Current Research (1999) Newfoundland Department of Mines and Energy
Geological Survey, Report 99-1, pages 183-194

MAGMATIC SULPHIDE–OXIDE MINERALIZATION IN THE NAIN HILL AREA (NTS 14C/12), NORTHERN LABRADOR

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ABSTRACT

The Nain Hill prospects consist of magmatic sulphide–oxide mineralization located within variably foliated anorthositic rocks near the village of Nain, Labrador. Most of the sulphide mineralization contains less than 0.6% Ni and 0.4% Cu, but grades locally range up to 1.6% Ni. Mineralization occurs in three main areas termed the Valley, Unity East and Unity West zones, and is spatially associated with sulphide-bearing gabbronorite and pyroxenite bodies that appear to intrude the dominant anorthosites. Diamond drilling at the Valley and Unity East zones confirms this relationship, and indicates that semi-massive to massive sulphide–oxide mineralization is gradational with gabbronorite and pyroxenite that contain disseminated sulphide and oxide. A grossly symmetrical pattern, where the more massive material flanks mineralized gabbronorite–pyroxenite and invades adjacent anorthosite rocks, is also commonly observed; this pattern suggests that sulphide- and oxide-rich residual material was expelled during crystallization of the gabbronorite. Within more massive mineralization, textural relationships show that the magnetite crystallized first, followed by the sulphides, which are interstitial. The overall distribution of mineralized zones in the Valley and Unity East zones suggests that they form subhorizontal to gently dipping units oriented at a high angle to the foliation in the anorthositic rocks. It is possible that both zones were originally linked as a single series of subparallel, sheet-like units.

INTRODUCTION

The Nain Hill prospects (also known as the NDT Ventures/Takla Star Resources Joint Venture, Project 44) are magmatic Ni–Cu–Co sulphide–oxide occurrences. The prospects occur within the Nain Plutonic Suite (NPS), which predominantly consists of anorthositic (*s.l.*) and granitic intrusions (Figure 1). The three prospects are located within 3 km of the town of Nain, Labrador, and are termed the Unity West zone, the Unity East zone, and the Valley zone (Figure 2). Surface outcrops within the area, and geophysical surveys conducted by NDT Ventures, indicate that these three principal zones are also surrounded by numerous other smaller sulphide-bearing zones.

The surface geology around the prospects is difficult to interpret due to extensive gossan development over sulphide-bearing rocks. However, diamond-drill core is very useful in determining unit relationships and providing a three-dimensional picture of the mineralized units. Of the three major mineralized zones, only the Unity East zone and the Valley zone were drilled.

The purpose and scope of this project by the senior author is to carry out detailed petrographic and geochemical studies on diamond-drill core samples collected during the 1998 field season. This report provides a basic outline of the regional and local geology, describes the principal geological units, and presents drill sections that provide three-dimensional information.

REGIONAL BACKGROUND

GEOLOGICAL SETTING

Northern Labrador is divided into three major geological units separated by a tectonic boundary developed during the Paleoproterozoic (1.85 Ga) collision of two continents; the tectonic boundary is a line running between Cape Chidley in the North and Snegamook Lake in the South (Wardle *et al.*, 1990). On the east side of the boundary is the Nain Province and the Churchill (Rae) Province is on the west side. A 30-km-wide band of paragneiss (Tasiuyak gneiss) occupies the eastern part of the Churchill Province

[1] Mineral Deposits Section

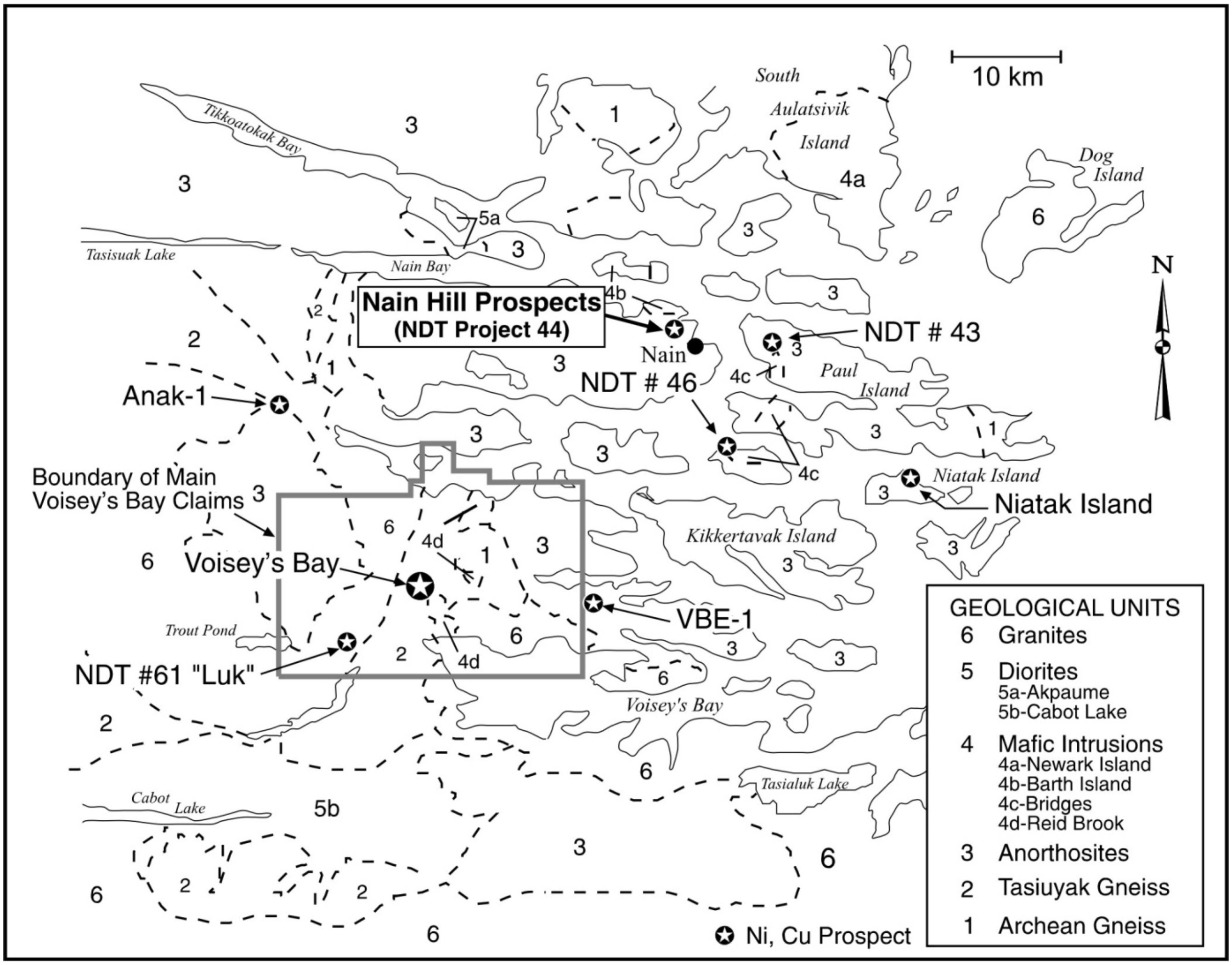

Figure 1. *Generalized map of the Nain Plutonic Suite in the Nain area (after Ryan, 1990), showing the location of the Nain Hill area, and locations of other sites of magmatic sulphide mineralization, including Voisey's Bay.*

adjacent to the boundary. The Nain Province consists of Archean gneisses, whereas the Churchill Province consists of Paleoproterozoic reworked Archean gneisses, Paleoproterozoic intrusive rocks and supracrustal rocks (Ryan *et al*., 1995). The western part of the Nain Province and the Tasiuyak gneiss were deformed by the Torngat orogeny, and contain a Paleoproterozoic foliation (Ryan *et al*., 1995).

The 1350 to 1290 Ma NPS covers approximately 20 000 km^2 between Okak Bay in the north and Hunt Lake in the south, and is centred on the community of Nain (Ryan *et al*., 1995; Ryan, 1997). The NPS is a large batholith of Mesoproterozoic igneous rocks having a wide range of compositions (e.g., Emslie *et al*., 1994; Ryan, 1997) and contains four major compositional divisions; anorthosite, troctolite, diorite, and granite (Ryan, 1997). After emplacement, the NPS was intruded by at least two suites of diabase dykes of Mesoproterozoic or younger age (Wiebe, 1985).

LOCAL GEOLOGY

The geology of the area, surrounding Nain, was compiled by Ryan (1990). Nain Hill is dominated by anorthosite and gabbronorite of the NPS. The dominant unit is a white to grey, medium- to coarse-grained, variably recrystallized and variably foliated anorthosite that ranges from a monomineralic plagioclase rock to leuconoritic or leucogabbroic rocks. The latter are usually present as layers oriented parallel to the foliation in the anorthosite, and their contacts with the anorthosite range from sharp to gradational. This older foliated anorthositic complex is intruded by younger gabbronorite to pyroxenite units, which do not form mappable units at 1:50 000 scale. The origin of the fabric in the

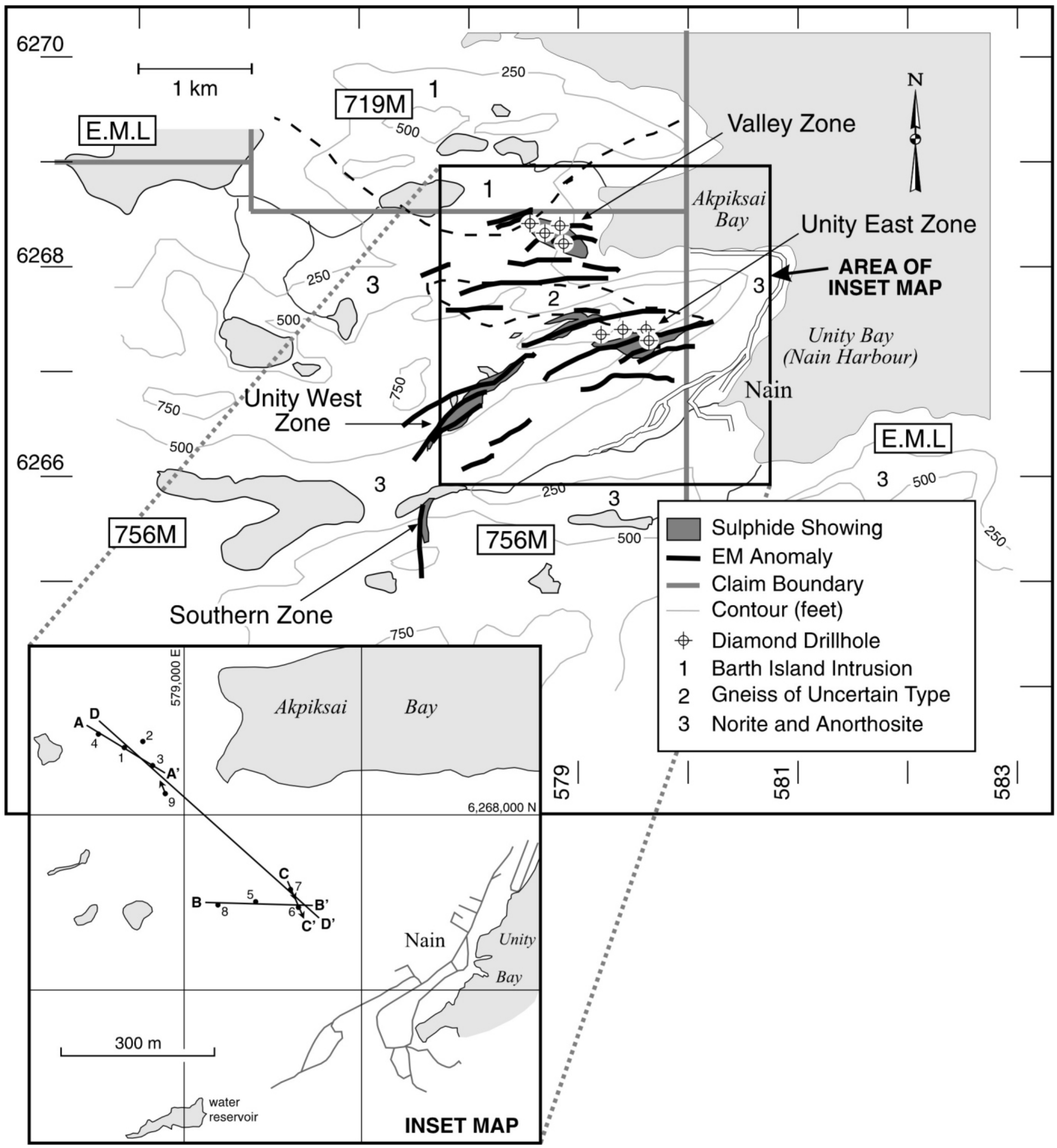

Figure 2. *General map of the Nain Hill area, showing the location of the three principal mineralized zones and drillholes. Inset shows the locations of drillholes in the area north of Nain, and positions of cross-sections illustrated in Figures 4, 5 and 6.*

anorthosite is unclear; it could have been developed during emplacement at the edge of a diapiric anorthositic pluton, or it could simply be a fabric imposed by regional deformation. If the latter is the case, the possibility that the Nain Hill anorthosite rocks are actually part of the Paleoproterozoic anorthosite suites recognized by Ryan *et al.* (1998) cannot be discounted. Some areas of the anorthosite are gneissic in appearance, but are still recognizable as strongly deformed mafic plutonic rocks. A gneissic unit of this type, on the north side of Nain Hill (Figure 2), was previously indicated as Archean (Ryan, 1990).

In the field, the sulphide and oxide mineralization is commonly spatially associated with a finer grained, mafic, gabbronorite to pyroxenite that contains disseminated sulphides and magnetite (Kerr, 1998). On the surface, this rock type forms flat-lying sheet-like bodies, and vertical or inclined vein-like bodies. These sheets and veins have sharp contacts against the anorthositic unit. These gabbronorite and pyroxenite bodies locally cut the fabric in the anorthosite and must have intruded it after its deformation. In places, however, they are also weakly foliated, which suggests that there was at least some local post-emplacement deformation.

EXPLORATION HISTORY

The 1995 and 1996 exploration programs in the Nain Hill area are detailed by Barbour and Dearin (1996), and public-domain results were summarized by Kerr and Smith (1997). The showings were discovered in 1995, during the post-Voisey's Bay exploration boom. Based upon the surface mineralization, and the presence of numerous strong conductors, diamond drilling on the property commenced in the summer of 1996. NDT Ventures completed 5 vertical drillholes on the Valley zone and 4 drillholes on the Unity East zone (Figure 2).

The diamond drilling program in the Valley zone intersected numerous sulphide and magnetite-bearing zones (1 to 10 m wide) within the foliated anorthosite. Most intersections contained less than 0.4% combined Ni and Cu (NDT Ventures, press release, July 30, 1996).The best intersection was 6.94 m of 0.51% Ni, 0.37% Cu and 0.04% Co, including 1.36 m of 1.08% Ni, 0.37% Cu and 0.10% Co (NDT Ventures, press release, July 30, 1996) in hole NDT 44-02. Intersections in NDT 44-03 gave grades of 0.54 to 0.58% Ni, 0.24% Cu and 0.036 to 0.037% Co over two short intervals. NDT Ventures suggested that all holes intersected one, main flat-lying mineralized horizon at varying depths (NDT Ventures, press release, July 30, 1996).

The results obtained from the Unity East zone were similar to those from the Valley zone. NDT Ventures suggested, however, that the mineralized zones in the Unity East zone were steeply dipping, in contrast to those in the Valley zone (NDT Ventures, press release, July 30, 1996). The best assay results from the Unity East zone were 6.28 m of 0.40% Ni, 0.35% Cu and 0.037% Co, including 0.81 m of 1.65% Ni, 0.30% Cu and 0.15% Co (NDT Ventures, press release, July 30, 1996). Several other short intervals containing 1 to 1.33% Ni were also intersected in the Unity East zone drillholes (NDT Ventures, press release, July 30, 1996).

After completion of the initial eight drillholes, a UTEM downhole EM geophysical survey probed all holes, and a gravity survey was conducted over the Valley and Unity East and West zones. On the basis of results from these surveys, two of the original eight holes were deepened, and a ninth hole was completed southeast of the Valley zone. However, no further significant mineralized intersections were encountered (NDT Ventures, press release, September 24, 1996). Some limited ground exploration work was conducted in the 1997 season, but the property was inactive in 1998.

GEOLOGY

SURFACE RELATIONSHIPS AND MINERALIZATION

Field work as part of this project was concentrated in the three mineralized zones; the Valley zone and the Unity East and Unity West zones (Figure 2). In the Valley zone, the mineralization is exposed as extensive, deeply weathered gossans that are rich in magnetite, and contain lesser sulphides. The gossans are associated with a finer grained, melanocratic rock type, which is distinct from the surrounding leucocratic anorthosite rocks. The finer grained rock type has been described as a gabbronorite (Kerr and Smith, 1997). The anorthositic rocks in the Valley zone are medium to coarse grained, containing plagioclase crystals from 1 to 4 cm in size. The primary mafic minerals display subophitic textures. The anorthosite is locally stained brown to purple, and shows a steeply dipping foliation oriented at about 110°; it is locally more mafic and this material also appears to be slightly foliated. Due to the surface extent of the gossans, the contact relationships are difficult to interpret, and the area is interpreted as a subhorizontal to gently dipping mineralized gabbronorite sheet sitting upon the anorthositic rocks.

The Unity zone is subdivided into the Unity East and the Unity West zones (Figure 2). In both zones, the host rock consists of a variably foliated and variably recrystallized white–grey anorthosite. The mineralization in the Unity zones is also associated with extensive gossans but it is possible to distinguish three different types of mineralization (Kerr and Smith, 1997). The first type consists of minor amounts of disseminated sulphides in the host anorthosite rocks. The second type consists of massive to semimassive veins of sulphides (and associated magnetite) within the anorthosite. The third type of mineralization consists of disseminated sulphides and magnetite hosted by a fine- to medium-grained gabbronorite to pyroxenite. Field relationships suggest that the gabbronorite and pyroxenite intrude the anorthosite.

The best surface example of massive sulphide mineralization is in the Unity East zone. In the gossan overlooking the town of Nain, there is a hollowed-out cavity having a vein-like geometry, almost at right angles to the foliation in the host anorthosite. Massive sulphides appear in the talus surrounding this cavity. The hollowed-out section is assumed to be the remnants of a massive sulphide vein that was originally at a high angle to foliation in the anorthosite. In the Unity West zone, most of the mineralization occurs as disseminated sulphides (pyrrhotite and minor chalcopyrite) within fine- to medium-grained gabbronorite to pyroxenite. The gabbronorite and pyroxenite are rusty-weathering, and appear to intrude the host anorthosite rocks, which are also iron-stained in places.

Massive sulphides are present in trenched areas, but their host rock is uncertain. The Unity West zone, although not drilled, provides the best field relationships. There are several exploration trenches present in this zone that reveal sharp contacts between the host anorthosite and the weakly mineralized gabbronorite. Blocks and xenoliths of anorthosite are present within the gabbronorite indicating that it intruded the anorthosite. There are also small apophyses of gabbronorite that intrude the anorthosite and resemble dykes. Locally, the host anorthosite in the area is also intruded by a medium-grained, pink granite. Its relationship to the mineralized gabbronorite is unknown. In the Unity West zone, the attitudes of the gabbronorite to pyroxenite bodies are variable. In some areas, they form subhorizontal bodies, whereas elsewhere they are steep to vertical, having widths of 1 to 3 m. These horizontal and vertical gabbronoritic bodies probably form a "net-like" or "stockwork" pattern of intrusions within the anorthosite.

All sulphide mineralization within the project area, whether massive or disseminated, is dominated by pyrrhotite, with lesser amounts of chalcopyrite. Magnetite is also a common constituent, and forms rounded bead-like masses in massive sulphide samples. Conversely, in magnetite-rich samples, pyrrhotite and chalcopyrite have an interstitial habit. Polished section studies (D. Wilton, R. Watanabe, both reported by Barbour and Dearin, 1996) indicate that pentlandite is present as small exsolution patches, notably along grain boundaries. Preliminary examination of polished sections confirms that exsolved pentlandite is present within and around pyrrhotite.

SUBSURFACE GEOLOGICAL RELATIONSHIPS

The nine drillholes from the Nain Hill area (located in Figure 2) were examined in detail and sampled. Holes NDT 44-01 (Figure 3) to NDT 44-04 are located in the Valley zone area, whereas holes NDT 44-05 to NDT 44-08 are located in the Unity East zone. Hole NDT 44-09 is located southeast of the Valley zone, but its lower section penetrates beneath hole NDT 44-03. The coordinates and elevations listed for the drillhole collars were provided by Barbour and Dearin (1996). Holes NDT 44-04 and NDT 44-05 were selected for more detailed petrographic and geochemical investigations as part of the thesis project of JH. Figures 4 and 5 illustrate the distribution of units in drillholes, and possible correlations.

Drillhole NDT 44-01 (Valley Zone)

Drillhole NDT 44-01 was drilled vertically to a final depth of 252.4 m from a collar position of 6268375N, 578664E, with an elevation of 145.6 m. There are three main rock types present in this hole. These are a coarse-grained, variably recrystallized, unfoliated grey anorthosite; a medium- to coarse-grained gabbronorite containing variable amounts of oxides and sulphides, which is associated with the mineralization; and a fine-grained, pale-grey mafic rock (gabbronorite) containing minor oxides. The two different gabbronorite units are distinct in appearance. The anorthosite shows secondary alteration of primary mafic minerals to bright-green material interpreted as a mixture of chlorite and actinolite.

The first 57.9 m of this hole are dominated by the anorthosite, but includes a 10.4-m mineralized section from 8.0 to 18.4 m. This appears to be a symmetrical unit, with a mafic (gabbronoritic) core containing disseminated sulphide and oxide, and marginal zones dominated by sulphides and oxides (containing only minor silicates) invading the anorthosite. The sulphide–oxide rock appears to invade the surrounding anorthosites as vein-like bodies. This symmetrical pattern is typical of many mineralized intersections, and is shown schematically in Figure 3. Anorthosite continues to 183.9 m, but is invaded in numerous places by sulphide and oxide veins (predominantly magnetite). At greater depths, there are two zones of gabbronoritic material (183.8 to 192.4 m, 226.5 to 246.3 m) containing oxides and sulphides. The contacts between the gabbronorite and the anorthosite are abrupt to sharp and are marked by smaller zones of magnetite and sulphide, which appear to invade the surrounding anorthosite. The last 32.2 m of the hole is a mixture of anorthosite and gabbronorite with oxides and sulphides, but also includes two intervals (220.2 to 222.9 m, 225.5 to 226.5 m) of the fine-grained, light-grey gabbronorite. This finer grained unit intrudes the mineralized gabbronorite unit, which itself intrudes and disrupts the anorthosite. Therefore, the finer grained, light-grey gabbronorite is interpreted to postdate mineralization.

Drillhole NDT 44-02 (Valley Zone)

Drillhole NDT 44-02 was drilled vertically to a final depth of 301 m from a collar position of 6268409N,

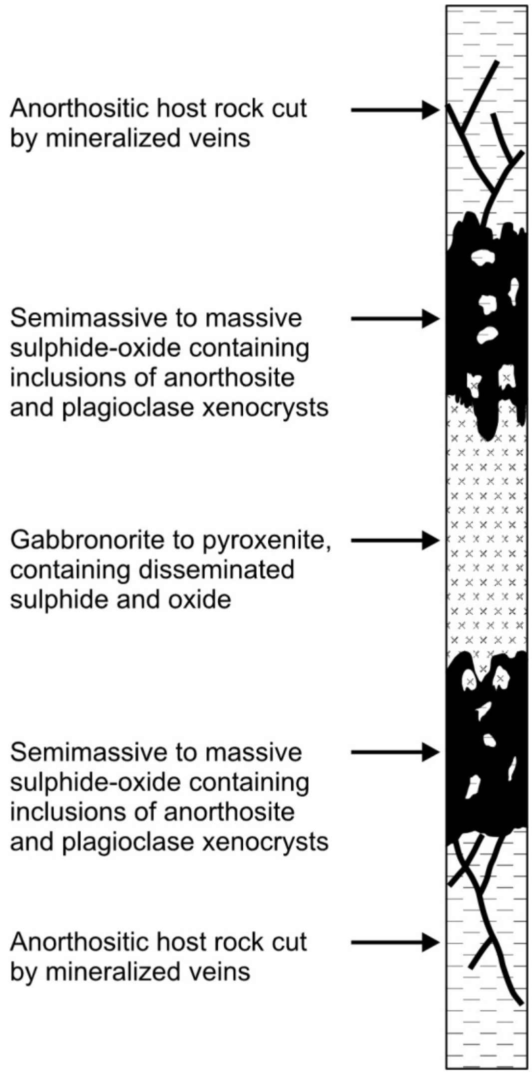

Figure 3. *Schematic section showing symmetrical distribution of semimassive to massive sulphide–oxide mineralization and gabbronorite units containing disseminated sulphides and oxides. This overall geometry is typical of many mineralized zones in the Nain Hill area.*

578767E, with an elevation of 137.9 m. There are two rock types present in this hole. The most abundant is a coarse-grained, variably recrystallized and altered grey anorthosite, in which primary mafic minerals are transformed to chlorite and/or actinolite. This anorthosite is identical to the equivalent rock type in hole NDT 44-01. The second rock type is a medium- to coarse-grained, dark-grey gabbronorite, containing about 50 percent plagioclase. This rock type is foliated at 60° to the core axis. This material was intersected in the first 14.7 m of the hole, and contains disseminated sulphides (mostly pyrrhotite). This is underlain by a thick sequence of anorthosite, which locally contains sporadic mineralization associated with thin gabbronorite units. One short section (25.2 to 26.6 m) stands out due to its sharp contacts with the anorthosite and a heavy concentration of disseminated sulphides. From 97.3 to 103.2 m, a gabbronorite unit contains disseminated sulphides and oxides. Large plagioclase crystals identical to those in the surrounding anorthosite are also present in this unit. Two other intervals of gabbronorite (at 124.2 to 146.2 m and 149.7 to 161.3 m), also contain disseminated sulphides and oxides (pyrrhotite, minor chalcopyrite and magnetite), and have sharp contacts with the surrounding anorthosite. The last 140 m of the hole are dominated by anorthosite and some minor intervals of the sulphide- and oxide-rich gabbronorite, and associated, locally massive, sulphide–oxide mineralization, which appears to invade the anorthosite. The sulphides commonly show an interstitial habit to the magnetite, suggesting that they crystallized later. The relationships in hole NDT 44-02 are very similar to those in hole NDT 44-01, but there is less mineralization.

Drillhole NDT 44-03 (Valley Zone)

Drillhole NDT 44-03 was drilled to a total depth of 159.1 m from a collar position of 6268276N, 578825E, with an elevation of 94.5 m. This hole is dominated by a medium-grained, variably recrystallized, unfoliated grey anorthosite that has some primary igneous textures preserved. This is very similar to the anorthosite in the other Valley zone holes. Much of the anorthosite intersected in this hole, however, is relatively mafic in composition and is probably leuconoritic to leucogabbroic. Locally, it is invaded by minor amounts of oxide–sulphide material, although this is less common than in holes NDT 44-01 and 44-02. The most significant mineralized interval is present at 38.8 to 45.2 m, where a fine-grained gabbronorite containing disseminated oxides and disseminated sulphides is present. Surrounding this short interval, the anorthosite is invaded by oxides and sulphides that appear to be gradational with the gabbronorite. The geometry resembles the general pattern in Figure 3. Toward the bottom of this hole, a 3.1 m interval (127.3 to 130.4 m) of a fine-grained, light-grey gabbronorite was intersected. This cuts the anorthosite and is probably equivalent to the post-mineralization unit in hole NDT 44-1. The remainder of the hole, to 159.1 m, consists of anorthosite, which becomes progressively finer grained and more recrystallized with depth.

Drillhole NDT 44-04 (Valley Zone)

Drillhole NDT 44-04 was drilled vertically to a final depth of 327.7 m from a collar position of 6268452N, 578522E, with an elevation of 156 m. It provides the best illustration of rock types and textural relationships that are typical of the Valley zone showings. There were five different rock types intersected in this hole. The dominant rock type is a medium- to coarse-grained, variably recrystallized, grey anorthosite containing altered mafic minerals, identical

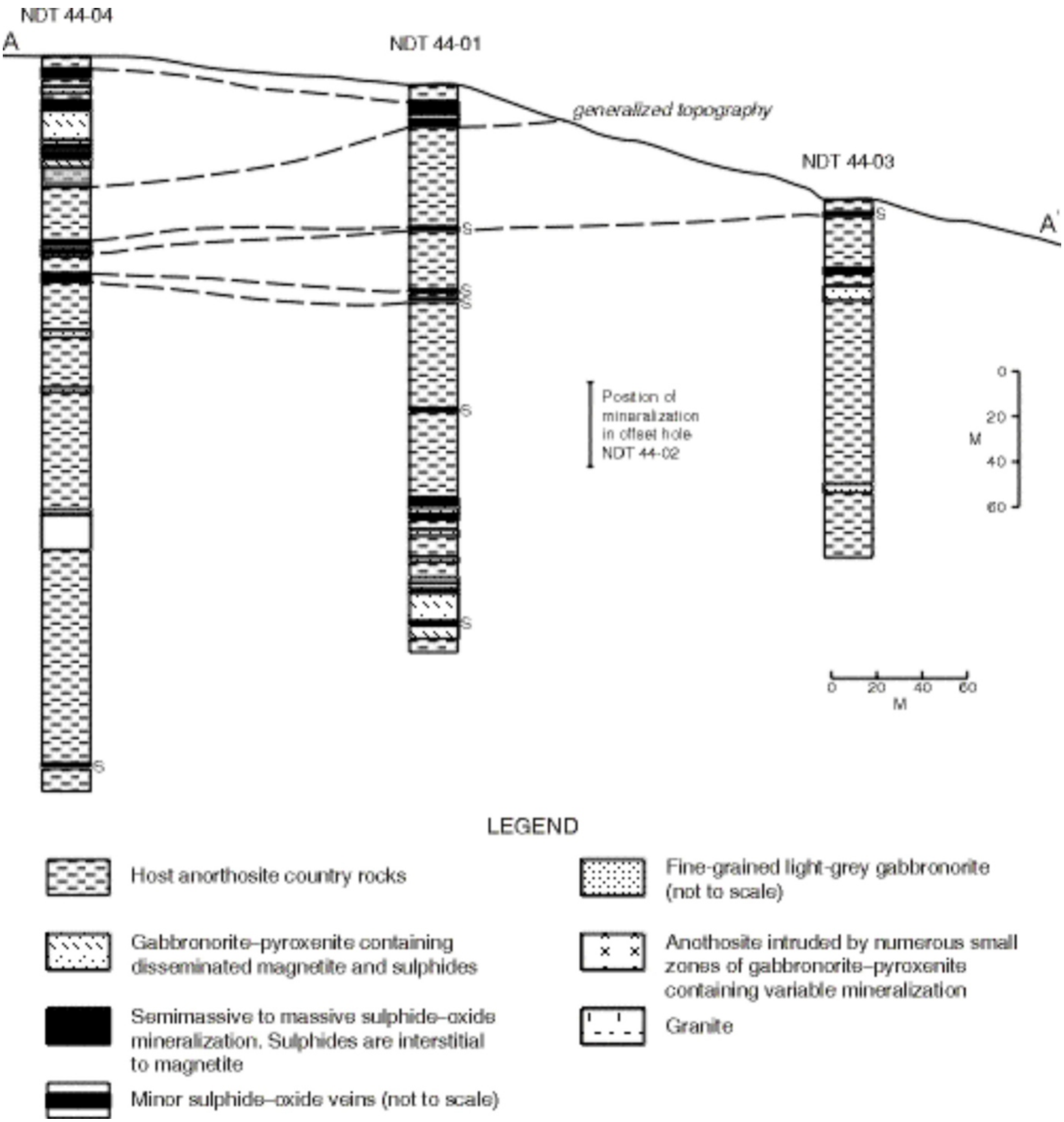

Figure 4. *Cross-section through the Valley Zone mineralization, along section line A-A' (Figure 2), looking northeast. No vertical exaggeration. Note that the core logs are schematic in that they represent all contacts as perpendicular to the core axes.*

to the anorthosite in the preceding holes. The next most abundant rock type is a homogeneous, medium-grained, gabbronorite containing disseminated oxides (magnetite) and sulphides. This unit, which is associated with mineralization, intrudes the anorthosite in numerous places. In one location (89.3 to 89.5 m), a finer grained, light-grey gabbronorite intrudes the mineralized gabbronorite. At 202.3 m, a 1 m interval of pyroxenitic material was intersected. In the lower 100 m of the hole, there are several intervals, up to 15 m thick, of a pink, biotite-rich granite.

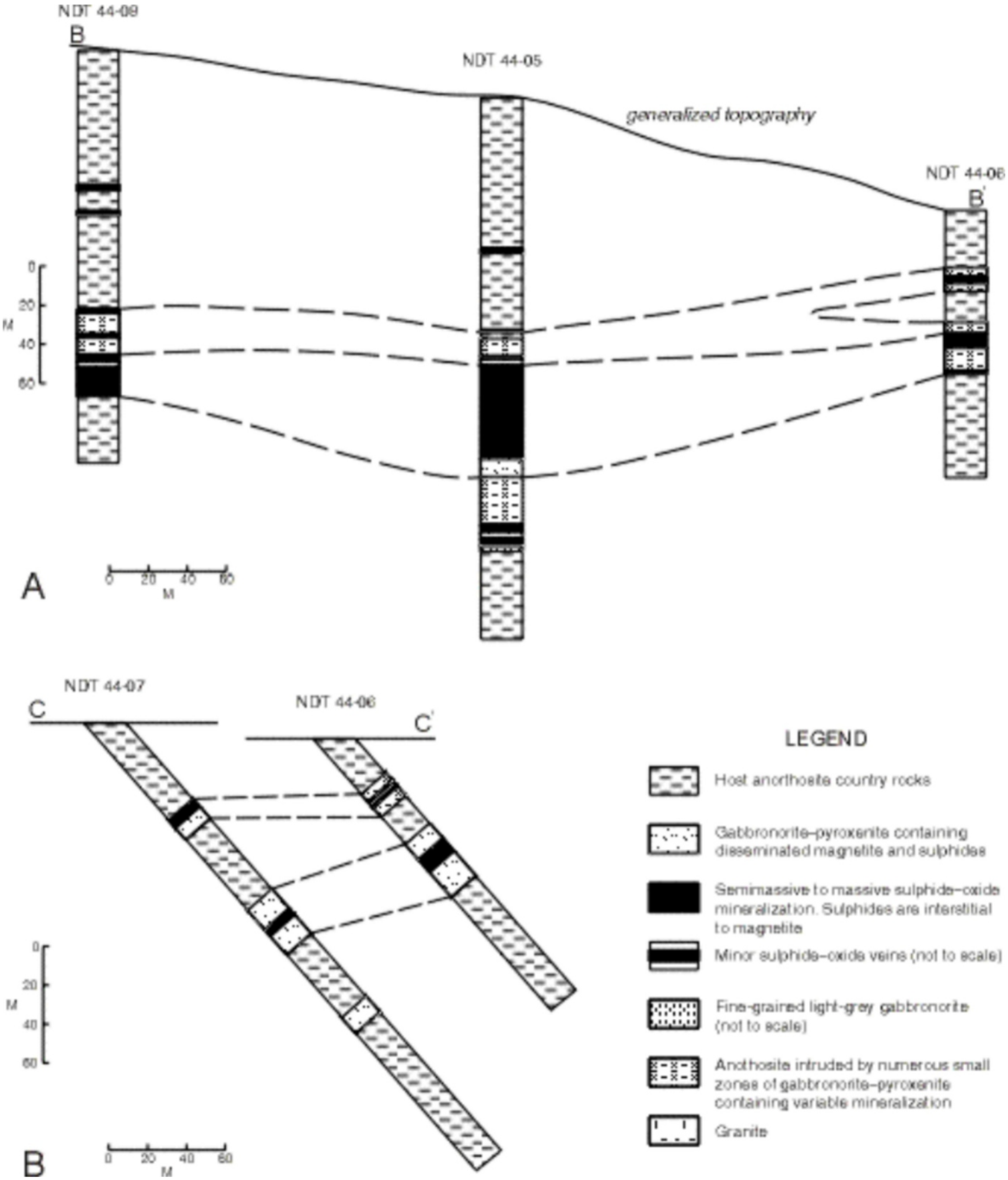

Figure 5. *Cross-sections through the Unity East zone mineralization. (a) Roughly east-west cross-section along section line B-B' (Figure 2), looking north. (b) Northwest-southeast cross-section along section line C-C' (Figure 2) looking northeast. No vertical exaggeration. Note that core logs are schematic in that they represent all contacts as perpendicular to the core axes.*

The entire drillhole intersected repeated cycles of anorthosite and gabbronorite containing disseminated sulphides and oxides. In most cases, the gabbronoritic units are less than 2 m thick, but thicker intervals are locally present. The contacts between these two rock types are abrupt, and commonly are associated with semimassive to massive oxide–sulphide mineralization, which invades the host anorthosite; the sulphides are interstitial to the magnetite. Some of the massive mineralization consists of almost pure magnetite, with only a few scattered plagioclase crystals contained within it. The symmetrical pattern illustrated in Figure 3 is shown well by a mineralized interval from 82.4 to 89.3 m.

Drillhole NDT 44-05 (Unity East Zone)

Drillhole NDT 44-05 was drilled vertically to a final depth of 279.8 m from a collar position of 6267510N, 579396E, with an elevation of 234.6 m. This drillhole contains at least three, and possibly four, different rock types. The dominant rock is a medium-grained, variably recrystallized anorthosite that is foliated at 60° to the core axis. This anorthosite is gradational with a more mafic variant that contains minor disseminated sulphides. The third rock type is a fine- to medium-grained gabbronorite to pyroxenite, which is associated with oxides and sulphides; locally, this rock is also foliated. The least abundant rock is a fine-grained, light-grey, homogeneous gabbronorite, which apparently postdates mineralization. All of these rocks have equivalents in the Valley zone holes (*see above*).

The first 124.3 m of the hole are dominated by the medium-grained, variably recrystallized anorthosite, including some sections of darker leuconorite or leucogabbro. This unit is locally altered with the mafic minerals transformed to chlorite or actinolite. An underlying interval (124.3 to 137.6 m) consists of anorthosite, intruded by numerous thin zones of gabbronorite to pyroxenite material, associated with sulphide–oxide mineralization. The contact relationships between the mineralized gabbronorite and the anorthosite are contradictory. In places, the contacts are very sharp, whereas in other areas they appear almost gradational. However, surrounding anorthosite rocks are invaded by oxide and sulphide veinlets. This interval also includes a small section (at 135.3 m) of fine-grained, light grey gabbronorite that cuts both the anorthosite and the mineralized gabbronorite to pyroxenite. The underlying section (137.6 to 185.3 m) contains a thick interval of semimassive magnetite containing interstitial sulphides. This interval includes semimassive mineralization, gabbronorite containing disseminated oxide and sulphide, and anorthosite. Semimassive magnetite contains interstitial sulphide and surrounds large plagioclase crystals identical to those in the surrounding anorthosite. The remainder of the drillhole consists of anorthosite containing some minor intervals of the mineralized gabbronorite. The mineralized sections have magnetite–sulphide veins associated with their margins, as shown in Figure 3. At 125.0 m and 233.6 m, thin intervals of the fine-grained, light-coloured gabbronorite are present, and locally cut the mineralized gabbronorite.

Drillhole NDT 44-06 (Unity East Zone)

Drillhole NDT 44-06 was drilled at a −45° angle to a final depth of 182 m from a collar position of 6267479N, 579635E, with an elevation of 178.6 m and an azimuth of 157°. This drillhole contains three major rock types. The dominant rock type is a medium-grained, white to grey, retrogressed anorthosite, containing a foliation at 60° to the core axis. As in hole NDT 44-05, the anorthosite includes more mafic variants, some of which contain minor disseminated sulphide. The anorthosite is intruded in numerous places by a finer grained gabbronorite to pyroxenite, which is associated with sulphide–oxide mineralization. A fine-grained, homogeneous light-coloured gabbronorite intrudes the anorthosite and the mineralized gabbronorite.

The mafic variants of the anorthosite have a locally gneissic appearance and show compositional layering. Mafic intervals at 19.5 to 22.9 m and 33.6 to 40.6 m have well-banded upper sections that are gradational with the anorthosite, however, in both cases, the lower contacts of the mafic variants are sharp. Mineralized zones in this hole occur at 40.6 to 55.3 m and 85.0 to 93.9 m. The upper zone contains two small sections of massive sulphides (dominantly pyrrhotite) from 46.1 to 46.2 m and 46.4 to 46.5 m. These thin sulphide zones contain plagioclase crystals similar to those in the host anorthosites. These two sulphide zones are located on either side of a thin zone of finer grained gabbronoritic material that contains disseminated sulphides, as illustrated in Figure 3. Many other thin sulphide and oxide zones are associated with gabbronorite through this interval. The lower zone of mineralization consists essentially of massive magnetite with interstitial sulphides, which contains numerous inclusions of anorthositic plagioclase. This resembles the material in NDT hole 44-05 (*see above*) and includes a similar mixture of rock types. The remainder of the hole consists of alternating anorthosite and gabbronorite with minor amounts of sulphides and oxides located mostly around their contact areas.

Drillhole NDT 44-07 (Unity East Zone)

Drillhole NDT 44-07 was drilled at a −48° angle to a final depth of 303.89 m from a collar position of 6267580N, 579595E, with an elevation of 186 m and an azimuth of 157°. There are three major rock types present in this hole. The most abundant is a white to grey, retrogressed, and foliated anorthosite, as described from other Unity East zone holes. This unit is intruded by gabbronorite to pyroxenite, which contain disseminated oxides and sulphides. A fine-grained, light-coloured gabbronorite is also present in small amounts.

The first 65 m of this hole is dominated by the anorthosite, with a foliation at 60° to the core axis. The anorthosite in the first 24.8 m of the hole has a gneissic appearance due to the interbanding of several more mafic intervals with the anorthosite, as seen in hole NDT 44-06. Toward the bottom of this interval, the anorthosite contains vein-like zones of sulphides and oxides. There are two major mineralized intervals. The upper zone (65.1 to 74.8 m) has a sharp upper contact with the overlying anorthosite. Massive sulphide–oxide mineralization is associated with gabbronorite or pyroxenite material, which appears to have intruded the anorthosite. The lower zone of mineralization (126.8 to 159 m) consists of two intervals where the anorthosite was intruded by gabbronorite material. Coarse, rounded plagioclase crystals are present within the gabbronorite. Massive magnetite, containing interstitial sulphides, invades and brecciates the surrounding anorthosite. Aside from one thin zone of mineralization (201.8 to 212.5 m) the remainder of this hole is dominated by the recrystallized, retrogressed, and foliated anorthosite, and contains only minor vein-like sulphide and magnetite zones.

Drillhole NDT 44-08 (Unity East Zone)

Drillhole NDT 44-08 was drilled vertically to a final depth of 213 m from a collar position of 6267491N, 579183E, with an elevation of 258.4 m. It contained the same three rock types observed in the other Unity East zone holes.

The first 70 m of this hole are dominated by anorthosite that locally contains minor disseminated sulphides. This is underlain by a 2 m interval where anorthosite has been invaded by sulphides and magnetite. Anorthosite continues from 72.0 to 157.8 m. There is an increase in the frequency of gabbronorite to pyroxenite intervals with depth. The major mineralized zone is from 157.8 to 178.8 m, where gabbronorite and pyroxenite are abundant. From 164 to 178.8 m, zones of semimassive to massive magnetite contain interstitial sulphides, and appear to surround a central section of fine- to medium-grained gabbronorite to pyroxenite material, which contains disseminated sulphides and oxides, as in Figure 3. The remainder of the hole consists of foliated, recrystallized anorthosite.

Drillhole NDT 44-09 (Southeast of the Valley Zone)

Drillhole NDT 44-09 was drilled at a −45° angle to a final depth of 342.2 m from a collar position of 6268122N, 578893E, with an elevation of 52.6 m and an azimuth of 337°. Most of the hole consists of a medium-grained, variably recrystallized, retrogressed white anorthosite, with intervals of medium-grained, gabbronorite to pyroxenite, associated with mineralization. These are familiar from other holes. A third rock type, not seen in other holes, consists of a fine-grained mafic rock that contains abundant plagioclase phenocrysts; this has been interpreted as a mafic dyke by Barbour and Dearin (1996).

The first 58.2 m of the hole are dominated by the fine-grained mafic rock with variable amounts of plagioclase phenocrysts. This unit gets gradually finer with depth. The underlying section (58.2 to 125.5 m) is dominated by the medium-grained, recrystallized and altered white anorthosite, locally showing a strong foliation at 65° to the core axis. There are some more mafic variants present within this anorthosite. Within this interval, there are three areas where the anorthosite is invaded by magnetite and sulphides, at 58.2 to 64.5 m, 77.3 to 77.7 m and 84.5 to 85.3 m. Toward the bottom of this interval, the anorthosite is cut in places by small granitic veins. From 125.5 to 125.8 m, anorthosite is intruded by a very fine-grained black mafic rock. This is interpreted as a diabase dyke and appears to have chilled margins; this unit has very minor amounts of sulphides associated with it. Another section of the fine-grained plagioclase–porphyritic mafic unit occurs from 128.8 to 151.8 m. Again, this unit appears to become finer grained with depth. The interval from 151.8 to 290.4 m consists of the white, recrystallized anorthosite.

The major mineralized zone in this hole is from 290.4 to 342.2 m. The upper part of this interval consists of anorthosite that is invaded by magnetite and sulphides. This passes downward into a section of gabbronorite to pyroxenite containing disseminated sulphides and oxide (301.1 to 317.7 m). The final section of the hole (317.7 to 342.2 m) consists of anorthosite alternating with sections of gabbronorite. At the contacts of these two rock types, semimassive to massive magnetite and sulphides invade the anorthosite, as shown in Figure 3.

DISCUSSION

Upon examination of field relationships and drill core from both mineralized zones, several consistent points emerge. The same general suite of rock types is intersected in both areas. The dominant rock type is anorthosite, which has been intruded in numerous places by gabbronorite to pyroxenite, containing disseminated sulphide–oxide mineralization. The massive oxide and sulphide mineralization in both zones is spatially associated with these gabbronorite to pyroxenite intervals, and semimassive to massive mineralization is gradational with the gabbronorite and pyroxenite. In many cases, the mineralized intervals show the overall symmetrical geometry illustrated in Figure 3. In both zones, there are also thin oxide–sulphide veins that cut the host anorthosite in many places, locally well removed from mineralized gabbronorite units. The sharp contacts of these mineralized veins against the host anorthosite suggest that they are younger and intruded it. In both zones, the host anorthosite is generally barren of any disseminated mineralization, except for some more mafic variants that contain minor amounts of disseminated sulphides and oxides. In both zones, a light-grey, unmineralized gabbronorite was also intersected in some drillholes, where it appears to postdate mineralization. Although this unit appears identical in both zones, it forms thin intervals and cannot be correlated precisely.

The overall relationships between the anorthosite and mineralized gabbronorite to pyroxenite units suggest that a solid (but not necessarily cold) anorthosite was intruded by a mafic magma containing an immiscible oxide- and sulphide-rich liquid. The oxide–sulphide material remained following crystallization of the silicates forming interstitial material. This formed the disseminated mineralization in the gabbronorite to pyroxenite unit. However, the oxide–sulphide liquid also coalesced, and migrated (or was expelled) into the surrounding anorthosite, producing local massive mineralization, and widely dispersed invasive veinlets. The textures in massive mineralization indicate that the magnetite crystallized first, and the sulphide crystallized later, as an interstitial phase. Sulphide-rich mineralization may record the further coalescence and movement of residual liquids.

Drill sections constructed along the section lines shown in Figure 2 suggest that both the Valley and Unity East zones can be explained as subhorizontal to gently dipping mineralized units (Figures 4 and 5). In the Unity East zone (section B-B'), the major mineralized interval defines a gently dipping unit, with a central zone of semimassive mineralization bounded above and below by mineralized gabbronorite and pyroxenite (Figure 5a). The same attitude is possible for a northwest–southeast section line drawn through holes NDT 44-06 and NDT 44-07 (section C-C'), suggesting that it is a true, rather than an apparent geometry. This interpretation differs from that presented by Barbour and Dearin (1996), who suggested a steeply dipping zone in hole NDT 44-06 that did not extend to the underlying hole NDT 44-07. The mineralized intervals in the Valley zone are more difficult to link, but the near-surface mineralized interval can be correlated between holes NDT 44-01 and NDT 44-04, and is probably above the erosion surface in NDT 44-03 and NDT 44-02 (Figure 4, section A-A'). A lower mineralized interval may dip gently southwest, based on its relative position in the off-section hole 44-02 (Figure 4). However, it is very difficult to link the myriad of smaller mineralized zones in this area, and the overall pattern is likely very complex.

On a wider scale, it may be possible to link the Valley zone and Unity East zone mineralized units across the valley that separates them (Figure 6, section line D-D'). The presence of sulphide mineralization in the cliffs on the northwest side of Nain Hill (Figure 6) is consistent with this general interpretation. However, there does not appear to be a single, continuous, sheet-like unit and the configuration is more likely to represent several subparallel or *en-echelon* bodies. The overall attitude(s) of the mineralized unit(s), as suggested by drillhole data (Figures 4, 5 and 6) are at a high angle to the regional fabric in the anorthosites, implying that mineralization must postdate this deformation.

Although the Valley and Unity East and West zones are very similar in many respects, there are some variations and differences between them. First, the appearance of the host anorthosite is different. In the Valley zone, it is medium to coarse grained, generally unfoliated and only weakly recrystallized, but it displays more pervasive recrystallization, deformation and retrogression in the Unity East zone. This contrast is supported by preliminary petrographic studies. Second, pink granite is present in one of the Valley zone holes, and was not observed in the Unity East zone. Also, plagioclase–porphyritic mafic dykes were encountered only in the Valley zone. Petrographic and geochemical studies to be conducted later, as part of the thesis project, will explore these similarities and contrasts in more detail, and compare the mineralized gabbronorites with similar rock types reported in other northern Labrador sulphide prospects (e.g., Kerr, 1998; Piercey and Wilton, *this volume*). Barbour and Dearin (1996) suggested a possible link between the mineralization and the nearby Barth Island intrusion, which is present along the north edge of the area shown in Figure 2. This hypothesis will also be investigated later in the thesis (J.H.) project.

ACKNOWLEDGMENTS

Field work in the Nain area was conducted as part of the Mineral Deposits Section Labrador nickel project, with field assistance provided by Karen Barefoot and Mark Wyatt, both of Nain. The assistance of Wayne Jenkins and Dennis Wyatt in Nain is gratefully acknowledged, and we also thank Dwayne Cole and Paul Spurvey (GeoScott Exploration Consultants) for their cooperation in arranging helicopter rides. Work to be conducted as part of the thesis project will be supported by NSERC grants to Derek Wilton at Memorial University. Charlie Dearin of NDT Ventures is thanked for his support of the project, and for permission to use unpublished proprietary information.

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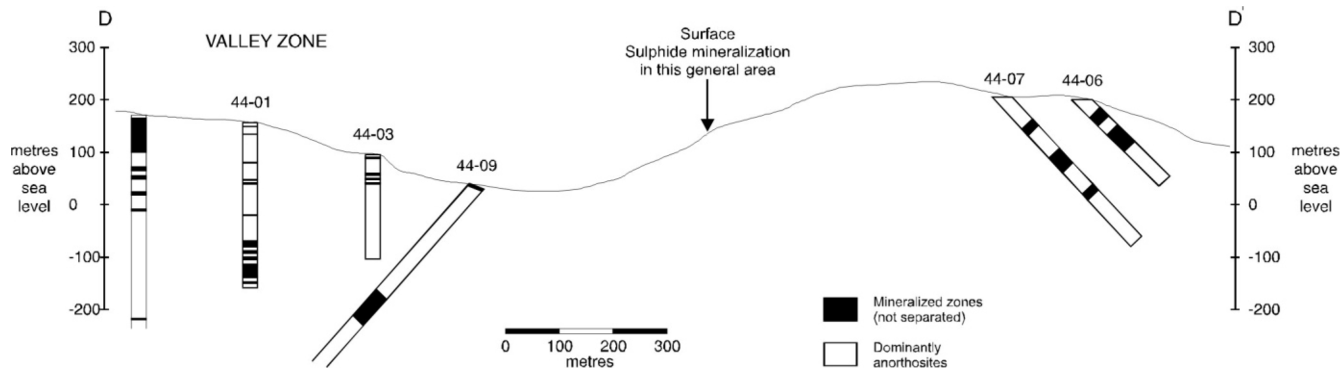

Figure 6. *Composite cross-section from the Valley zone to the Unity East zone, along section line D-D' (Figure 2) looking northeast. No vertical exaggeration. This section illustrates that the two mineralized zones could be part a single broad zone, but the available data do not allow unique correlations.*

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