MAP 2018-04

GEOLOGICAL MAP OF THE KINGURUTIK LAKE AREA (NTS 14D/16)

Scale 1:50 000

Open File 014D/16/0340

NOTES FOR MAP USERS

(These notes apply to this map and to Map 2018-03 (14D/09; Tikkoatokak Bay); the contents are, therefore, not all relevant to this sheet.)

The area covered by map NTS 14D/16 and map NTS 14D/09 is overwhelmingly dominated by intrusive rocks of the Mesoproterozoic Nain Plutonic Suite (NPS). These rocks are mostly anorthositic (anorthosite, leuconorite, lesser leucotroctolite), but interspersed among these anorthositic intrusions are subordinate granitic plutons (syenite, monzonite, quartz monzonite, and granite, many of which contain fayalitic olivine) and lesser iron-oxide-rich gabbronoritic (ferrodioritic) rocks. The NPS has intruded, and largely excised, an Archean to Paleoproterozoic terrane of gneisses and foliated metaplutonic rocks, the latter of which have many compositional and textural similarities with the NPS.

The following notes for the two map sheets are presented for the benefit of map users. They are not strictly concerned with the attributes of the various map units, but rather to ancillary aspects such as the correlation challenges encountered during the field work and map assembly, the lithological nomenclature, some of the structural symbols, the geochronological results, and the mineralization.

1. The Data Sources for Maps

The area covered by these two geological maps, NTS 14D/09 and 14D/16, has been periodically examined at varying scales over many years. These examinations, commencing in the 1920s with the pioneering forays by Everett Pepperrell Wheeler 2nd, have had different objectives. Most studies have centred on the regional geological framework, but limited-scale examinations in support of mineral exploration have also taken place. The present maps are largely a result of work undertaken by Bruce Ryan and Donald James, of the Geological Survey of Newfoundland and Labrador (GSNL) in 2002 and 2003, building on local mapping undertaken by Ryan in 1990s.

a) Initial work on NTS 14D/09 by the GSNL was carried out through helicopter reconnaissance by B. Ryan (GSNL) and Ronald Emslie (Geological Survey Canada, Ottawa) in 1990, and this was followed by ground traversing, boat-supported shoreline examination and helicopter reconnaissance by B. Ryan in 1991 and 1992. Helicopter-supported mapping and limited ground traversing of that sheet was carried out by B. Ryan and D. James in 2002 and 2003.

b) Initial helicopter reconnaissance of sheet 14D/16 was undertaken by B. Ryan and R. Emslie in 1991, and limited ground traversing, mostly along the eastern side of the sheet was done in 1992. R. Emslie, as well as undergraduate students Audrey Hynes and Ramsey Way from Memorial University of Newfoundland, carried out several traverses in the eastern part of the sheet in 1996. Helicopter reconnaissance of the whole sheet was undertaken by B. Ryan and D. James in 2002, and in 2003 focused mapping commenced by B. Ryan and D. James employing both ground traversing and helicopter ‘spot checking’ methods, augmented by boat-based examination of the shoreline of Kingurutik Lake. Additional ground traversing was carried out by B. Ryan in 2004.

c) The data periodically collected by government survey personnel between 1990 and 2004 have been supplemented on both these map sheets by information contained on manuscript maps of E.P. Wheeler 2nd resulting from his excursions in the Nain region between 1926 and 1974; copies of Wheeler’s hand-drawn, hand-coloured, unpublished maps are housed at the Geological Survey of Newfoundland and Labrador. Other information has been gleaned from assessment reports submitted to the Department of Natural Resources by various exploration companies active in the area in the mid- to late-1990s, and from studies such as theses and relevant information published in the geological literature. Rarely do all the foregoing data sources agree on every aspect of rock-type distribution in a particular area.

d) Regional aeromagnetic patterns derived from government and industry data (Kilfoil, G. 2002, “A Digital Atlas of Merged Magnetic Data from Existing Airborne Surveys, Labrador”, Geological Survey, NL Dept. Mines and Energy, Open File LAB/1370) have been used to extrapolate rock units and construct lithological boundaries in areas having poor exposure or lacking ‘ground truthing’.

The final maps are a result of data compilation and interpretation undertaken by B. Ryan between 2006 and 2012.

2. Anorthosites and Anorthosites

Rocks of anorthositic (s.l) composition are found in diverse geological settings in the survey area. By far, the bulk of these are pristine igneous rocks that, based on field attributes, can be fairly confidently assigned to the Mesoproterozoic Nain Plutonic Suite, and geochronological investigations corroborate the field designation. There are, however, ones that are more enigmatic in their interpretation and of less certain affinity. These have been allocated to several stratigraphic niches based on their mesoscopic characteristics; geochronological investigations are not conclusive as regards to their age.

a) The northwest-trending gneissic meta-anorthosite unit (Unit A/P?man) bordering the Ikpialuk pluton (Unit MIkln, MIklno) south of Webb's Pond on NTS 14D/16, for example, is superficially similar to rocks west of Iglusuataliksuak Lake equated with the Paleoproterozoic Aupalukitak Mountain intrusion (Unit P?AMa) to the north. The two are assigned individual unit status because the former rocks are much more intensely deformed, their deformation is polyphase, they are migmatized by several generations of granitoid injection, and they also form rafts within granulite-facies gneisses to the east. If the latter gneisses are Archean, then the meta-anorthosite must be likewise. Zircons extracted from a pink granitic aplite intruded into this unit crystallized at *ca.* 1870 Ma (U–Pb age determined on NTS 14C/13 to the east) indicating the meta-anorthosite is Paleoproterozoic or older. Geochronological investigation of white granite dykes in an outcrop of the unit west of Iglusuataliksauk Lake yielded a zircon crystallization age of *ca.* 1872 Ma, but this dyke also contains zircons having crystallization ages in the 1335–1320 Ma range, the latter results indicative of NPS events.

b) Rocks assigned to the Aupalukitak Mountain intrusion (Unit P?AMa) on 14D/16 have been so designated because they are the direct continuation of anorthosite and leucogabbronorite allocated to this pluton on NTS 14E/01 to the north, where a Paleoproterozoic age (*ca.* 2112 Ma) is indicated for its crystallization. Numerous, massive and foliated, 'granulite' (two-pyroxene mafic; gabbronoritic) dykes and granitic dykes, the total recrystallization of the pyroxene, and the nearly universal presence of hornblende and biotite set this unit apart from the NPS plutons, but its relationship to the gneissic meta-anorthosite (Unit A/P?man) to the east has not been confidently determined; the polydeformed nature of the latter, noted above, can be cited as evidence for the two units having a differing history. A geochronological examination of zircons from one part of this intrusion yielded a U–Pb age of 1326 Ma, indicating Mesoproterozoic emplacement; this age is at odds with the one derived to the north, and may record the thermal (contact) influence of nearby NPS intrusions on an older rock or else the presence of NPS-age microgranitoid veins in the sample examined.

c) Foliated and gneissose rocks of troctolitic affinity (Unit APMt1) comprise a significant component of metaplutonic rocks bordering the NE edge of the syenite intrusion (Unit Mfs) south of Kingurutik Lake on NTS 14D/16. These are superficially and mineralogically similar to NPS rocks such as the blotchy leucotroctolite (Unit Mblt) near Iviangiujak east flank lakes, and although an 'early' NPS stratigraphic niche cannot be ruled out, the polydeformed nature of these gneissose olivine-bearing rocks sets them apart from any of the deformed NPS plutons, the latter simply having a single penetrative fabric.

d) Layered and granular anorthosite and leucogabbronorite (units APMa1, APMa2, APMgl1, APMgl2) comprise part of the north–south septa of gneisses transecting Tikkoatokak Bay on NTS 14D/09, where they are in close proximity to deformed members of the NPS. Those to the north of the bay have a high aeromagnetic expression relative to those on the south side, perhaps reflecting the paucity of quartzofeldspathic and interlayered mafic gneisses in the latter area. In places it has been difficult to confidently assign some of these anorthositic rocks a relatively 'older' (pre-NPS) and 'younger' (NPS) status. Some of the ones assigned to the gneissic group here, especially granular and diffusely layered rocks in the southernmost part of the wedge between Tikkoatokak Bay and Nain Bay may, instead, be part of the NPS. No direct intrusive contacts have been observed, but their association with quartzofeldspathic and metasedimentary gneisses, their local migmatitic character, the locally attenuated and disrupted layering, and their high-strain deformational fabrics have been used as criteria to separate them from the simply foliated ‘marginal-type’ leuconorite and the more massive anorthosite and leuconorite of the NPS.

e) Granular to foliated to gneissose anorthositic and leucogabbronoritic rocks (units APMmag1–APMmag4), seemingly remnants of a layered basic intrusion, comprise a fairly extensive regional unit to the east of granulite-facies felsic and metasedimentary gneisses between Nain Bay and Anaktalik Brook on NTS 14D/09. They have an overall compositional range and some textural attributes akin to the Archean(?) gneissic anorthositic rocks northeast of Kingurutik Lake (Unit A/P?man), the Paleoproterozoic Aupalukitak Mountain intrusion (Unit P?AMa), and the leucocratic basic rocks of the NPS. They are demonstrably older than local NPS anorthositic intrusions, but their relationship to the adjacent gneisses and to other similar basic rocks is not confidently established.

f) Massive, white-weathering NPS anorthosite underlies the western part of each map sheet. All the anorthosite south of the Fraser River on NTS 14D/09 has been assigned to the Pearly Gates intrusion (Unit MPGman), but this name has not been imposed on the rocks north of the river. Instead, the anorthosites between the Fraser River on NTS 14D/09 and Iviangiujak east flank lakes on NTS 14D/16 have been separated into provisional units using alphanumeric designators. Although it is possible that there is lithological and stratigraphic continuity across the whole area, the rocks seem to have enough textural differences to raise uncertainties about their correlation. For example, north of Kingurutik Lake (NTS 14D/16) the anorthosite (Unit Mman1) is white, pegmatitic, and displays local labradorite colour, features analogous to those evident in the Pearly Gates intrusion. The anorthosite (Unit Mman3) underlying the upland area southwest of Seal Bay on Kingurutik Lake (NTS 14D/16) has some characteristics that resemble those of Unit Mman1 to the north, but also the ‘giant-pyroxene’ anorthosite (Unit Mgpa1) to the east. The white anorthosite here could thus be part of either of these units, but is lithologically separated from Unit Mman1 by its lack of labradorite and general subophitic distribution to orthopyroxene, and from Unit Mgpa1 by its lack of large pyroxene masses and their associated biotite. Anorthosite to the south of the western half of Tikkoatokak Bay on NTS 14D/09 has been regionally separated into several mega-scale units (units Mman2, Mgpa2, Msfln2, Mlpa, Mman5) but these do not appear to be laterally continuous northward toward Kingurutik Lake or southward across the Fraser River. The perceived differences outlined here may, however, be a reflection of the field data available. Conceivably, with additional ground work, subdivisions such as those outlined north of the Fraser River can, for example, be delineated in rocks now combined in the Pearly Gates pluton.

3. Establishing NPS Unit Boundaries

Because of the superficial similarity of many of the NPS anorthositic and leuconoritic rocks throughout the area, the subdivision of these into differing map units and/or intrusions based entirely on field examination is, at times, difficult. Ground traversing can be successful in this regard, but not all the area has been so treated. The necessity during the surveys to examine some parts of the area solely by ‘helicopter hopping’ renders sections of the maps highly suspect as regards to stratigraphic subdivisions. Some map-unit boundaries have been sketched based on colour changes observed through binoculars or from the helicopter, and these differing colours can occasionally be influenced by the lighting conditions rather than real lithological changes. Petrography can further refine some of the subdivisions, but even rocks that are clearly of differing relative age, as determined from outcrop relations, may prove to be petrographically similar. Thus, some boundaries shown on the map are rather subjective and not, in reality, demarcated by abrupt lithological breaks or by clear intrusive contacts, and could be drawn differently using alternative criteria. Even where changes in volumes of pyroxene, in rock texture, or in outcrop colour point to differing anorthosite and leuconorite on the local to kilometre scale, these can sometimes be easily accommodated by a 'variation on a theme' argument rather than by separating them into unique map units. In spite of these limitations, an attempt has been made to portray as many of the rock variations as possible within the context of the overall plutonic assemblage. Users may note that some unit outlines on the present maps differ substantially from those on maps of the same region compiled by exploration company geologists and included with their assessment reports filed with the GSNL. These variances reflect differences in emphasis used to subdivide the rocks, but the users should, nevertheless, be aware that the subdivisions portrayed on the present maps are not always 'cast in stone'. In certain cases, for example, the subdivisions are based on subtle textural differences between adjacent outcrops. In other cases, aggregated characteristics of a specific area of outcrops are used to allocate an individual outcrop having slightly differing character to one unit rather than to another (see (a) below). In still other cases, boundaries are located between similar rocks where two adjacent areas have primary planar features that are markedly different in orientation (*e.g.*, units Mblna and Mgbln northeast of Polygon ponds on NTS 14D/16). Some of the problematic unit boundaries are displayed on the map as assumed contacts having interrogation marks (….?...), and map-users are encouraged to re-examine the position of these less-strenuously defined junctions and determine if they are justified. Examples of questionable boundaries and unit designations:

a) West of the Polygon ponds on NTS 14D/16, anorthositic rocks of the 'giant-pyroxene' anorthosite (Unit Mgpa1) and some of those within the leuconorite subdivision of the Ikpialuk intrusion (Unit MIkln) are superficially similar both in colour (grey, pink, mauve) and texture (granular, adcumulate-type), but the prevalence of the giant orthopyroxenes within any one area and of tabular feldspar megacrysts in the anorthosite of another have been used to outline the possible distribution of the two units.

b) The location of the contact between the 'giant-pyroxene' anorthosite (Unit Mgpa1) and the foliated and recrystallized anorthositic rocks (Unit Mfln2) west of the gneissic septum north of Kingurutik Lake on NTS 14D/16 is especially equivocal. The line shown reflects the approximate junction between outcrops of white massive anorthosite locally containing large coherent orthopyroxenes (the 'giant-pyroxene' unit) and outcrops of massive anorthosite and leuconorite in which the pyroxenes have a preferred orientation (the Mfln2 unit). Otherwise, however, the rocks are practically identical even though it can be locally shown that massive rocks crosscut the fabric of the foliated rocks. However, there are domains within the 'giant-pyroxene' anorthosite unit in which there is a clear measurable orientation to the orthopyroxenes, so both Unit Mfln2 and deformed variants of Unit Mgpa1 may be intimately interlayered here.

c) Field boundaries between massive mauve to grey anorthosite (Unit MIka), grey to brown massive leuconorite (Unit MIkln) and mottled-brown elongate-oikocryst leuconorite (Unit Msfoln) on NTS 14D/16 vary from abrupt to diffuse. More than one intrusion may be 'lumped' into any such units outlined. In some cases, all variations in texture and composition can be observed over restricted area without consistent pattern. Map users will likely note that the trace of contacts as portrayed on the map could be interpreted to indicate that the foliated rocks are crosscut by the more massive types and this is also the impression gained from some outcrops where the two abut, but this relationship cannot be vigorously argued because seemingly gradual transitions between the rock types are apparent in the field. The regional significance of the contacts is also open to question because the foliation defined by elongate pyroxene oikocrysts in the ‘deformed’ rock is paralleled by trains of feldspar megacrysts in abutting more massive leuconorite and anorthosite, so the distinction between the units in some cases essentially reflects a mesoscopic textural variation. One consistent relationship, especially in those rocks allocated to the Ikpialuk intrusion, seems to be that fragments of massive pink and grey anorthosite occur in brown leuconorite, implying anorthositic rocks are relatively older than the leuconorites. Near the Iviangiujak east flank lakes, however, a pink anorthosite (Unit Mpaln) intrudes, and contains inclusions of, elongate-oikocrystic leuconorite.

d) Contacts between the brown-weathering leuconoritic (Unit MIkln) and pink to grey anorthositic (units MIka, MIka1, MIka2, MIka3) subdivisions of the Ikpialuk intrusion on NTS 14D/16 are nebulous and irregular at outcrop scale, and are thus likely the same on the regional scale. The portrayed map-scale boundaries of the units commonly represent the ‘best-fit’ contacts, across which one rock type predominates over the other. Such junctions are most reliable where ground traversing has been carried out and they are more speculative where constructed on the basis of helicopter-supported mapping. ‘Spot checks’ of individual outcrops in either subdivision may not necessarily correspond to the unit designation as a whole.

e) The definition of unit boundaries and relative ages of rocks south from PuijiKaut (Seal Bay) on Kingurutik Lake is not firm. Field relations on this part of NTS 14D/16 are indicative of the speckled leuconorite (Unit Mspk) being older than both the white anorthosite (Unit Mman3) and the ‘giant-pyroxene’ anorthosite (Unit Mgpa1), including crosscutting contacts against foliated speckled rock and inclusions of the speckled rock in both of the other units. The largest screens of the speckled rock are cut by dykes of white anorthosite, but the source of the dykes – whether the ‘giant-pyroxene’ unit or the massive white anorthosite – is not always clear. The unit assignment of the isolated outcrop visited in the valley is debatable, the field character being insufficient to reliably designate it as either the speckled leuconorite or the ‘giant-pyroxene’ anorthosite, but the former is indicated.

f) Limited outcrop visits in the northwest quadrant of NTS 14D/16 mean that the map patterns are far from definitive. Many of the exposures of anorthosite examined in the high country here have a mauve or pink tinge, and foliated and massive anorthositic to leuconoritic rocks of several types occur. Local outcrop relations (crosscutting junctions and types of inclusions) in the mountains and near the Iviangiujak east flank lakes imply multiple intrusive events: pink anorthosite inclusions occur in leuconorite in some places, yet similar pink anorthosite is intruded into leuconorite in others. The differing intrusions implied by the outcrop relations have not been satisfactorily determined.

g) There is insufficient ground control for the region south of the east end of Kingurutik Lake on NTS 14D/16 to assign some of the rocks mapped here to common units. White weathering, labradorite-bearing anorthosite has been allocated to the Mount Lister intrusion (Unit MMLan), as has a pink-tinged coarse-grained anorthosite to the west (Unit MMLpan). Foliated leuconorite (Unit MMLfoln), characterized by blotchy, elongate, orthopyroxene oikocrysts, located at the highest elevations in this area is unlike most other Mount Lister rocks examined, and field relationships indicate it is intruded by the more massive white to pink anorthosite. Nevertheless, all are provisionally assigned to the Mount Lister intrusion.

h) There is a high degree of uncertainty in the distribution and relative ages of units south of Tikkoatokak and Nain bays on NTS 14D/09. The database for south of Tikkoatokak Bay comprises information collected from shoreline outcrops by boat visits in 1991, by helicopter reconnaissance in 2002, and by helicopter stops supplemented with short (few hundred metres) traverses in 2003; no concentrated ground traversing was conducted in either year. One example of geological uncertainty is the highland region north of the entrance to the Fraser River where there seems to be a confluence of several of the units established to the north (units APMqflm, Mman5, Mfln4, Mgln). As for the region south of Nain Bay, limited ground work was undertaken there in 1990, 1991, and 1992, focusing on the gneisses more so than the NPS plutonic rocks; consequently, the lithological subdivisions of the latter are very tentative. The regional geology is likely more complex and varied than is shown. This complexity is borne out by the manuscript maps of E.P. Wheeler 2nd, from which most of the 'compiled' outcrops in this area were taken. Although some of Wheeler's subdivisions have been re-interpreted and/or revised, his subdivisions are also retained within the context of our own mapping in areas we have not visited (*e.g.*, the west and northwestwards extension of the paragneiss [Unit APMgpg] south of inner Nain Bay). The westernmost part of the area south of Nain Bay includes information derived from mapping undertaken by Tanya Tettelaar in 2002 as part of her Earth Sciences M.Sc. program at Memorial University of Newfoundland.

i) Map users should also bear in mind that some of the geological patterns on the maps are predicated on the compiler's interpretation of outcrop data and unit contacts gleaned from several sources, and that these data may not always be unambiguous and supportive of the interpretation imposed on them here. Interpretation liberties taken by the complier are certainly questionable for outcrop data that have been derived from detailed industry maps and from the manuscript maps of E.P. Wheeler 2nd; many outcrop areas demarcated on such maps were not visited during the dedicated 2003 survey of the two map sheets, and the outcrops may not necessarily conform to the general descriptions of a particular unit nor be part of that unit.

4. Ferrodiorite versus Gabbronorite

There is a group of generally fine-grained, dark-brown-weathering, granular rocks in the area, such as on the mountain west of Iglusuataliksuak Lake (Unit Mgf), for which there can be debate as to a compositional name. These rocks have a high content of Fe–Ti oxides, have Fe-rich pyroxenes (and rarely olivine), have andesine plagioclase (less calcic than An_{50}), and commonly have modally significant apatite. There has been discussion in the geological literature for a more than a half-century about an appropriate name for such rocks. Up until the early 1960s they were captured under the name 'ferrogabbro' but subsequently, using the contemporary criterion that rocks having andesine plagioclase should be named 'diorite', the name 'ferrodiorite' was substituted (*see* discussion by L.R. Wager and E.A. Vincent, 1962, "Ferrodiorite from the Isle of Skye", Min. Mag., v. 33, p. 26-36). There is still a broad adherence to this school of thought, and the name 'ferrodiorite' has been applied for several decades to Fe-rich rocks among the Nain Plutonic Suite, including ones that would modally be termed leuconorite. In fact, it has been stated (*see* R.A. Wiebe, 1990, "Dioritic rocks in the Nain complex, Labrador", Schweiz. Mineral. Petrogr. Mitt., v. 70, p. 199-208) that 'diorite' bodies pass gradationally through 'gabbro' and 'norite' into 'anorthosite', and that 'diorite' and 'leuconorite' are intimately interlayered, the rock-type distinction being made solely on plagioclase composition. Some concerns have been raised by this feldspar-composition-based rock classification, however, because by strictly adhering to it, many of the leuconoritic and anorthositic rocks, especially along the western side of the NPS, would be reclassified as 'leucodiorite'. The recognition that a 'leuconorite' is, in fact, a 'diorite' cannot be easily done in isolation in the field because the An value of the feldspar cannot be determined by visual observation at outcrop scale. On the other hand, ortho- and clinopyroxene are commonly easily distinguishable in the more leucocratic rocks, and a mode-based name such as leuconorite or leucogabbro would be more readily applied. The IUGS Subcommission on the Systematics of Igneous Rocks recommended that plagioclase composition take a secondary role to the nature of the ferromagnesian minerals in mafic rocks from anorthositic terranes (*see* A. Streckeisen, 1975, Earth-Sci. Rev., v. 12, p. 19), and this approach represents the second school of thought by those working with the rocks in such settings. This recommendation reflects, to some degree, the early-1950s view that 'diorite' is a hydrous rock having hornblende and biotite as the chief mafic minerals whereas 'gabbro' is an anhydrous rock having augite as the dominant mafic mineral, and hypersthene and olivine as subordinate accompaniments. This mode-based naming method generally allows ready classification in the field, without resorting to the chemical composition of the plagioclase feldspar. In many cases, the 'ferrodiorite' group of the Nain area contains subordinate quartz and potassium feldspar, and in the early 1970s it was concluded that the rocks have a median composition of 'monzogabbro' (*see* D. de Waard, 1974, "On the nomenclature and classification of rock groups in the Nain anorthosite complex (continued)", Nain Anorthosite Project Labrador, Field Report 1973, Geology Dept., Univ. Mass., Contrib. no. 13, p. 41). To add to the nomenclature confusion, Fe-rich rocks of this type elsewhere, especially if they contain appreciable volumes of potassium feldspar, have been given the names 'jotunite' and 'monzonorite'. Most of the fine-grained, mafic-rich, granular NPS 'dioritic' rocks examined in the Kingurutik Lake region are, in fact, best classed as 'gabbronoritic' because field observation and microscopic examination demonstrate that they contain modally important volumes of two pyroxenes: an augitic clinopyroxene and a complexly exsolved hypersthene – usually having a poikilitic habit – derived from inverted pigeonite. The name 'gabbronorite' reflects the modal IUGS classification, and it has been argued that this name is more fitting than 'diorite' because the latter is inappropriate and misleading for pyroxene-rich, hornblende-free rocks having a high color index (*see* B.E. Owens and R.F. Dymek, 1992, "Fe–Ti–P-rich rocks and massif anorthosite: problems of interpretation illustrated by the Labrieville and St-Urbain plutons, Quebec", Can. Mineral., v. 30., p. 163-190). In recent years OAGN has been suggested as an acronym for this Fe-rich group, capturing the essential character of the rocks as being oxide–apatite–gabbronorite. To reflect the essence of the foregoing review, the geological legend for the maps employs the name 'gabbronorite' to better indicate the modal mineralogical composition of the rocks in question, with 'ferrodiorite' as a qualifier to conform to current nomenclature for the NPS. These are characteristically dark-brown-weathering, commonly friable rocks having granular textures and generally lacking widespread cumulate structure. Metallic oxides are such a prominent constituent that a magnet immersed in the sand or fine gravel that is commonly developed locally by weathering of such rocks will be encrusted with radial arrays of such oxide when removed from the soil. We do not include as 'ferrodiorite' any of the coarser rocks that can be more easily designated otherwise in the field according to their modal minerals (leuconorite, leucogabbro).

5. Foliation Symbols

The rocks of the map area display outcrop-scale, planar, compositional and mineral fabrics of many types. Some of the primary plutonic mineral fabrics, such as the common orientation of plagioclase laths in anorthosite and leuconorite, are specifically denoted, as is the probable expression of such features on flat outcrop surfaces where the determination of the 3-D attitude is not possible. Other types of foliations are also present, however, and the symbols used to designate these are an attempt to differentiate them for the map-user.

a) The gneissosity symbol is used mainly in the metamorphic rocks of the envelope to the NPS, and it denotes a planar feature in which a compositional layering is generally accompanied by a layer-parallel mineral foliation. These fabrics are a result of structural transposition and interslicing of differing rock compositions, and of the enhancing of primary compositional variations in the precursor; small-scale folds and/or migmatitic (veined) structure are locally obvious. The symbol is also used, however, to portray the planar fabric element in foliated metaplutonic rocks that are part of, or associated with, rocks having a well-developed gneissosity, where the metaplutonic component is considered to be an integral part of these larger pre-NPS gneissic units. Some such metaplutonic rocks display a simple mineral foliation and lack a distinct compositional (gneissic) layering and a migmatizing vein network. The letters S, M and V identify, respectively, steep, moderate or vertical attitudes reproduced from the symbol set on unpublished manuscript maps of E.P. Wheeler 2nd.

b) The layering symbol in NPS and pre-NPS rocks denotes a planar compositional feature considered to be of primary magmatic origin. In the undeformed rocks, normal field criteria can be applied to interpret this feature. In gneissic and deformed plutonic rocks, however, this is not so easily done, and the use of such symbols in units of the latter type reflects field observations of characteristics that are more consistent with a primary rather than secondary (deformational) origin for the feature. Granted, however, primary layering is locally enhanced, attenuated and transposed by deformation, and a gneissic layering symbol is thus used where the deformational and recrystallization overprint has been fairly severe (*see* (a) immediately above).

c) Primary magmatic mineral fabrics and pre-full consolidation mineral fabrics in the NPS rocks include those small-scale structures that can be interpreted to have formed prior to the complete solidification of the parental magma to the rock. The symbol denoting these structures in the syenitic, monzonitic and granitic rocks demarcates the alignment of feldspar phenocrysts and mafic mineral streaks, in places within compositionally layered rocks having a gneissic appearance. Similarly, some of the medium- and fine-grained leuconoritic rocks have isolated streaks of pyroxene that are likely of magmatic origin. The orientation of long axes of ellipsoidal pyroxene oikocrysts in the leuconoritic rocks is also portrayed with this symbol because there is no indication that these forms are a result of processes imposed on the rock significantly later than final crystallization (*e.g.,* the pyroxene of the oikocryst is not recrystallized).

d) Fabrics developed by solid-state deformation of the NPS plutonic rocks are defined as those where the measured penetrative structure has been imposed upon, and significantly modifies, a primary igneous crystallization texture. This is particularly evident in, for example, outcrops of leuconorites, where the deformation and recrystallization overprint primary subophitic/intercumulus orthopyroxene. It is also evident where warped remnants of orthopyroxene and plagioclase megacrysts are still recognizable within an otherwise granular, well-foliated host rock. The best examples of such textures occur in the marginal leuconorite subdivisions of the Pearly Gates and Mount Lister intrusions.

e) In some of the NPS anorthositic rocks there are trains of anhedral to lozenge-like orthopyroxene (single grains and granulated clusters) which constitute a measurable feature of outcrops. In many cases, the plagioclase in such rocks is granular and a product of recrystallization of much coarser grains. It is difficult to interpret these measurable features in terms of a pre-full consolidation or solid-state processes because they may be a product of both, inasmuch as the pyroxene concentrations are a primary magmatic feature but the deformation of individual grains is a solid-state one. Thus, these are unspecified at map scale. Similarly, some of metre-scale mafic and felsic dykes in the region are foliated parallel to their strike, and it is not always possible to differentiate between internal foliations that are due strictly to magma flow or to post-emplacement movement of opposite walls just prior to or following complete solidification. The ‘unspecified’ symbol is also used for fabrics of unknown type derived from the unpublished maps of E.P. Wheeler 2nd, and the letters S, M and V, refer to his representations of the inclination of these features as simply being, respectively, steep, moderate or vertical.

6. Geographic Nomenclature

As is the case with much of northern Labrador, there are very few formally named geographic features on the NTS topographic base maps (NTS 14D/09, 14D/16) for the survey area. In the absence of a comprehensive formal nomenclature gazetteer, it has been necessary to draw on other sources for names of physical features. The main existing published source of geographic names is the classic and extensive list of Inuttitut (Inuktitut, Nunatsiavumiuttut) ones gathered by E.P. Wheeler 2nd during the first half of the twentieth century (*see* E.P. Wheeler 2nd, 1953, “List of Labrador Eskimo Place Names”, National Museum of Canada, Bull. 131, 105 pages). In addition, Wheeler’s archived (unpublished) and annotated manuscript (hand-drawn) “Place Name” maps and geological “Note Locality” maps have been consulted for some names not appearing elsewhere. The nomenclature from the foregoing sources has been augmented, and in some cases superseded, through communication with the Nunatsiavut government, taking into account the application of the ‘Labrador dialect’ to the spellings. In this regard the invaluable service provided by Mr. Wilson Jararuse, translator of the Inuttitut language within the Department of Culture, Recreation and Tourism at Nain, is acknowledged with much appreciation. The embedded names on the English–French-language topographic base-maps differ in some respects from the orthography set out by Wheeler and provided by Mr. Jararuse, and alternative spellings of the embedded names are provided where applicable. Some of the informal English identifiers are those used by Wheeler on his geographic “Place Name” maps referenced above, as well as on his geological manuscript maps (*e.g.,* “Polygon ponds” for the bodies of water in an area north of Kingurutik Lake designated, because of the patterned ground, as “Polygon ridge”).

7. Geochronology

The U–Pb isotopic ages depicted on the maps were determined from analyses of zircon; reference to concordia as follows: c=concordant, nc=near concordant, ui=upper intercept; li=lower intercept. Funding for the geochronological studies was provided, in part, by the Targeted Geoscience Initiative (TGI), a collaborative cost-shared arrangement between the governments of Canada (through the Geological Survey of Canada, Natural Resources Canada) and Newfoundland and Labrador (through the Geological Survey of Newfoundland and Labrador, Department of Mines and Energy). The ages comprise results from published and unpublished analytical work by Staci Loewy (SL) and James Connelly (JC), University of Texas at Austin, Austin, Texas, for various samples collected in 2003 from the Aupalukitak Mountain anorthosite and the anorthositic gneiss west of Iglusuataliksuak Lake, for the Ikpialuk intrusion, and for gneisses north and south of Tikkoatokak Bay. The age of the Hare Hill intrusions was determined by J. Connelly in 1993, from samples collected in 1991. Michael Hamilton (MH), Jack Satterly Geochronological Laboratory, University of Toronto, Toronto, Ontario, undertook the U–Pb investigation of mafic dykes in the Aupalukitak Mountain anorthosite and of the charnockite west of Iglusuataliksuak Lake, collected in 2003. The age of the Anaktalik Brook syenite dyke on NTS 14D/09 was initially derived by Christopher Roddick (CR), Geological Survey of Canada, Ottawa, Ontario, as a preliminary study of a sample supplied by R.F. Emslie in 1990; that age was subsequently verified by M. Hamilton. Sandra Kamo (SK), Geochronology Laboratory, Royal Ontario Museum, Toronto, Ontario, undertook the age determination study of the syenite intrusion south of Kingurutik Lake, employing a zircon-rich sample collected by B. Ryan in 1992. The ages of the marginal zone of the Pearly Gates intrusion and the oxide-rich leuconorite were determined by Tanya Tettelaar (TT) as part of her M.Sc. thesis at Memorial University, St. John’s, Newfoundland, and are used with her permission.

14D/16

- Unit A/P?man: foliated, white to pink, granitic dyke in meta-anorthosite; 1872 Ma (ui, igneous crystallization); 1320 Ma (li, contact metamorphism) SL
- Unit P?AMa: white recrystallized anorthosite; 1326 ± 1 (ui, contact metamorphism?) JC
- Unit P?AMa: foliated, mesocratic, biotite gabbronorite ('granulite') dyke, cutting anorthosite (Unit P?AMa, above); cut by charnockite (Unit Mgc, below); 1328 ± 1 (ui, contact metamorphism?) MH
- Unit Mgc: charnockite; intruded into anorthosite having biotite gabbronorite ('granulite') dykes; 1327 ± 2 Ma (ui, igneous crystallization?) MH
- Unit MIka3: granitic pod interstitial to plagioclase in anorthosite; 1326 ± 1 Ma (nc, ui, onset of igneous crystallization), 1322 ± 1 Ma (ui, culmination of igneous crystallization) SL
- Unit MIkln: brown leuconorite; 1324 ± 1 Ma (nc, c, igneous crystallization) JC
- Unit MIkln: brown leuconorite; 1323 ± 1 Ma (c, igneous crystallization) JC
- Unit Mfs: syenite; 1333 ± 3 Ma (c, igneous crystallization) SK

14D/09

- Unit APMa1: gneissic meta-anorthosite; 2025 Ma (ui, igneous crystallization?), 1750 Ma (ui, metamorphism?) JC
- Unit APMqflm: gneissic, recrystallized, metagabbronoritic rock; 2860 Ma (ui, igneous crystallization?), 1870 Ma (ui, regional metamorphism?), 1320 ± 2 Ma (c, contact metamorphism) SL
- Unit MfmzH: foliated porphyritic mangerite; 1351 ± 3 Ma (c, igneous crystallization) JC
- Unit MABs: foliated syenite; 1326 ± 1 Ma (c, igneous crystallization) CR, MH
- Unit MPGfln: foliated and recrystallized anorthosite and leuconorite; 1370 ± 5 Ma (c, onset of igneous crystallization), 1335 +7/-3 Ma (ui, culmination of igneous crystallization) TT
- Unit Moxn: oxide-rich gabbronorite; 1342 ± 1 Ma (weighted average of three $^{207}Pb/^{206}Pb$ ages, igneous crystallization) TT

8. Mineralization

The map area has local pockets of base-metal sulphide minerals which have been the focus of periodic assessment for copper (Cu), nickel (Ni) and cobalt (Co) by exploration companies since the mid-1990s. The following highlights regarding some such occurrences shown on the maps are condensed from details presented in assessment reports submitted to the Mineral Lands Division of the Department of Natural Resources.

a) Castle Rock Exploration investigated three occurrences of sulphide mineralization within massive anorthositic to leuconoritic rocks in the eastern part of the Ikpialuk pluton (Unit MIKa) on NTS 14D/16. They were dubbed the NBK showings, comprising syn- to epigenetic disseminated grains and vein-hosted massive pyrrhotite, chalcopyrite, and pentlandite. Ground examination and assays conducted on the mineralized rocks in the three areas of interest failed to prove that there were sufficient metal grades or volumes to encourage a concerted effort to ascertain their subsurface extent.

b) A number of gossanous sulphide zones were discovered in the Ikpialuk intrusion during the 2003 mapping by GSNL, the most extensive being occurrences located southeast of the 'NBK Main' showing and to the north of the Polygon ponds. The latter was subsequently examined and drilled during joint exploration by Benton Resources Corporation and Teck Cominco Limited between 2007 and 2010, and referred to as the 'P Zone'. The drilling intersected mineralized intervals in the anorthosite, but base-metal assays returned low (<1%) Cu, Ni and Co concentrations and no further investigations were undertaken.

c) Several other base-metal exploration targets were examined during the Benton and Teck Cominco exploration programs, one being in the gneissic septum (units APMlm and APMmq1) between foliated leuconorite (Unit Mfln2) and Ikpialuk leuconorite (Unit MIkln). This target area was designated as ‘Black Beard’, the surface examination and drilling of which failed to demonstrate the existence of any significantly elevated metal values (all <0.5%) in either the gneisses or bounding Mesoproterozoic plutonic rocks. The results stemming from the ground and subsurface investigations of the Black Beard area by Benton Resources Corporation were sufficiently discouraging to negate subsequent exploration of the septum and its enclosing rocks.

d) Small zones of disseminated sulphide within graphitic and pyroxene-rich gneissic panels (Unit APMmq2) in pink anorthosite (Unit MIka2) south of Kingurutik Lake were investigated by NDT Ventures Limited in the mid-1990s, but the low assay values for Cu, Ni and Co derived from the mineralized gneisses (and enclosing anorthosite?) did not provide any incentive for exploration activity beyond an initial ground assessment.

e) The most significant sulphide occurrence on NTS 14D/09 is the Nain Bay (Michelle) nickel prospect, 1.8 km south of Maligiak. Pyrrhotite-rich, massive sulphide is hosted by a pegmatitic leuconoritic dyke within granular recrystallized leucogabbronorite (Unit APMmag1), the dyke likely being an off-shoot from the pegmatitic anorthosite (Unit MMLan) to the east. Ground examination and drilling were undertaken by Archean Resources Limited and the Voisey’s Bay Nickel Company Limited in the mid-1990s. Narrow intervals of disseminated and concentrated sulphide mineralization (pyrrhotite, chalcopyrite) were encountered in several different subsurface settings, signifying that mineralization likely occurs in the gneissose metaplutonic rock as well as in the younger pegmatitic one. No substantial base-metal contents were recorded from any of the assayed sulphide zones, with Cu, Ni and Co being <1%, resulting in the cessation of the economic assessment of the Nain Bay (Michelle) nickel prospect in 1996.

In addition to metallic minerals, the anorthositic rocks, both the gneissic units and the pristine plutonic ones, have plagioclase feldspars that commonly display a labradorescence. The colour shades exhibited are usually slightly differing hues of blue and green, with rare copper-brown and bronze reflections, the latter two being associated with colour-zoned crystals. Rocks having plagioclase exhibiting a conspicuous labradorite colour are duly designated on the map, the largest and most impressive examples of such being those of the Pearly Gates (Siggualuit) showing and its proximal anorthosite on NTS 14D/09. This labradorite occurrence is well known, and comprises talus slopes and large boulders in a linear below a near-vertical cliff just east of Tessiatsujunguak; individual labradorite crystals, exhibiting shades of blue to green, are up to a metre in size, but are crosscut by myriad fractures along which the colour is destroyed.