes in order of observed abundance are:-

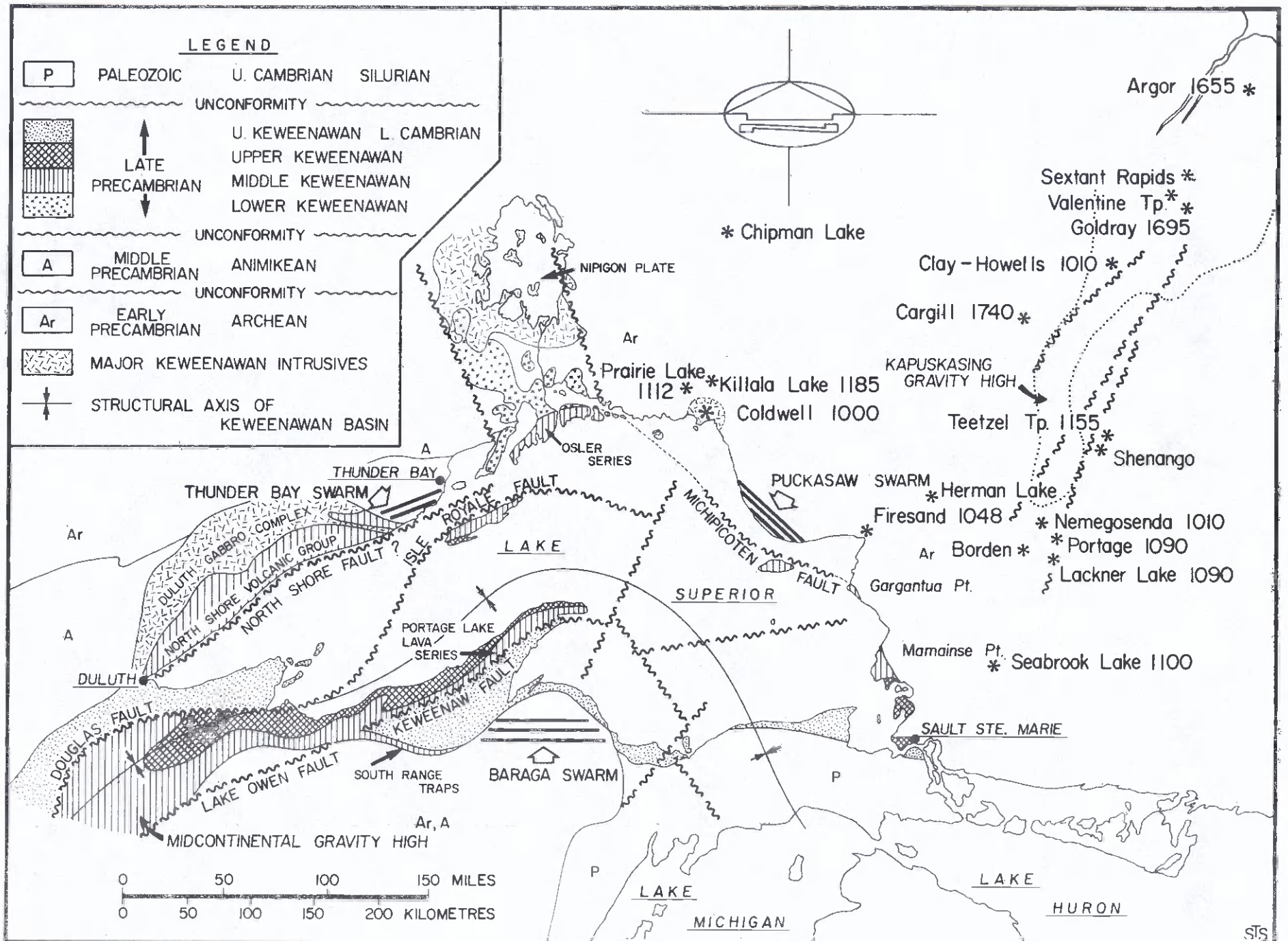
1) ocellular lamprophyres

2) analcite tinguaites (heronites)
3) porphyritic (Al-Cr-cpx) lamprophyres
4) glomeroporphyritic and alkali basaltic dikes (? Pukasaw swarm)
5) porphyritic (resorbed quartz) lamprophyres
6) nepheline syenite
7) rhyolitic dikes
8) syenites with a high organic content

TECTONIC SETTING

The complex is a part of the Keweenawan igneous activity centered around Lake Superior which includes the Keweenawan basalts, the Duluth Complex and the Logan sills. A summary of the regional geology and tectonic framework is given in figure 2. The complex is located at the 'hinge point' of two belts of essentially tholeiitic volcanics, i.e. the North Shore-Osler volcanics and the Mamainse-Michipicoten volcanics and is itself the southern most member of a north-south trending belt of alkaline intrusions. A belt of alkaline intrusions, some being contemporaneous with the Coldwell Complex, is found along the "Kapuskasing High" but no petrological or tectonic connection between these two belts is known to exist. The tectonic setting and type of igneous activity is similar to that found in the Kangerdlugssuaq area of East Greenland and the Gregory-Kavirondo Rifts of East Africa. Both of these areas have been considered to be the sites of plume generated triple junctions, the alkaline rocks being associated with the failed arm of the spreading center.

Figure 2 - Tectonic setting of the Coldwell alkaline complex, compiled from data given by Card et al (1972), Currie (1976), Gittins et al (1967), Halls and West (1971). Alkaline complexes and carbonatites are designated * and their radiometric ages (mostly K-Ar) are given in millions of years.


LEGEND
P
PALEOZOIC
U. CAMBRIAN
SILURIAN
UNCONFORMITY
LATE PRECAMBRIAN
U. KEWEENAWAN
L. CAMBRIAN
UPPER KEWEENAWAN
MIDDLE KEWEENAWAN
LOWER KEWEENAWAN
UNCONFORMITY
A
MIDDLE PRECAMBRIAN
ANIMIKEAN
UNCONFORMITY
Ar
EARLY PRECAMBRIAN
ARCHEAN
MAJOR KEWEENAWAN INTRUSIVES
STRUCTURAL AXIS OF KEWEENAWAN BASIN
* Chipman Lake
Argor 1655 *
Sextant Rapids *
Valentine Tp.* *
Goldray 1695
Clay - Howells 1010 *
Cargill 1740 *
NIPIGON PLATE
Ar
Prairie Lake 1112 *
*Killala Lake 1185
Coldwell 1000
KAPUSKASING GRAVITY HIGH
Teetzel Tp. 1155
* Shenango
OSLER SERIES
A
THUNDER BAY
THUNDER BAY SWARM
PUCKASAW SWARM
* Herman Lake
Firesand 1048 *
* Nemegosenda 1010
Ar
Borden *
* Portage 1090
* Lackner Lake 1090
Gargantua Pt.
Ar
DULUTH GABBRO COMPLEX
NORTH SHORE VOLCANIC GROUP
NORTH SHORE FAULT ?
ISLE ROYALE FAULT
LAKE SUPERIOR
MICHIPICOTEN FAULT
A
PORTAGE LAKE LAVA SERIES
Marnainse Pt.
* Seabrook Lake 1100
DULUTH
DOUGLAS FAULT
KEWEENAW FAULT
SAULT STE. MARIE
SOUTH RANGE TRAPS
BARAGA SWARM
LAKE OWEN FAULT
P
Ar, A
MIDCONTINENTAL GRAVITY HIGH
0 50 100 150 MILES
0 50 100 150 200 KILOMETRES
P
LAKE MICHIGAN
LAKE HURON
STS

STOP 1 EXPLOSION DIATREME - DEADHORSE CREEK

Two small explosion diatremes (Deadhorse Creek & McKeller Creek) are located in the Archean greenstone belt just to the west of the Coldwell alkaline complex. A third subcircular diatreme (The Neys Diatreme) cuts rocks of the Coldwell complex. Located on the west side of the Coldwell Peninsula, this latter diatreme has been studied by Balint (1977). Neither diatreme in the greenstone belt has been studied in detail.

This stop examines the small diatreme exposed on the Ministry of Natural Resources access road which parallels Deadhorse Creek. Here the diatreme cross-cuts Archean metavolcanics and pyroclastics.

The matrix of the diatreme, when unweathered, is dark green in colour and consists of carbonate and a greenish amphibole. Embedded in this are clasts of varying size and angularity. By far the most prominent are fragments from the greenstone belt. Of regional geological interest are occassional clasts of orthoquartzite. Similar clasts, together with red-purple shales, are found in greater abundance in the McKeller Creek diatreme. These clasts closely resemble rocks formed extensively in the paleohelikian Sibley Group. Until now, the most easterly extension of this group of rocks was thought to be some forty miles to the west in the vicinity of Rossport.

Fragments similar in appearance to certain felsic porphyries of the Keweenawan Osler volcanic rocks are present. This may indicate an easterly extension of Keweenawan volcanism, although the seeming total lack of Keweenawan basaltic rocks makes this assumption problematical.

STOP 2 - WESTERN MARGIN OF THE ALKALINE COMPLEX

This stop investigates the complexities of the western contact region of the Coldwell Complex as exposed in the outcrops and road cuts adjacent to Hwy. 17. In this region, the border intrusive rocks of the complex are in contact with folded Archean metasediments.

The rocks of the intrusion exposed in this region are extremely varied, ranging from ultramafic cumulates, olivine gabbros and syenodiorites to nepheline syenites, quartz syenites and syenitic pegmatites with and without natrolite. Later diabasic and lamprophyric dykes also cross cut the region.

The interrelationships between these various rock types is still somewhat prohlematical as is their exact relationship to the intrusive history of the complex in general. We believe, however, that the geographic relationships of the major intrusive phases of the contact zone are at least in part fault controlled.

It is convenient, for the purposes of this stop, to traverse the contact zone from the body of the intrusion out towards the contact. For descriptive purposes, we will consider the rocks exposed in three major zones. These are outlined as the accompanying sketch map and described below: -

Zone 1

The main Coldwell rock of this zone is a banded syenodiorite consisting of subequal amounts of oligoclase and alkali feldspars, the latter showing incipient exsolution. Apatite is ubiquitous and the mafic minerals consist of ferroaugite, fayalitic olivine and exsolved ilmeno-magnetite. Thick ultramafic bands develop by the

accumulation of the mafic minerals, particularly the ilmeno-magnetite.

Cross cutting the syenodiorite is a relatively wide dyke or sheet of nepheline syenite, most probably associated with Center 2. Alkalic feldspar is the predominant felsic phase with nepheline occurring in the interlath regions. Green (acmitic) pyroxene is the major mafic phase, while opaque minerals and accessory fluorite make up the remaining mineral phases.

Cutting both the syenodiorite and the nepheline syenite is a coarse-grained natrolite syenite pegmatite. In this, the natrolite is seen as large reddish patches.

At least two thin lamprophyres intrude the rocks of this zone.

These zone 1 rocks have not been recognized along the coastal section of the contact region lying some 1 mile to the south of our present location. Here gabbros of zone 2 are in contact with ferroaugite syenites, as shown on the geological map of the southwestern margin of the complex below (Aubut 1977).

Zone 2

A zone of banded olivine gabbro intruded by syenite and natrolite-bearing syenitic pegmatites.

The gabbros show considerable evidence of textural and mineralogical readjustment. Invariably the plagioclase crystals have been granulated and recrystallized giving rise to microscopic 'augen'-like textures. The olivines are commonly surrounded by coronas of amphibole and mica and in many instances the original olivine is now represented by somewhat rounded replacement zones of

green-blue amphibole and pale green-brown mica. Thin microscopic shear zones cross cut the gabbro.

Again, later lamprophyric dykes intrude the main Coldwell intrusive rocks.

Along the coastal section lying to the south, this combination of olivine gabbro intruded by syenitic pegmatites can also be identified. Here the gabbros are somewhat coarser than those seen on the highway. The olivines in general are fresh, although the plagioclase crystals still show considerable evidence of readjustment.

On the coast, the gabbros are in direct intrusive contact with Archean metasediments and often contain inclusions of the latter. (Aubut, 1977)

The Highway section however, shows a third zone of rocks lying between the gabbro-pegmatite grouping and the Archean country rocks.

Zone 3

This zone consists of quartz syenite which is often seen intruding a 'hybrid' rock of overall syenitic mineralogy.

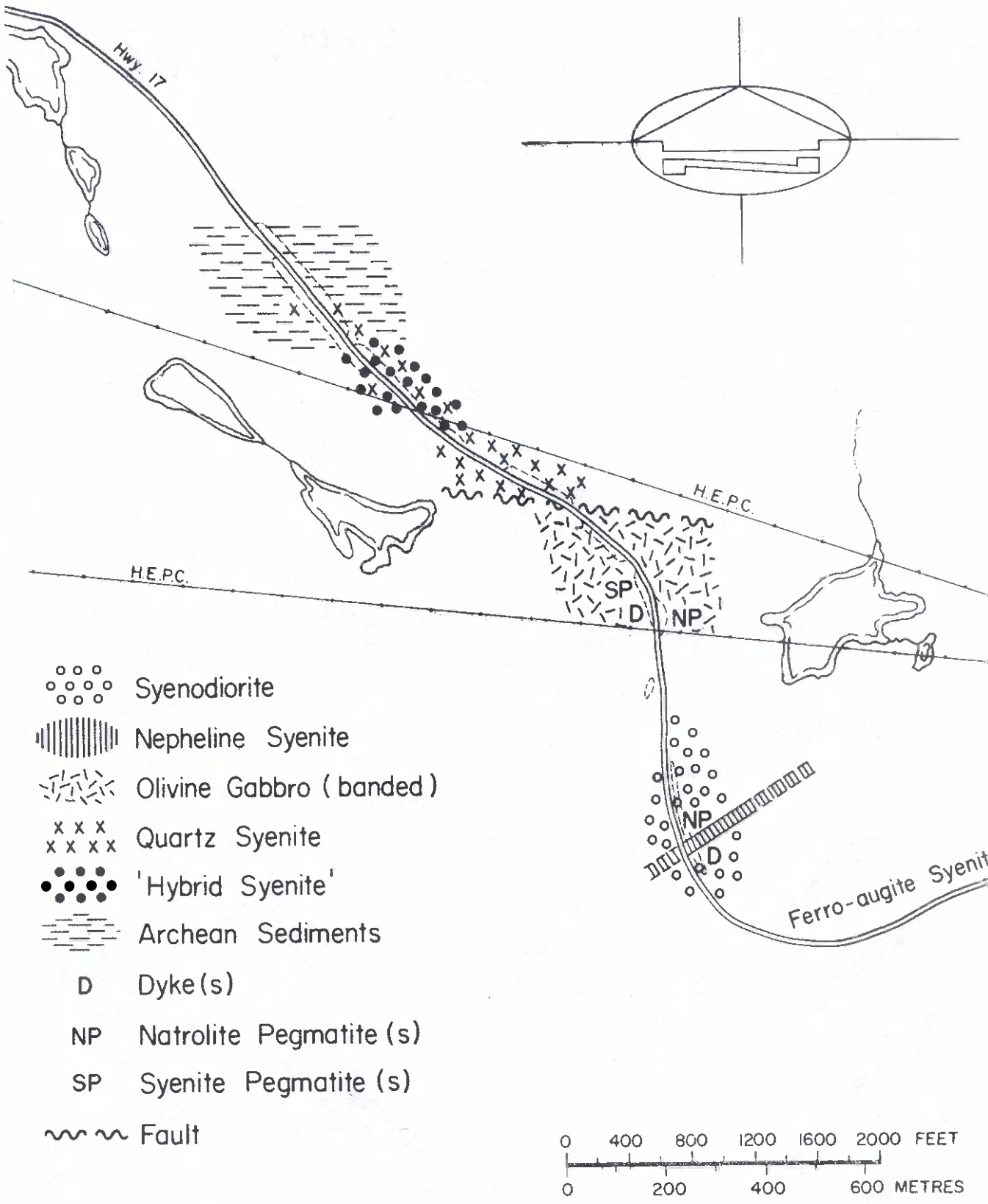
The quartz syenite is yellowish to pink in colour and consists predominantly of perthite with interstitial quartz and minor proportions of biotite, amphibole, zircon and fluorite. As yet, we do not know if there is more than one generation of quartz syenite. Thin veins and dykelets are seen invading the country rock. These syenites have been ascribed to Center 3.

The colour of the 'hybrid' syenite of this zone is generally purple-brown, although this varies, as does the degree to which it is invaded by the quartz syenite.

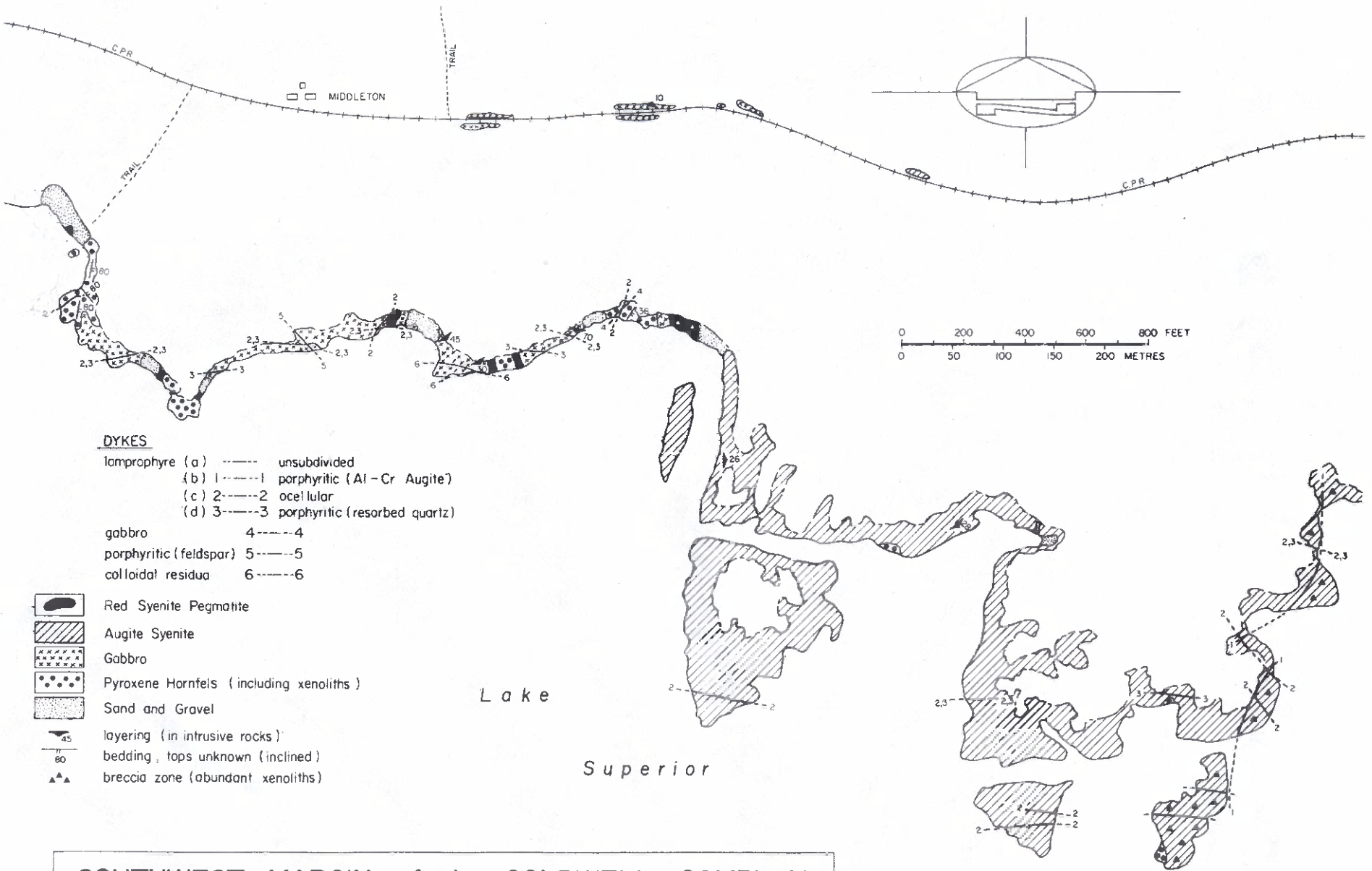
This 'hybrid' syenite is of problematic origin. Its mineralogy is syenitic consisting predominantly of perthitic alkali feldspars. The large red-pink alkali feldspar crystals visible in hand specimens invariably have remnant cores of plagioclase. The visible mafic spots, common throughout the rock, consist of biotite and/or amphibole. Texturally the rock is hornfelsic.

No later dykes are seen to cut this zone.

We believe that this zone of quartz syenite/hybrid syenite is in fault contact with the banded gabbro-pegmatite complex of zone 2. We also feel that the quartz syenite rocks represent a higher structural level of the intrusion and that the hybrid syenite represents a block of highly metasomatised country rock.



Stop 2. Western Central Region.



SOUTHWEST MARGIN of the COLDWELL COMPLEX

(after A. Aubut, 1977)

STOP 3 LITTLE PIC LOOKOUT

Parking Lot

To the southwest can be seen cliffs of xenolith free ferroaugite syenite along the west bank of the Little Pic River. The river probably occupies a fault zone, the east bank being a down faulted block of Center - 2 and 3 rocks from higher levels of the intrusion. To the south lies the Coldwell Penninsula and Pic Island. Densely wooded shores are alkali gabbro and nepheline syenite. The distant barren shores are syenite and quartz syenites.

Highway Cuts

The highway cuts on the north side of highway 17 provide excellent examples of the complex multiple igneous breccias which are characteristic of the Little Pic - Redsucker Cove block. The oldest breccias are of Center 2 rocks, alkali gabbro and nepheline syenites similar to those exposed on the West side of the Coldwell Penninsula. These breccias are found as large xenoliths in the later Center 3 quartz syenite breccias. Xenoliths in the quartz syenite are oligoclase basalts showing all stages of assimilation from relatively unaltered sericitized basalt to almost completely digested xenoliths of amphibolite mineralogy. Development of "clots" of biotite and amphibole is a characteristic metasomatic feature of the xenoliths. The oligoclase basalts probably are remnants of Proterozoic extrusives which originally capped the complex.

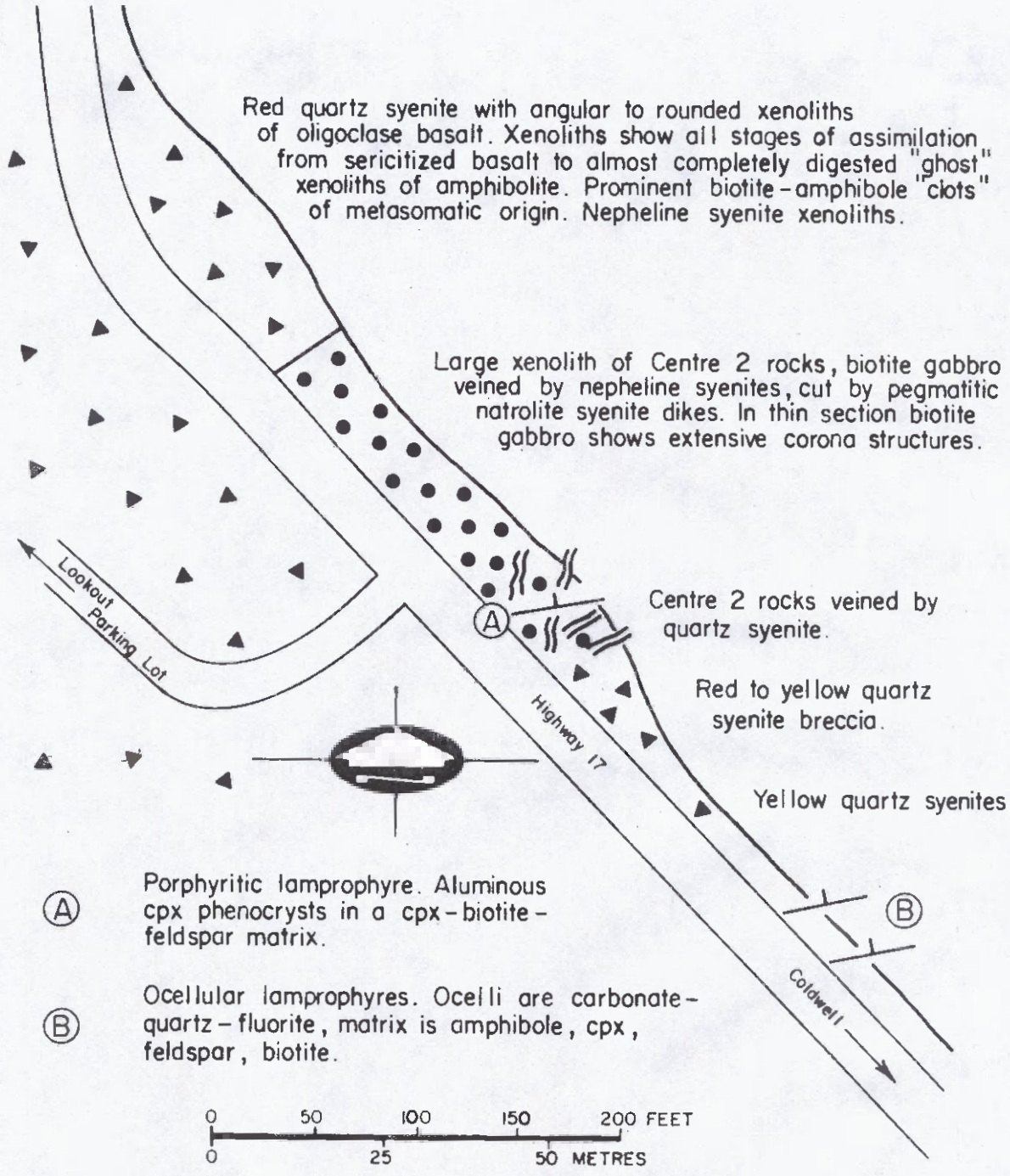
These outcrops demonstrate conclusively that Center 3 quartz syenites are younger than Center 2 undersaturated

rocks.

Two types of lamprophyre can be found crosscutting the breccias.

(a) porphyritic lamprophyre, characterized by greenish phenocrysts of Al-Cr augite, possibly of high pressure origin.

(b) ocellular lamprophyre, characterized by ocelli of carbonate, quartz and fluorite.



Stop 3. Little Pic River Lookout.

STS

STOP 4 - BRECCIA DIKES

At this locality are found several natrolite syenite breccia dikes. These dikes are of variable thickness, they pinch and swell and terminate in thin natrolite syenite veins. Bifurcations of the dikes are common. The outcrop of the dikes are sinuous and give the impression that they may have been emplaced in relatively plastic host rocks. The thicker portions of the dikes are crowded with dark grey xenoliths set in a fine grained reddish natrolite syenite. As the dikes thin the amount of xenolith decreases and the terminating veins are composed of xenolith free coarse grained natrolite syenite. The xenoliths are rounded to very irregular in shape. Crenulated margins are typical. No angular xenoliths are present although the wedging action of the syenite on the xenolith causing further fragmentation is commonly visible. The shape of the xenoliths is considered to be the result of brecciation and corrosion both in situ and during transport.

The xenoliths are of two types, the most abundant being a fine grained dark grey rock which in thin section is seen to be composed of amphibole and mica, alkali feldspar and plagioclase. Rare relict sericitized phenocrysts of plagioclase are present. The xenolith margins are enriched in amphibole and mica relative to the interior. Rounded aggregates of mica up to 5 mm. in diameter are common. Although the xenoliths have been extensively metasomatized they bear a resemblance to the metavolcanic xenoliths seen at Stop 3. At the western end of the outcrop occur xenoliths which consists of rounded aggregates of greenish mica set in a matrix of pale green clinopyroxene and minor oligoclase. Rare euhedral pyroxene

phenocrysts are found. The mica "rosettes" are the result of intense metasomatism of pyroxenite. No comparable rocks are known elsewhere in the intrusion.

The matrix of the dikes is a leucocratic natrolite syenite composed of alkali feldspar (patch perthites) with albite replacements, natrolite, minor green alkali amphibole and accesory zircon and fluorite.

The host rock of the dikes is a leucocratic syenite composed of patch perthite, minor amphibole and accessory zircon and fluorite. Although natrolite has not yet been observed these rocks bear a remarkable mineralogical similarily to the matrix of the dikes. These rocks have been intruded by a very dark quartz syenite.

The breccia dikes are considered to be intrusive breccias, rather than multiple intrusions, connected with Center 2 activity. A tabular lamprophyre dike can be observed at the eastern end of the outcrop.

This area is located at the eastern margin of the faulted block characterized by extensive igneous breccia development. Here the arcuate structure defined by the gabbros and nepheline syenites of Center 2 is truncated by Center 3 quartz syenite. The Center 2 rocks contain abundant xenoliths of earlier rocks, whilst the Center 3 rocks are relatively xenolith free.

Biotite gabbros are the oldest rocks at this locality and are found as greenish massive coarse grained to pegmatitic rocks which in many places are commonly brecciated and veined by natrolite-nepheline syenites. The gabbros are composed of hortonolitic olivines, augite, plagioclase (andesine-labradotite) biotite and alkali feldspar which in some examples becomes sufficiently abundant that the rocks should be termed syenodiorite. Corona structures of alkali amphibole and biotite are commonly developed around olivine and augite.

The nepheline syenites are leucocratic rocks containing patch perthites, nepheline and/or natrolite together with acicular crystals of hastingsitic amphiboles.

Quartz syenites in this area are reddish rocks which have been extensively brecciated and sheared.

At the localities shown can be found the following:-

A. A lamprophyre dike which illustrates the segregation of carbonate ocelli into the upper portions of the dike, a characteristic feature of many of the lamprophyres in this area.

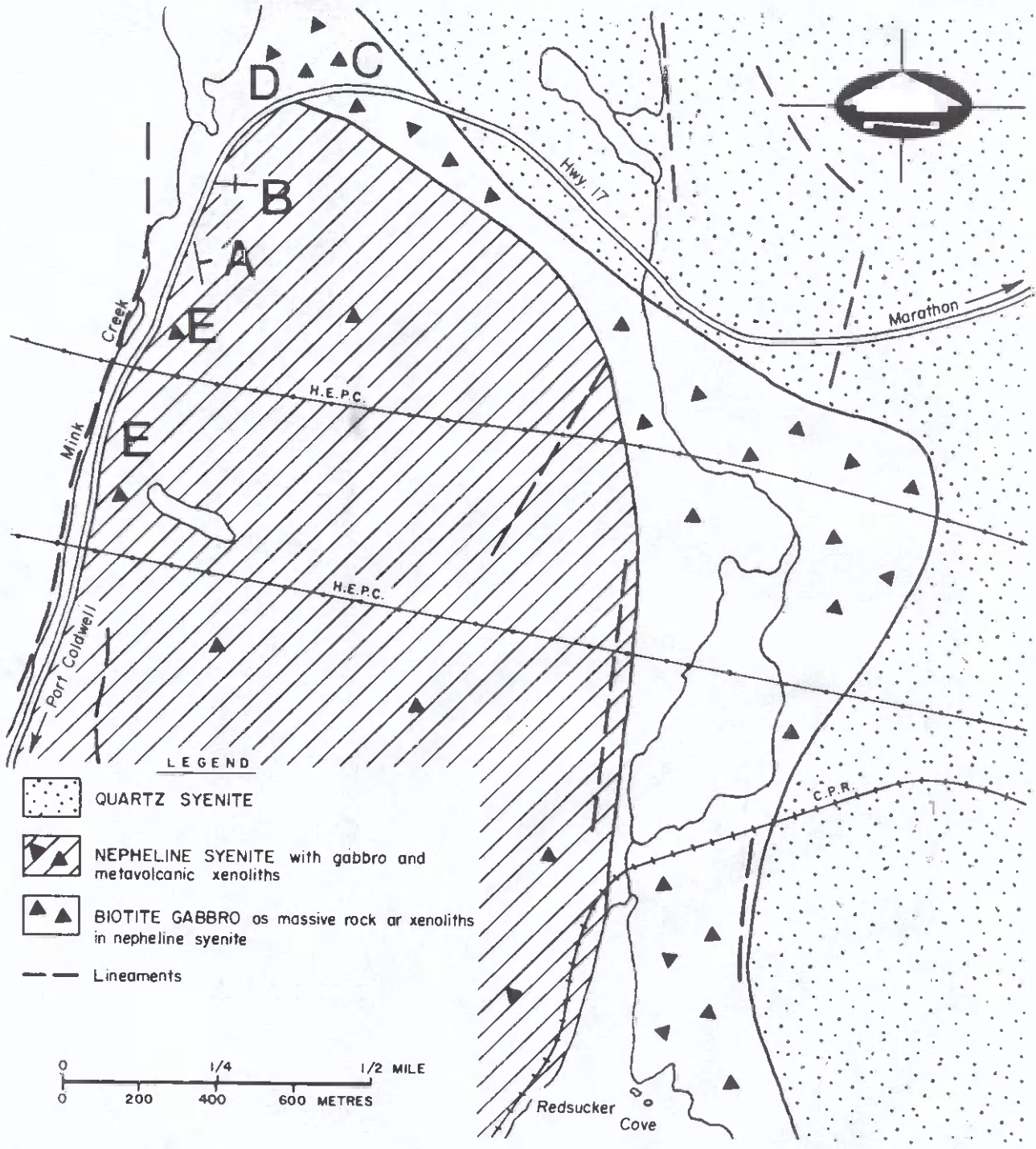
B. A lamprophyre dike which illustrates the intense metasomatism associated with many of the Coldwell minor intrusions. The metasomatism is manifested

by a "reddening" of the host rock feldspars. Widths of the metasomatic zones are commonly much greater than the width of the dike causing the alteration.

C. Igneous breccia. Xenoliths of greenish biotite gabbro in natrolite-nepheline syenite.

D. Hybrid grey syenites.

E. Coarse grained amphibole-nepheline-natrolite syenites.



Stop 5. Mink Creek – Redsucker Cove.

STS

Ferroaugite syenite was formerly quarried at Marathon for use as a building stone under the name "laurvekite", a term first used by Kerr (1910) because of the supposed similarity between the Coldwell complex and rocks of the Oslo igneous province. Unfortunately this term has permeated much of the geological literature concerning the Coldwell complex. The only similarity in fact between the Coldwell ferroaugite syenites and the Oslo larvikites is the presence of cryptoperthitic intergrowths which impart an intense schiller to the feldspars. The Oslo larvikites are monzonitic rocks which grade into nepheline plagi-foyaite (lardalite). They do not show extreme iron enrichment nor do they differentiate to oversaturated residua.

The quarry at this stop exposes highly weathered ferroaugite syenite and illustrates the typical deeply weathered friable appearance of ferroaugite syenite away from the polished glaciated outcrops on the lake shore (Stop 8).

The fresh ferroaugite syenite exposed in the road cut to the east of the quarry is an example of one of the most highly differentiated portions of the ferro-augite syenite. Olivines are fayalite ($Fa_{94}Tp_4Fo_2$), pyroxenes are light greenish brown ferroaugite ($Di_{10}Hd_{85}Ac_5$) zoned to acmitic-hedenbergite ($Ac_{50}Hd_{50}$). Amphiboles are light green ferrorichterite ($Na_2CaFe_5Si_8O_{22}(OH)_2$) with minor mantles of arfvedsonite ($Na_3Fe_5Si_8O_{22}(OH)_2$) Aenigmatite ($Na_2Fe_5TiSi_6O_{20}$) is abundant and calcite and quartz can be found as interstitial residual phases.

STOP 7 - GABBRO

The arcuate mass of basic rocks which define the eastern margin of the complex is commonly referred to as the eastern gabbro to distinguish it from the alkaline gabbro of Center 2. This eastern gabbro is considered to belong to Center 1 activity as it is intruded in many places by ferroaugite syenite. The petrological relationship between the two magmas is however unclear. Ferroaugite syenite is unlikely to be a direct differentiate of the gabbro because of the greater volume of the former and lack of mineralogical gradations between the two rock types. The zone of gabbro defines a prominent magnetic low on figure 1B and is considered by Lilley (1964) to be due to reversed magnetization of the gabbros. The gabbros are composed of olivine (Fo_{67-43}), augite, plagioclase (An_{60-35}) and minor orthopyroxene (En_{55-66}) (Lum, 1973). The orthopyroxene may be a product of assimilation of Archean metasediments, a xenocryst derived from the pyroxene hornfels thermal aureole or a relict high pressure phase. The gabbro has been extensively prospected with regard to its copper potential as accumulations of pyrrhotite and chalcopyrite with minor pentlandite, cubanite, pyrite, bornite, arsenopyrite and mackinawite (Watkinson et al. 1973, Lum, 1973) are common.

The excursion stop is close to the contact between the gabbro and the ferroaugite syenite. Many pegmatites of ferroaugite syenite cut the gabbro at this locality and demonstrate that the gabbro is the earliest activity present in the complex. The gabbro is widely variable in appearance due to the presence of variable amounts of Archean xenoliths. At this location the gabbro shows all transitions from massive homogenous gabbro to rocks

with well developed igneous layering. The layers are not tracable over large distances and do not serve to outline the structure of the gabbro intrusion.

Proceed from the parking lot at the foot of Howe St., Marathon along the trail through the woods to avoid the boulder beach. The trail emerges at location F, from that point follow the coast to location A.

Location A

Hornfelsed Archean metasediment cut by analcite tinguaite dikes. These rocks were initially described by Coleman (1900) as heronites. The tinguaites, after lamprophyres, are the second most abundant type of minor intrusion at Coldwell and are probably associated with the undersaturated Center 2 magmatism. Xenoliths of coarse grained nepheline syenite can be found in some examples at Heron Bay. The majority of the tinguaites are intensely hematized and carbonatized, are very fine grained and brick red to dark reddish-brown in color. At this locality is found a relatively fresh 3-4 ft. wide vertical dike. Black margins with conchoidal fractures may represent an original chilled glassy margin. The tinguaite is porphyritic with phenocrysts of pale green ferroaugite with titan-acmite rims, brown hastingsite and anorthoclase set in very fine grained groundmass of apatite, acicular pyroxene, hematized feldspar, fluorite and analcite.

Location B

Glomeroporphyritic diabase representative of the post-Coldwell alkali basaltic magma activity. The glomeroporphyritic feldspars are labradorite set in a groundmass of andesine and aluminous augite (8% Al_2O_3).

Several thin ocellular lamprophyre dikes can be

observed between locations A and B. Ocelli in these rocks contain quartz plus calcite or dolomite.

Extensive deposits of sand and gravel cover the contact between the intrusion and the Archean country rocks and no outcrops are found between locations B and C. The area however presents excellent exposures of the lowest of the six beach terraces at Marathon.

Location C

Xenolith bearing gabbro considered to be equivalent to the hypersthene gabbro observed at Stop 7.

Location D

Fayalite-ferroaugite syenite with well developed igneous layering defined by the mafic minerals. Cross-bedding, slump structures, and diffuse turbulent layering are all well developed in this area.

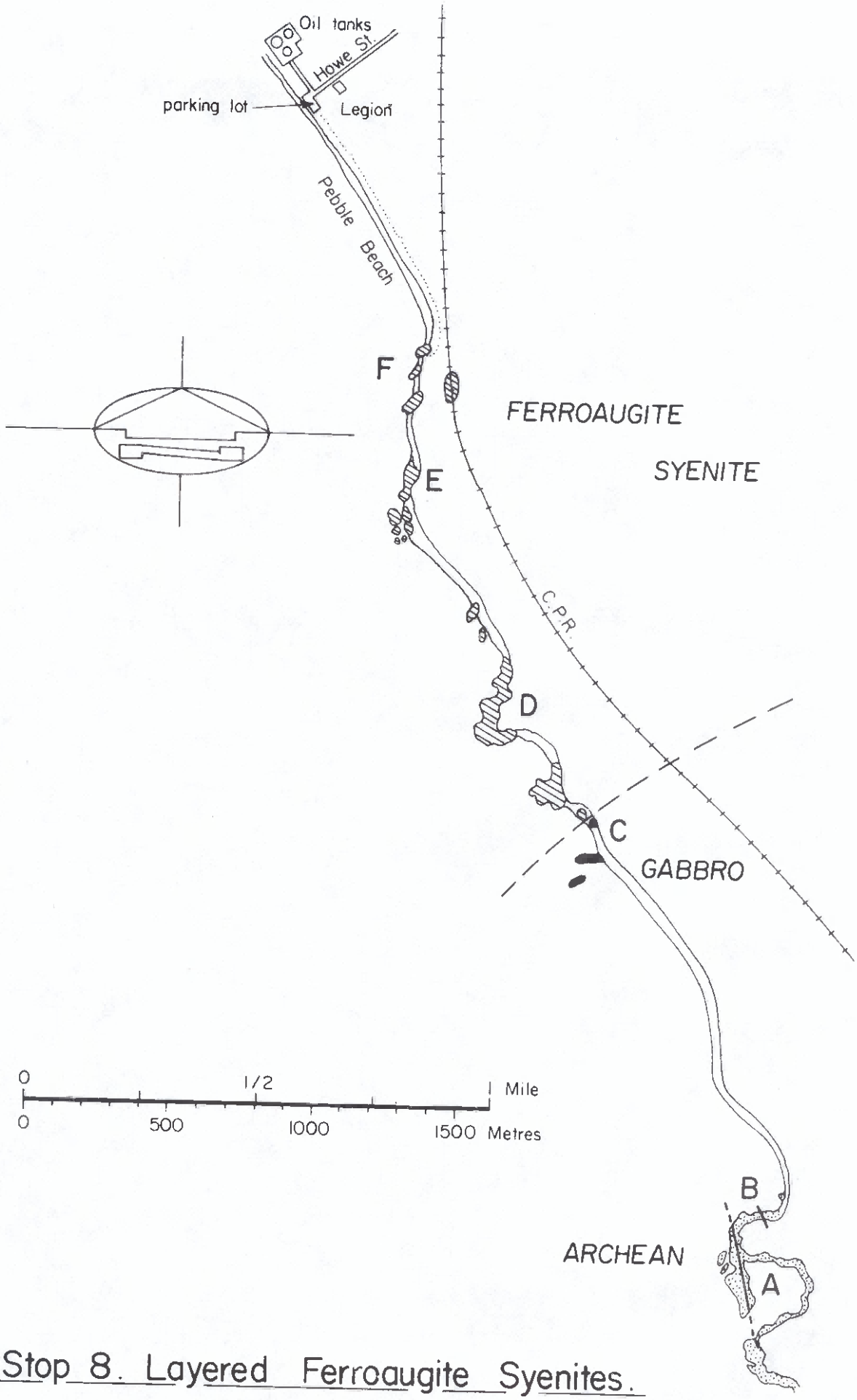
The mafic minerals are fayalite, ferroaugite, and amphiboles belonging to the ferroedenite-hastingsite series ($NaCa_2Fe_5Si_7AlO_{22}(OH)_2$-$NaCa_2Fe_5Si_8Al_2O_2(OH)_2$).

Location E

Ferroaugite syenites representative of the more extreme differentiates of this magma. Pyroxenes are members of the acmite-hedenbergite series and amphiboles are subaluminous ferroedenite ($NaCa_2Fe_5Si_{7.5}Al_{0.5}O_{22}(OH)_2$) or ferrorichterite ($Na_2CaFe_3Si_8O_{22}(OH)_2$) Aenigmatite ($Na_2Fe_5TiSi_6O_{20}$) is abundant.

Location F

Ferroaugite syenite cut by very coarse patch and sheet pegmatites. The pegmatites illustrate the over-saturated nature of the ferroaugite syenite differentiation trend, and contain ferrorichterite altering to ferro-actinolite, feldspars, quartz and zircon.



Stop 8. Layered Ferroaugite Syenites.

REFERENCES

Aubut, A.J. (1977): Geology of the southwestern margin of the Coldwell alkaline complex, Northwestern Ontario. H.B.Sc. Thesis, Lakehead Univ., Thunder Bay, Ontario.

Ayres, L.D., Lumbers, S.B., Milne, V.G., and Roberson, D.W. (1970): Ontario Geological Map. East Central Sheet, Ontario Dept. Mines Map, 2198a.

Balint, F. (1977): The Neys diatreme, Coldwell alkaline complex, Northwestern Ontario. H.B.Sc. Thesis, Lakehead Univ., Thunder Bay, Ontario.

Card, K.D., Church, W.R., Franklin, J.M., Frarey, M.J., Robertson, J.S., West, G.F., and Young, G.M. (1972): The Southern Province. In : Variations in Tectonic Style in Canada. Eds., Price, R.A., and Douglas, J.W. Geol. Assoc. Canada Spec. Paper 11, 335-380.

Coleman, A.P. (1900): Heronite or analcite tinguaite. Ann. Rept. Bur. Mines Ontario 9, 186-191.

Currie, K.L. (1976): The alkaline rocks of Canada. Geol. Surv. Canada Bull., 239.

Einarrson, G.W. (1973): Variations in the style of metamorphism in Archean supracrustal units of the Superior Province. H.B.Sc. Thesis, Lakehead Univ., Thunder Bay, Ontario.

Gittins, J., MacIntyre, R.M., and York, D. (1967): The ages of carbonatite complexes in eastern Canada. Canad. J. Earth Sci. 4, 651-655.

Halls, H.C., and West, G.F. (1971): A seismic refraction survey in Lake Superior. Canad. J. Earth Sci. 8, 610-630.

Kerr, H.L. (1910): Nepheline syenites of Port Coldwell, Ann. Rept. Bur. Mines Ontario, 19, 194-232.

Lilley, F.E.M. (1964): An analysis of the magnetic features of the Port Coldwell intrusive. M.Sc. Thesis. Univ. Western Ontario, London, Ontario.

Lum, H.K. (1973): Petrology of the eastern gabbro and associated sulphide mineralization of the Coldwell alkalic complex. B.Sc. Thesis, Carleton, Univ., Ottawa, Ontario.

Milne, V.G. (1967): Geology of the Cirrus Lake-Bamoos Lake area. Ontario Dept. Mines, Rpt. 43.

Mitchell, R.H., and Platt, R.G. (1977): Mafic mineralogy of ferroaugite syenite from the Coldwell alkaline complex. 23rd Ann. Institt. Lake Superior Geology, Thunder Bay (abstract).

Puskas, F.P. (1967): The geology of the Port Coldwell area Ontario Dept. Mines Open File Rpt. No. 5014, Thunder Bay, Ontario.

Thompson, J.E. (1931): Geology of the Heron Bay area. Ann. Rept. Ontario Dept. Mines, 40, 21-39.

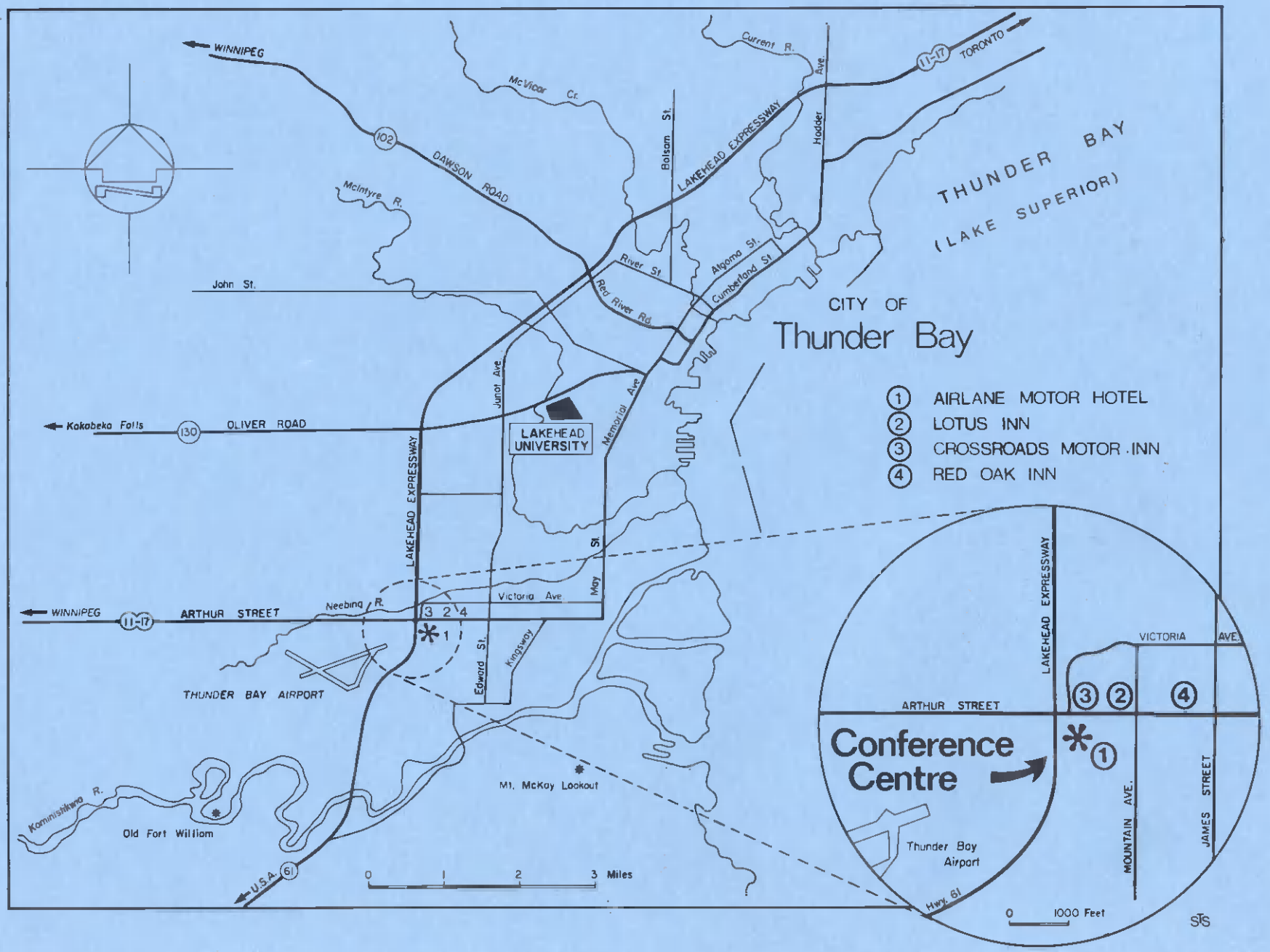
Walker, J.W.R. (1967): Geology of the Jackfish-Middleton area, Ontario Dept. Mines Geol. Rpt. 50.

Watkinson, D.H., Mainwaring, P.R., and Lum, H.K. (1973): Petrology and copper mineralization of the Coldwell complex, Ontario. Geol. Soc. Amer. Abs. Ann. Mtg. 5, 856.

ACKNOWLEDGEMENTS

Research on the petrogenesis of alkaline intrusions in Northwestern Ontario is supported by the National Research Council of Canada.

Sam Spivak is thanked for drafting services involved in the production of this guide book.


WINNIPEG
102
DAWSON ROAD
McIntyre R.
McVicar Cr.
Current R.
Balsam St.
LAKEHEAD EXPRESSWAY
Hodder Ave.
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TORONTO
THUNDER BAY
(LAKE SUPERIOR)
John St.
River St.
Red River Rd.
Algoma St.
Cumberland St.
CITY OF
Thunder Bay
1 AIRLANE MOTOR HOTEL
2 LOTUS INN
3 CROSSROADS MOTOR INN
4 RED OAK INN
Kakabeka Falls
130
OLIVER ROAD
Junot Ave.
LAKEHEAD UNIVERSITY
Memorial Ave.
LAKEHEAD EXPRESSWAY
May St.
WINNIPEG
11-17
ARTHUR STREET
Neebing R.
Victoria Ave.
3 2 4
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Edward St.
Kingsway
THUNDER BAY AIRPORT
Kaministiquia R.
Old Fort William
Mt. McKay Lookout
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Conference Centre
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MOUNTAIN AVE.
JAMES STREET
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