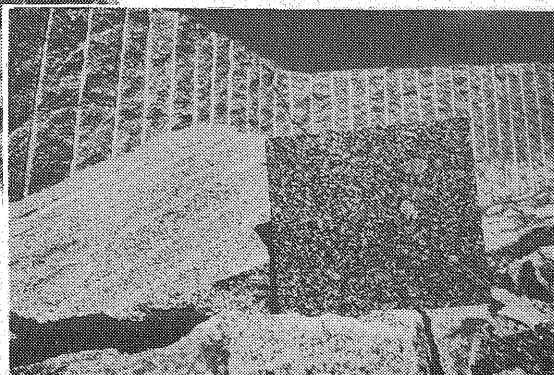


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DIMENSION STONE INVENTORY of Northern Minnesota 1993

REPORT
298

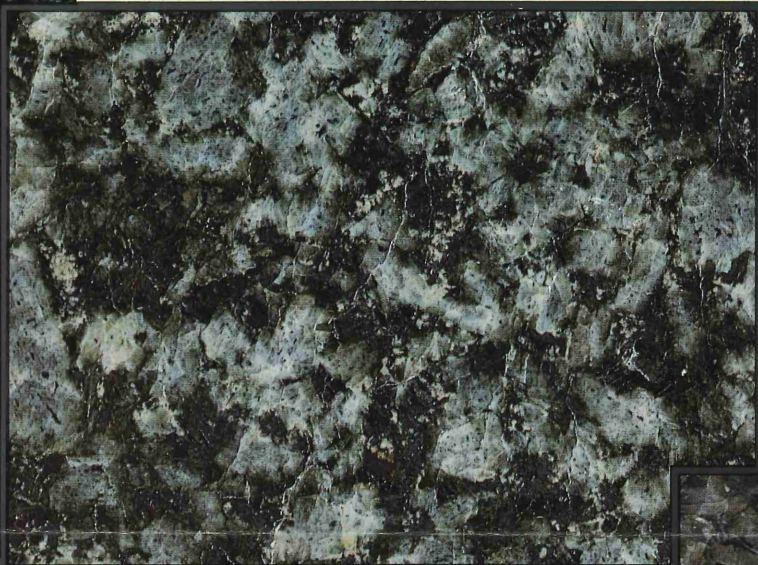


Minnesota Department of Natural Resources
Division of Minerals

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NEW DIMENSIONS IN BUILDING STONE

Unique and beautiful building stone resources are now available for development in northern Minnesota

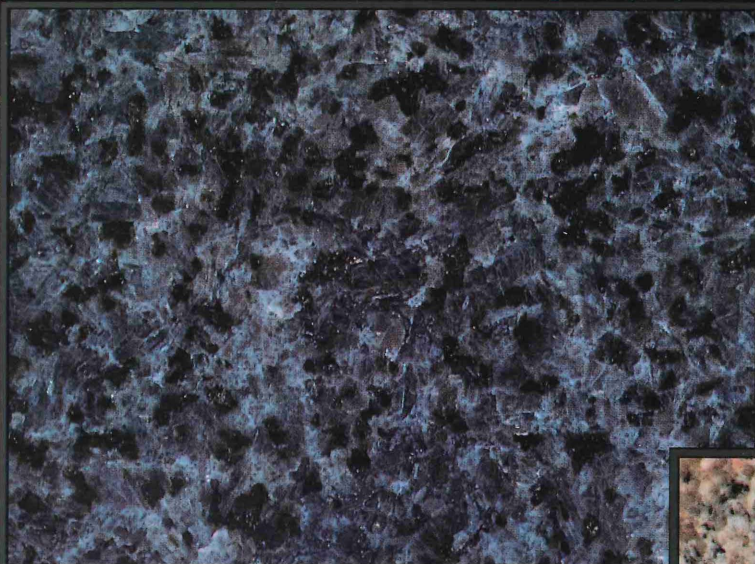


◀ Porphyritic gabbroic anorthosite to gabbro
Lake County Site 80

Pyroxene and olivine-bearing anorthosite ▶
Lake County Site 82



◀ Gabbroic anorthosite
Lake County Site 84

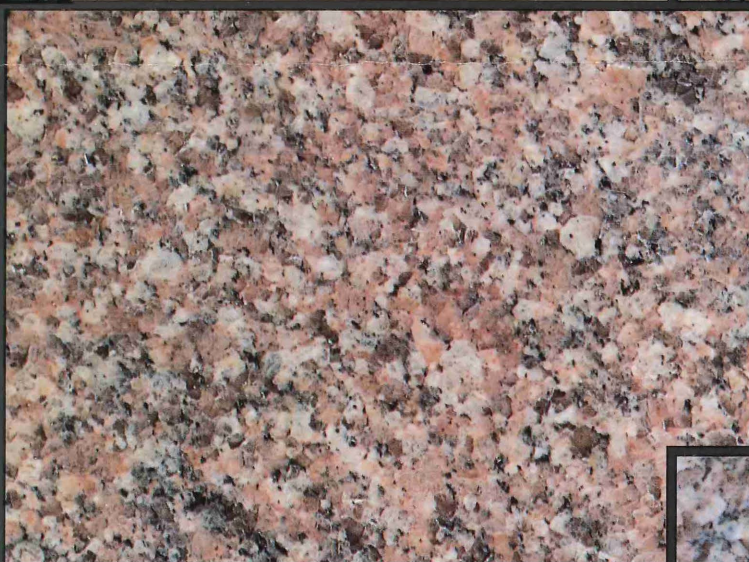


◀ Olivine-bearing anorthositic gabbro
Lake County Site 114

Tonalite to granite gneiss ▶
St. Louis County Site 119



◀ Granite
St. Louis County Site 190



Granite
St. Louis County Site 196
▼



The stones depicted in this insert are from the quarry prospects described in *Report 298, Dimension Stone Inventory of Northern Minnesota, 1993*. Polished samples are available for inspection at the Minnesota Department of Natural Resources, Minerals office in Hibbing (218-262-6767) and the Superior National Forest office in Duluth (218-720-5360).



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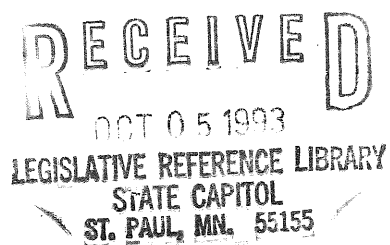
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Dimension Stone Inventory of Northern Minnesota 1993

By Matt Oberhelman
1993

Report No. 298

Minnesota Department of Natural Resources
Division of Minerals
William C. Brice, Director



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Abstract

This report presents the results of the third and fourth years of the Minnesota Department of Natural Resources' (MDNR) dimension stone inventory. The inventory is being conducted on government-owned and administrated lands in six northern Minnesota Counties: Cook, Itasca, Koochiching, Lake, Lake of the Woods, and St. Louis. During this phase of the inventory one hundred and fifty-six Precambrian outcroppings were evaluated for dimension stone potential. Outcrop evaluations were based on surface observations with respect to joint spacing, color, texture, deleterious minerals, and size of extractable blocks.

Field investigations identified seven new prospects that exhibit potential for dimension stone development. These prospects include black, green, beige, pink, and gray "granites" in a variety of textures.

A previous report entitled Dimension Stone Inventory of Northern Minnesota, 1991, report 289; describes the results of the first two years of the inventory, including eight prospect descriptions.

To date, approximately four hundred sites have been evaluated of which fifteen have been identified as prospects. Three quarry prospect sites have been acquired by the Cold Spring Granite Company through a public lease offered by the Superior National Forest. Quarry operating plans have been submitted for two of the sites.

Polished tiles from the prospects can be examined at offices of the Minnesota Department of Natural Resources in St. Paul and Hibbing, and the Superior National Forest office in Duluth. A brochure entitled Minnesota Granite is also available from the mentioned offices. The brochure contains photographs of polished tiles from selected prospects.

During the 1993 field season, the Minerals Division will continue to evaluate outcrops in areas previously not evaluated within the original survey area. Inventory updates can be obtained from the Division's Open File Bulletins.

Introduction

This report presents the results of the third and fourth years of the Minnesota Department of Natural Resources' (MDNR) dimension stone inventory. The field investigations described in this report were conducted during the fall of 1991 and spring through fall of 1992. A previous report entitled *Dimension Stone Inventory of Northern Minnesota 1991*, report 289; describes the results of the first two years of the inventory. The inventory is one of several projects initiated by the Division of Minerals to encourage the diversification and expansion of the state's industrial minerals industry.

The purpose of this inventory is to identify areas of crystalline rock in northern Minnesota that have potential for dimension stone development, thereby encouraging the stone industry to evaluate these sites further. The ultimate goal of the project is to increase the utilization of the state's dimension stone resources and create additional economic opportunities within the state.

The field investigations conducted during the first two years of the inventory have led to strong industry support. Three quarry prospect sites have been acquired by the Cold Spring Granite Company through a public lease offered by the Superior National Forest. Quarry operating plans have been submitted for two of the sites. A number of firms, including both

domestic and multinational, have requested information about the inventory. The MDNR and the Superior National Forest anticipate offering new sites for lease in the near future.

The Industrial Minerals staff conducted investigations of crystalline rocks on government lands in portions of Cook, Itasca, Koochiching, Lake, Lake of the Woods, and St. Louis counties (Fig.1). Field investigations were conducted by one field crew, which consisted of a geologist and a field technician.

Regional Geologic Setting

The study area is underlain by Middle Proterozoic (Keweenaw) rocks (ca. 1100 m.y.) and Archean (>2700 m.y.) rocks of the Wabigoon, Quetico, and Wawa-Shebandowan subprovinces of the Superior Province. Within Minnesota, the Middle Proterozoic rocks consist mainly of lava flows, gabbroic intrusions, sandstones, and other sediments (Ojakangas and Matsch, 1982). Archean rocks of the Superior Province consist mainly of belts of metavolcanic and metasedimentary rocks (greenstone belts) and of enclosing granitic and, locally, gneissic rocks (Sims, 1972).

The inventory of dimension stone resources encompassed the following rock units: (Fig. 2):

Middle Proterozoic (Keweenaw) rocks:

Logan Intrusions, diabase and gabbro in dikes and sills (Morey and others, 1982).

Duluth Complex, which includes anorthositic, troctolitic, gabbroic, granodioritic, and granitic rocks (Phinney, 1972a).

Beaver Bay Complex, composed of rocks ranging from troctolite to granite; ophitic olivine gabbro is the dominant rock type (Green, 1972).

Archean rocks:

Granodiorite gneiss, composed chiefly of medium-grained hornblende biotite granodiorite gneiss (Day and Klein, 1990).

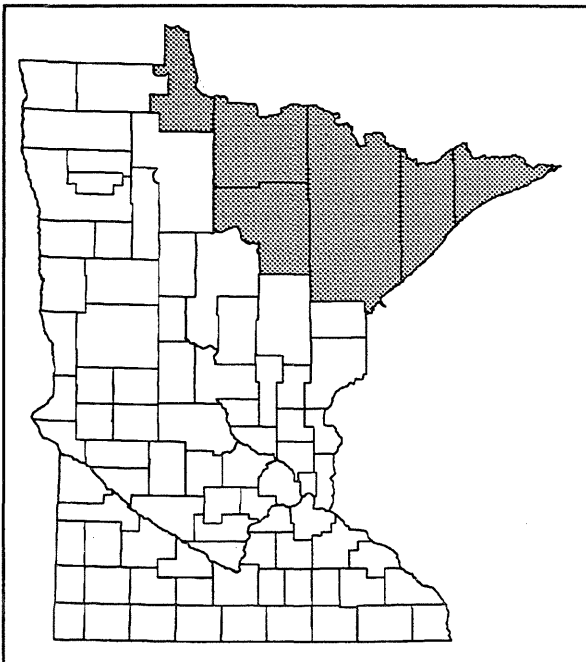


Figure 1. Dimension stone inventory study area.

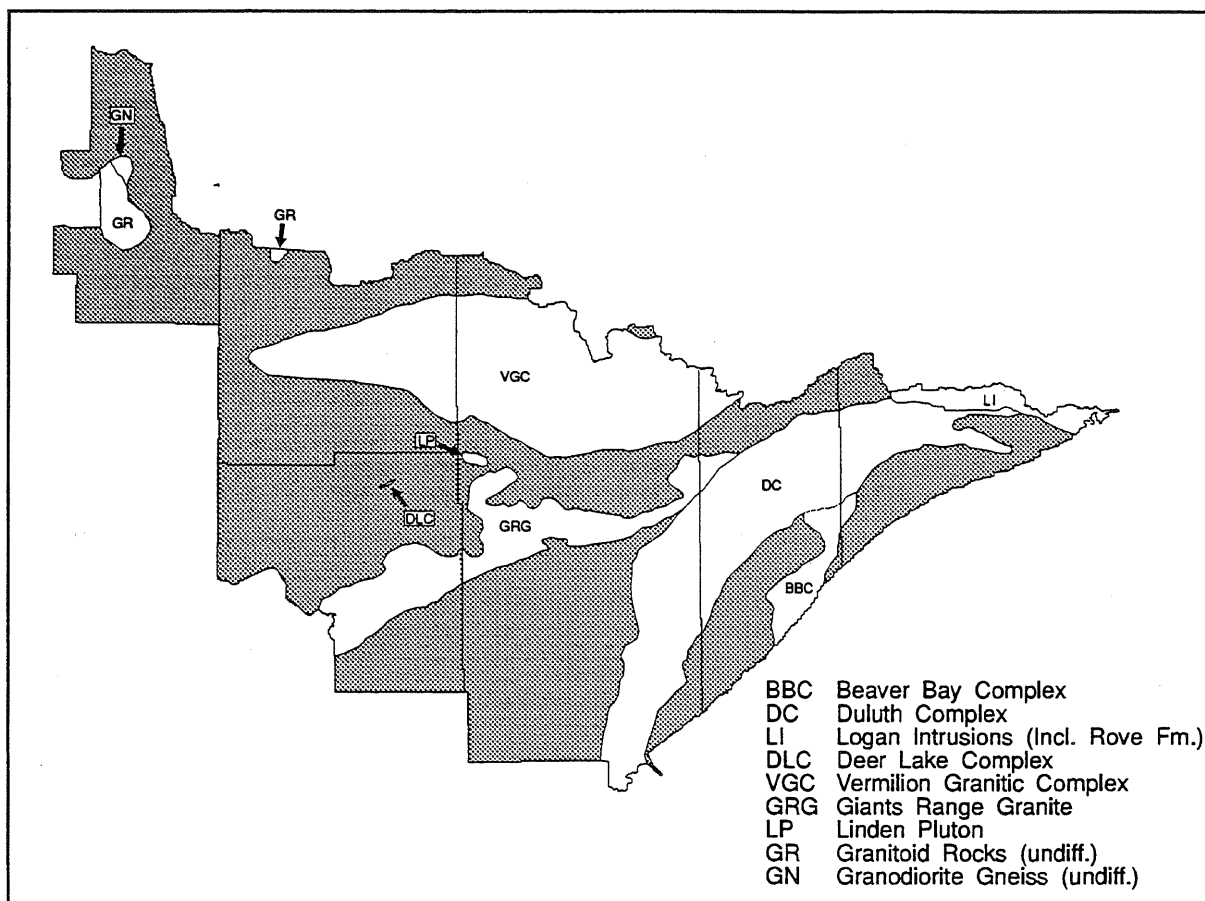


Figure 2. Generalized map of rock units investigated within the study area. Adapted from Morey and others, 1982; Sims and others, 1970; Day and Klein, 1990; and Phinney, 1972a.

Methodology

Granitoid rocks, including moderately to well-foliated tonalite, granodiorite, granite, and minor monzodiorite (Day and Klein, 1990).

Linden Pluton, composed of syenitic rocks displaying a pronounced foliation and lineation (Sims, Sinclair and Mudrey, 1972).

Giants Range Granite, composed chiefly of granitic rocks, ranging in composition from tonalite to granite (Sims and Viswanathan, 1972).

Vermilion Granitic Complex, composed chiefly of granitic rocks, granite-rich migmatites, and schist-rich migmatites (Southwick, 1972).

Deer Lake Complex, composed of peridotite, pyroxenite, diorite, and gabbro (Berkley and Himmelberg, 1978).

In the course of this investigation the various stages of work included site selection, field work, and analysis of field data.

Site Selection

The site selection phase consisted of a review of available geologic maps and pertinent literature — in addition to discussions with geologists familiar with the region — to identify areas that contain outcropping rocks with potential for dimension stone development. The next step consisted of an examination of color aerial photographs (1:15,840 scale) and U.S. Geological Survey 7.5 minute series topographic maps to locate specific outcrops that had not been previously evaluated by the inventory.

Field Work

The inventory focused on the evaluation of outcrops further from roads and in areas previously not evaluated within the original survey area. (see Dimension Stone Inventory of Northern Minnesota 1991, report 289 for results of first two field seasons). Traverses were generally limited to areas within a mile and a half from roads.

The evaluation of outcrops was based primarily on surface observations. *The criteria used to assess quarry potential of specific outcrops are as follows:*

1. A minimum spacing for vertical joints of approximately 6 ft (2 m), and a minimum spacing for horizontal joints (sheeting) of approximately 3 ft (1 m). The spacing and distribution of joints controls the size of blocks that can be quarried.
2. A sufficient volume of stone to allow quarrying for a minimum of twenty years. The deposit size should be a minimum of 500 x 500 ft (150 x 150 m), although some companies may require a larger deposit with a depth of at least 100 feet of homogeneous rock. The determination of the actual volume of specific deposits is outside the scope of this inventory. The uniformity of rock at depth can only be determined by drilling, which was not a component of this survey. It was often difficult to estimate the actual areal extent of a rock type because of the presence of glacial overburden.
3. The color and texture (size, shape, and arrangement of crystals) of the stone should be relatively consistent and the deposit should have an absence of dikes, veins, and inclusions, which are usually considered to be imperfections because they tend to interrupt the continuity of the stone.
4. An absence of deleterious minerals. These minerals tend to weather easily and are usually considered undesirable in a building stone. For example, some sulfide minerals, such as pyrite, may cause rust staining upon weathering.
5. The deposit should be accessible and located in an area without land-use constraints. The Boundary Waters Canoe Area Wilderness and federal and state parks were excluded from evaluation.

Analysis of Field Data

After the field work was completed, the outcrops were classified into the following two groups: (1) **Prospects** (areas of potential) and (2) **Occurrences** (sites of little or no potential).

Additional steps were completed to assess the outcrops thought to have potential for development. They included the preparation of polished tiles and petrographic analysis (mineralogy and geologic rock names).

Representative samples from each prospect have been collected to evaluate color, texture, and polishing characteristics. Rock samples were extracted from outcrops using a 6 inch diameter portable core drill. They were then cut into tiles and polished. The tiles are available for inspection at the MDNR Minerals offices in Hibbing and St. Paul, and the Superior National Forest office in Duluth.

Petrographic analysis (mineralogy and geologic rock names) was determined by thin section study at the MDNR office in Hibbing. Geologic rock names were assigned using Phinney's (1972) classification for the mafic rocks and Streckeisen's (1973) rock classification for the granitic rocks, illustrated in figures 3 and 4, respectively. One should note that the stone industries use of the term "granite" is much broader than that used by petrologists. The commercial stone term "granite" includes most crystalline igneous rocks and some metamorphic rocks, whereas the petrologist's definition of granite is very specific (see Fig. 4).

A complete evaluation of the prospects requires further analysis to determine if the rock is of suitable quality and quantity for quarrying. Further investigative methods may include: the extraction of large test blocks, which are used to test physical properties and to evaluate the consistency of color and texture in large finished pieces; and the removal of overburden adjacent to outcrops and drilling to gain a better understanding of the rocks continuity and jointing characteristics both laterally and at depth. It is intended that this next phase of assessment be carried out by the stone industry.

Results

During this phase of the inventory 156 new sites were evaluated within the survey area. From this initial evaluation, seven new prospects were identified. These sites have potential for the extraction of moderate to large quarry blocks (5ft x 5ft x 8ft [1.5m x 1.5m x 2.5m] minimum). The size of quarry blocks was estimated from the joint intensity and joint patterns observed on the outcrop surface. Horizontal jointing (sheeting) is often not evident from outcrop exposures; drilling would aid in understanding the horizontal jointing characteristics. The actual size of quarry blocks cannot be definitely determined until stone has been removed.

The 149 sites classified as occurrences have little or no potential for dimension stone development based on the criteria established for this inventory. The outcrops at these sites have one or more unfavorable characteristic, such as closely spaced joints, nonuniform color or texture, or an abundance of veins, dikes, or inclusions. In these cases, the site description is limited to the location, a brief geologic description, and comments on the reason for the marginal rating.

Summary of Prospect Sites

The following sites, consisting of rock of a variety of color and texture, exhibit potential for dimension stone development (see Fig. 5).

Site No.: Lake - 80. This stone displays a unique greenish-gray hue and porphyritic texture. The joint spacings appear adequate for the removal of large quarry blocks. This stone is very similar to prospect Lake - 53 described in report 289.

Site No.: Lake - 82. This black granite, although only observed in small exposures, displays joint spacings of up to 30 ft (9 m).

Site No.: Lake - 84. Exposures of this black granite commonly display joint spacings of up to 30 ft (9 m).

Site No.: Lake - 114. Exposures of this black granite commonly display joint spacings greater than 10 ft (3 m).

Site No.: St. Louis - 119. Undulating pink, beige, and gray gneissic bands give this rock a pleasing appearance. Joint spacings in excess of 15 ft (4.5 m) are common.

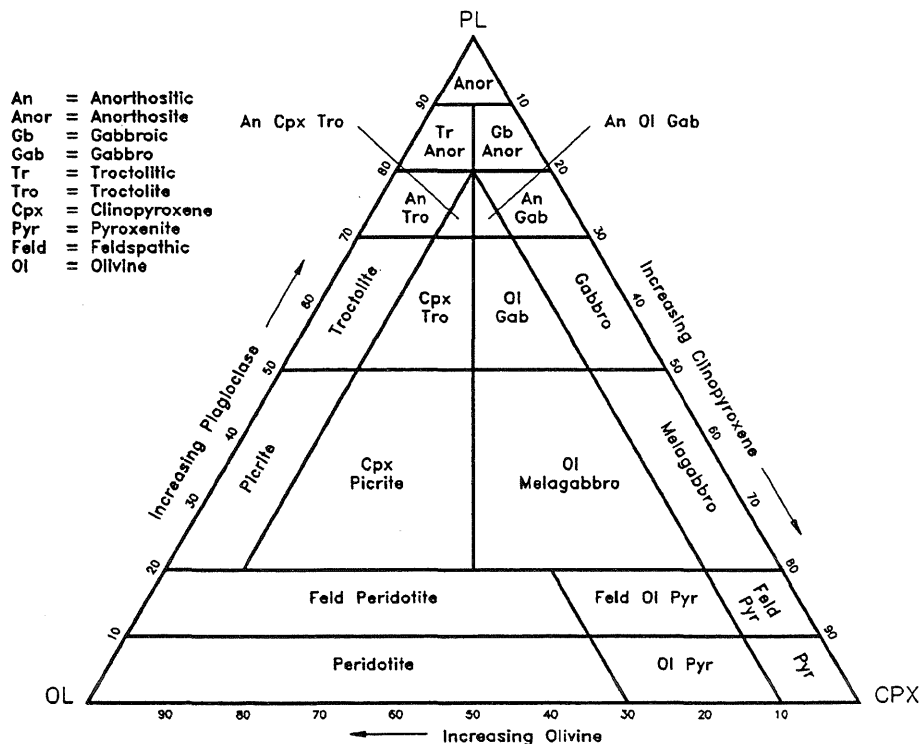


Figure 3. Classification for mafic rocks (from Phinney, 1972). $PL + OL + CPX = 100$

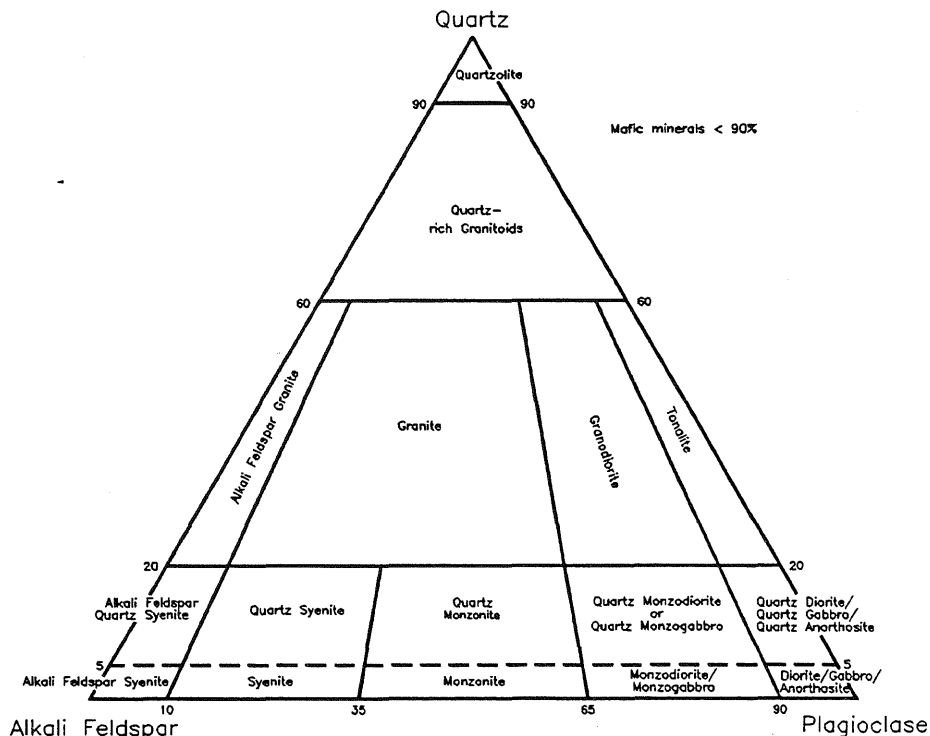


Figure 4. Classification for granitic rocks (from Streckeisen, 1973). Qtz + Ksp + Plag = 100.

Site No.: St. Louis - 190. This grayish-pink granite displays wide joint spacings, commonly up to 30 ft (9 m). This site has the potential for very large quarry blocks.

Site No.: St. Louis - 196. This grayish-pink granite displays wide joint spacings, commonly up to 30 ft (9 m).

Detailed descriptions of these sites are presented in the following section. The format and explanations of the data are listed below.

Classification: Prospect (area of potential)

Site No:

Commodity:

Geologic Rock Name:

Location Information: includes County, Township (T), range (R), section (Sec) and section locators, UTM coordinates, and USGS quadrangle map name

Access:

Color of Fresh and Weathered Surfaces: the determination of color is strongly affected by the perception of the person viewing the stone

Texture: shape and arrangement of crystals

Grain Size:

fine-grained = less than 1 mm

medium-grained = 1-5 mm

coarse-grained = more than 5 mm

Joint Pattern: regular pattern (recurring joints of relatively uniform strike and dip), irregular pattern (randomly oriented joints, often discontinuous or curved). The strike and dip of dominant joint sets were recorded when possible.

Joint Intensity:

intense: average spacing < 1.5 ft (0.5 m)

moderate: average spacing 1.5 - 6 ft (0.5 - 2 m)

limited: average spacing > 6 ft (2 m)

Geological Setting: geological rock unit

Geology: geologic description of site

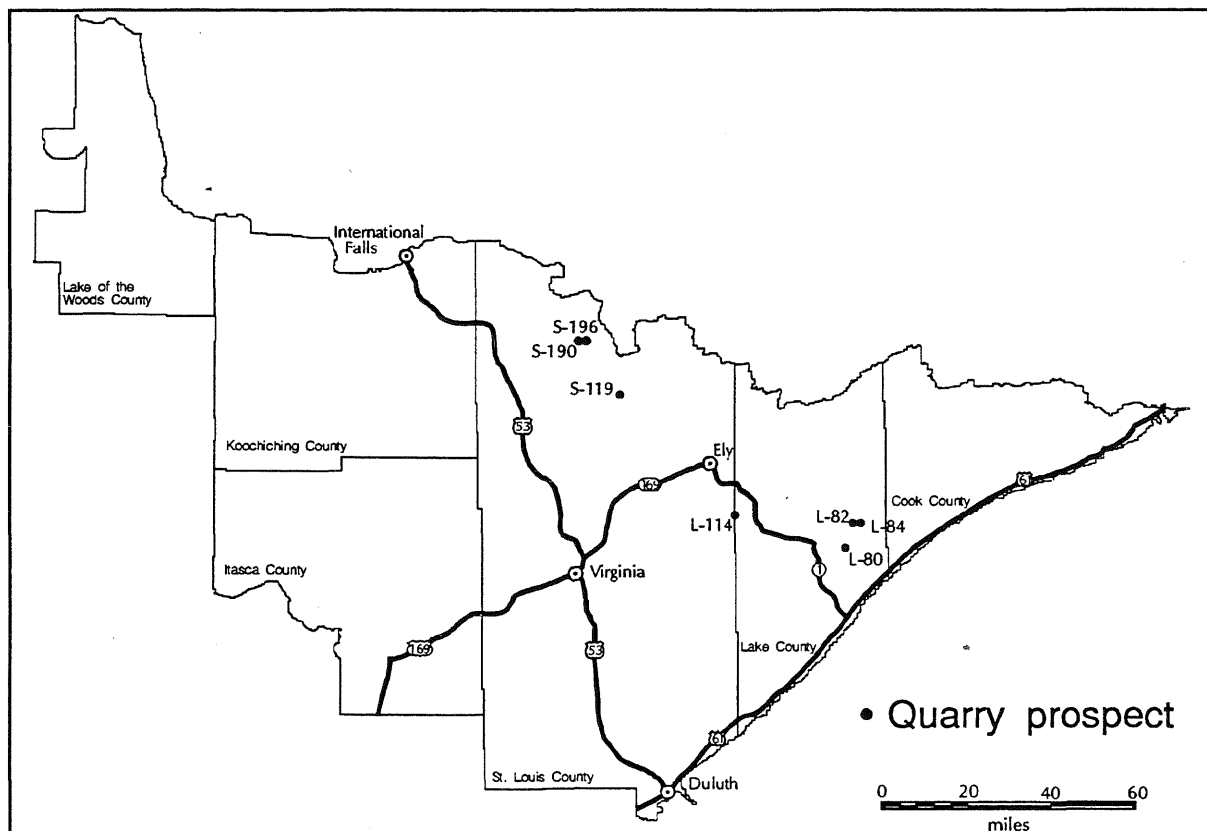


Figure 5. Location of new quarry prospects within study area.

Mineralogy: determined by division petrologist from thin section study

Polished Tile No.:

Location Map:

Other Features: features such as veins, inclusions, dikes, pegmatitic masses, etc.

Deleterious Minerals: for example sulfides, such as pyrite, may rust upon weathering

Outcrop Exposure:

Quarry Block Potential:

Surface and Mineral Ownership:

Photo: photo of outcrop taken

Use of explosives: previous blasting may affect joint and fracture densities

Sample No.:

Thin Section No.:

Quarry Prospect Descriptions (areas of potential)

Site No.: Lake - 80

Commodity: Green granite

Geological Rock Name: Porphyritic gabbroic
anorthosite to gabbro

County: Lake

TRS: T 59 N R 7 W Sec 3 gov. lots 3 and 4

T 59 N R 7 W Sec 4 gov. lots 1, 2, 3, and 4

UTM: 633,200 m E, 5,276,600 m N, Zone 15

USGS Quadrangle Map: Silver Island Lake

Access: This site can be reached by Forest Road 172 (Wanless Road).

Color: Fresh Surface - Greenish gray

Weathered Surface - Whitish gray

Texture: Porphyritic, subhedral

Grain Size: Medium to very coarse

Joint Pattern: Regular and irregular

Joint Intensity: Variable; joint spacings range from 0.3 to 30 ft (0.1 to 9 m), sheeting spacings are observed up to 8 ft (2.4 m).

Geological Setting: This area is underlain by Middle Proterozoic mafic intrusive rocks of the Duluth Complex.

Geology: This rock is a greenish gray, medium- to coarse-grained porphyritic gabbroic anorthosite to gabbro. Light greenish gray, coarse- to very coarse-grained plagioclase crystals (phenocrysts) are distributed in a dark green ground mass. The color and porphyritic texture that make this rock unique appear to be consistent throughout most of the exposures, although some textural variations are observed. Regular and irregular joint patterns are present. The dominant joint sets trend at approximately 140°. Joint spacings are variable ranging from 0.3 to 30 ft (0.1 to 9 m); joint spacings are commonly in excess of 10 ft (3 m). Healed fractures (black lines) were noted in some areas of the outcrop.

Mineralogy: Thin section study indicates a composition of approximately 67% plagioclase, the plagioclase crystals appear fractured and exhibit sericite alteration, 14% orthopyroxene, 10% clinopyroxene, pyroxenes are partly replaced by serpentine, 4% granophyric intergrowths (quartz and K-feldspar), 3% opaques, 2% quartz, and accessory sulfide.

Other Features: 1 ft (0.3 m) basaltic dike observed; outcrops of diorite and hornfels basalt are locally observed in the surrounding area.

Deleterious Materials: Trace amount of sulfides

Outcrop Exposure: Fair to good; intermittently exposed ledges and knobs

Quarry Block Potential: Poor to good

Surface Ownership: USA

Mineral Ownership: State of MN

Photo: Yes

Use of Explosives: No

Sample No.: 2980000001

Thin Section No.: 2980000001

Polished Tile No.: L-80

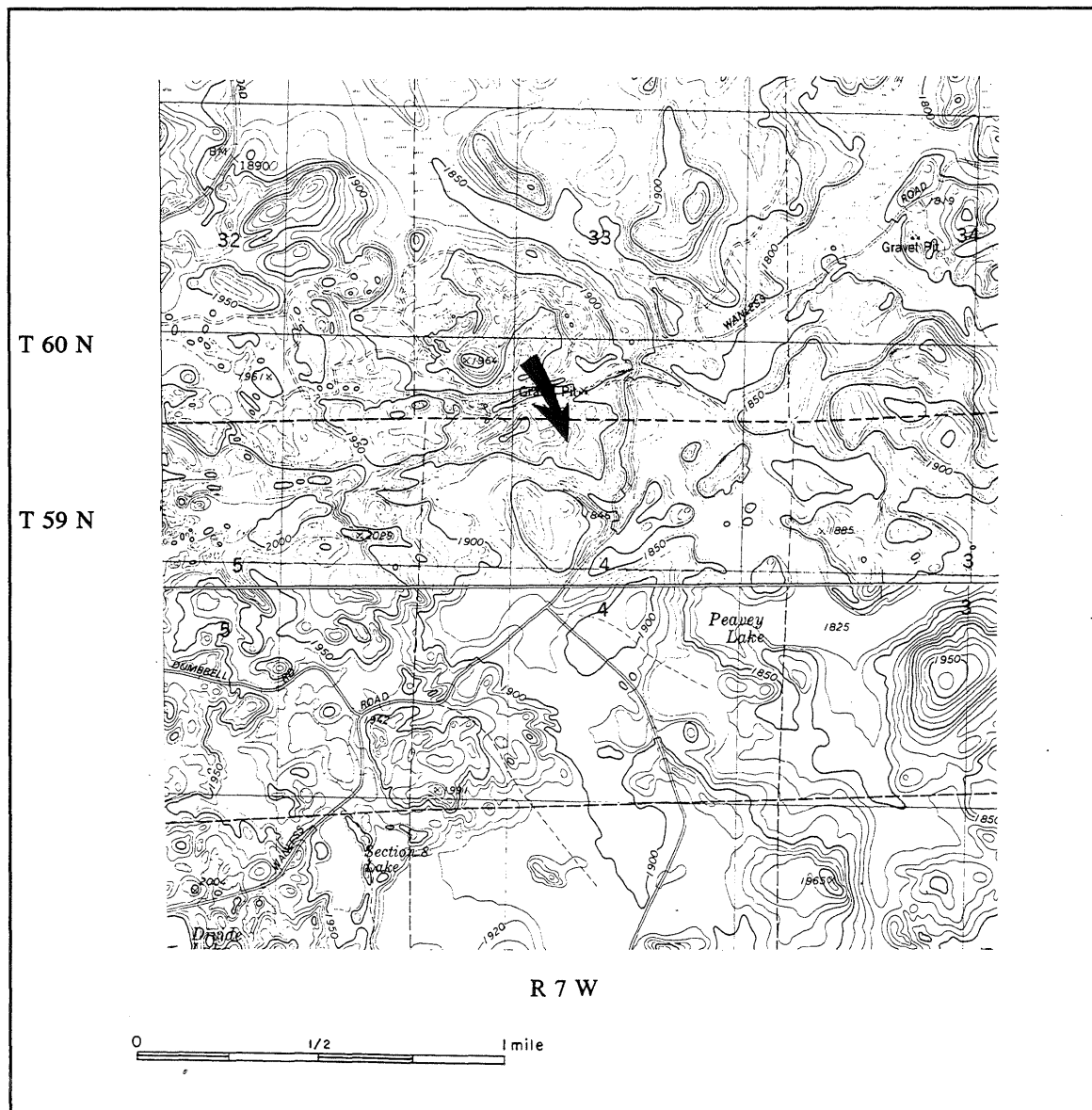


Figure 6. Site Number: Lake - 80. Base map from U.S. Geological Survey Silver Island Lake 7.5 minute quadrangle.

Site No.: Lake - 82

Commodity: Black granite

Geological Rock Name: Pyroxene and olivine-bearing anorthosite

County: Lake

TRS: T 60 N R 7 W Sec 11 NW1/4, N1/2 SW1/4, and W1/2 NE1/4

UTM: 636,440 m E, 5,284,300 m N, Zone 15

USGS Quadrangle Map: Silver Island Lake

Access: This site can be reached by a primitive logging road leading southeast from Forest Road 175 (Silver Island Road).

Color: Fresh Surface - Gray
Weathered Surface - Gray

Texture: Weakly laminated; subhedral

Grain Size: Medium and coarse

Joint Pattern: Regular

Joint Intensity: Limited; few joints observed in intermittently exposed outcrops

Geological Setting: This area is underlain by Middle Proterozoic mafic intrusive rocks of the Duluth Complex.

Geology: This gray rock varies from a medium-grained anorthosite to a coarse-grained pyroxene and olivine-bearing anorthosite. A weak lamination results from the preferred orientation of plagioclase laths. The jointing that is exposed is widely spaced, joint spacings of up to 30 ft (9 m) are present. The dominant joint sets trend at approximately 30° and 120°. The limited exposure prevents a complete analysis of joint patterns and the extent of rock types. Surface weathering was observed in samples collected to a depth of 1 ft (0.3 m), the depth of surface weathering is undetermined.

Mineralogy: Thin section study indicates a composition of approximately 95 % plagioclase, 3 % clinopyroxene, 2 % olivine, and accessory biotite and apatite.

Other Features:

Deleterious Materials: None observed

Outcrop Exposure: Poor; intermittently exposed outcrops along a primitive logging road and in a clear cut area

Quarry Block Potential: Good

Surface Ownership: T 60 N R 7 W Sec 11 N1/2 NW1/4: State of MN
T 60 N R 7 W Sec 11 NW1/4 SW1/4: State of MN
T 60 N R 7 W Sec 11 S1/2 NW1/4: USA
T 60 N R 7 W Sec 11 W1/2 NE1/4: USA
T 60 N R 7 W Sec 11 NE1/4 SW1/4: USA

Mineral Ownership: T 60 N R 7 W Sec 11 N1/2 NW1/4: State of MN
T 60 N R 7 W Sec 11 NW1/4 SW1/4: State of MN
T 60 N R 7 W Sec 11 S1/2 NW1/4: USA
T 60 N R 7 W Sec 11 W1/2 NE1/4: USA
T 60 N R 7 W Sec 11 NE1/4 SW1/4: USA

Photo: Yes

Use of Explosives: No

Sample No.: 2980000002

Thin Section No.: 980000002

Polished Tile No.: L-82

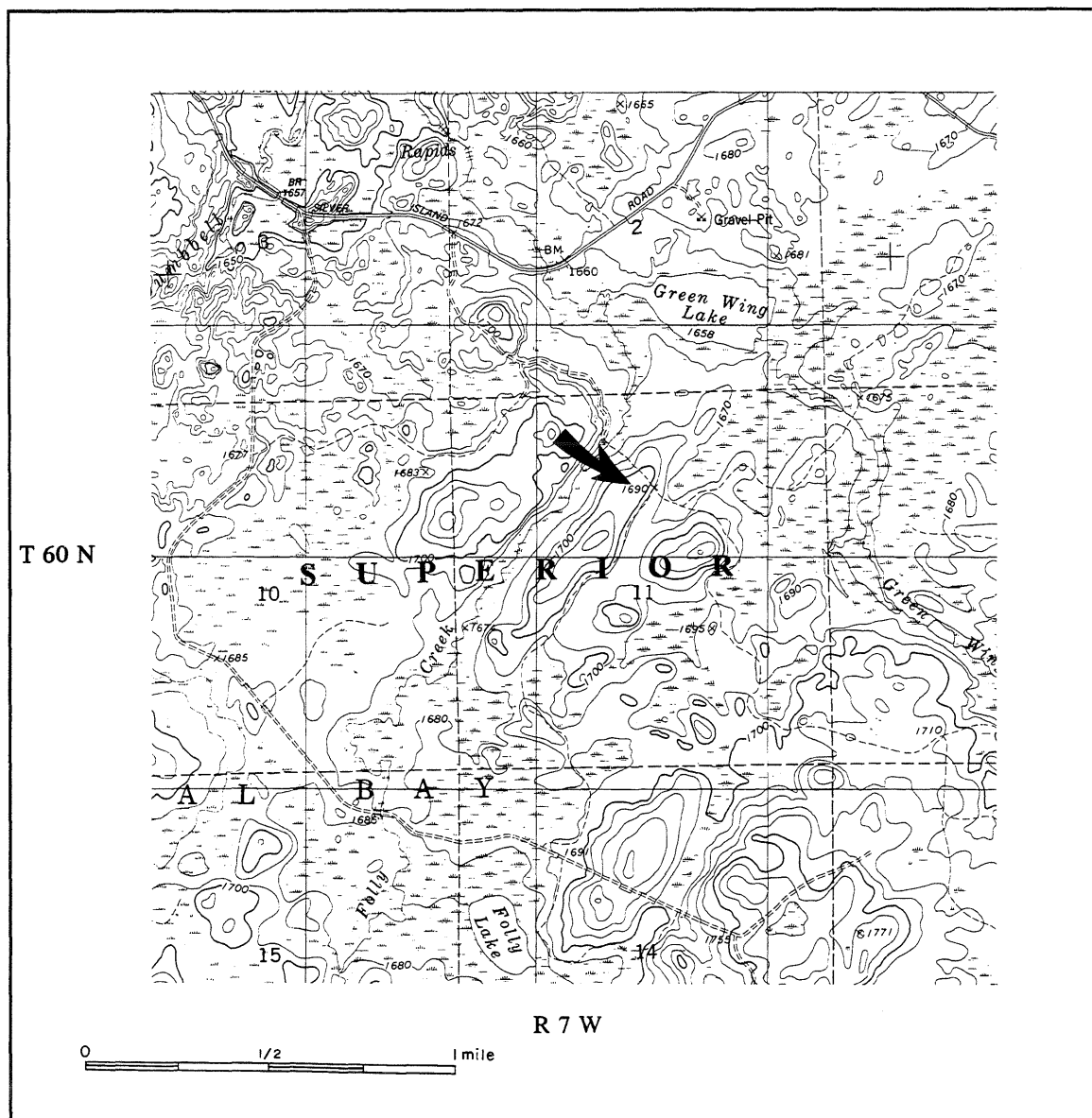


Figure 7. Site Number: Lake - 82. Base map from U.S. Geological Survey Silver Island Lake 7.5 minute quadrangle.

Site No.: Lake - 84

Commodity: Black granite

Geological Rock Name: Gabbroic anorthosite

County: Lake

TRS: T 60 N R 7 W Sec 11 E1/2 SE1/4

T 60 N R 7 W Sec 12 SW1/4 (west of Green Wing Creek)

UTM: 637,200 m E, 5,283,325 m N, Zone 15

USGS Quadrangle Map: Silver Island Lake

Access: This site can be reached by a primitive logging road leading southeast from Forest Road 175 (Silver Island Road).

Color: Fresh Surface - Gray, uniform
Weathered Surface - Light gray

Texture: Laminated; subhedral

Grain Size: Coarse; slightly variable

Joint Pattern: Regular

Joint Intensity: Limited; joint spacings of up to 30 ft are common

Geological Setting: This area is underlain by Middle Proterozoic mafic intrusive rocks of the Duluth Complex.

Geology: This rock is a gabbroic anorthosite of uniform gray color. It is coarse-grained and exhibits a moderate lamination resulting from the preferred orientation of plagioclase laths. The joint pattern is regular. The dominant joint sets trend at approximately 70° and 140°. Large areas of the outcrop exhibit widely spaced joints, joint spacings of up to 30 ft (9 m) are common. Sheeting is present, but difficult to assess due to the low lying nature of the outcrops. Surface weathering was observed in samples collected to a depth of 1 ft (0.3 m), the depth of surface weathering is undetermined.

Mineralogy: Thin section study indicates a composition of approximately 84-88% plagioclase, 11-15% clinopyroxene, 1% opaques, and accessory biotite, apatite, and secondary amphibole.

Other Features:

Deleterious Materials: None observed

Outcrop Exposure: Fair; intermittently exposed low lying outcrops

Quarry Block Potential: Good

Surface Ownership: USA

Mineral Ownership: USA

Photo: Yes

Use of Explosives: No

Sample No.: 2980000003, 2980000004

Thin Section No.: 2980000003, 2980000004

Polished Tile No.: L-84a, L-84b

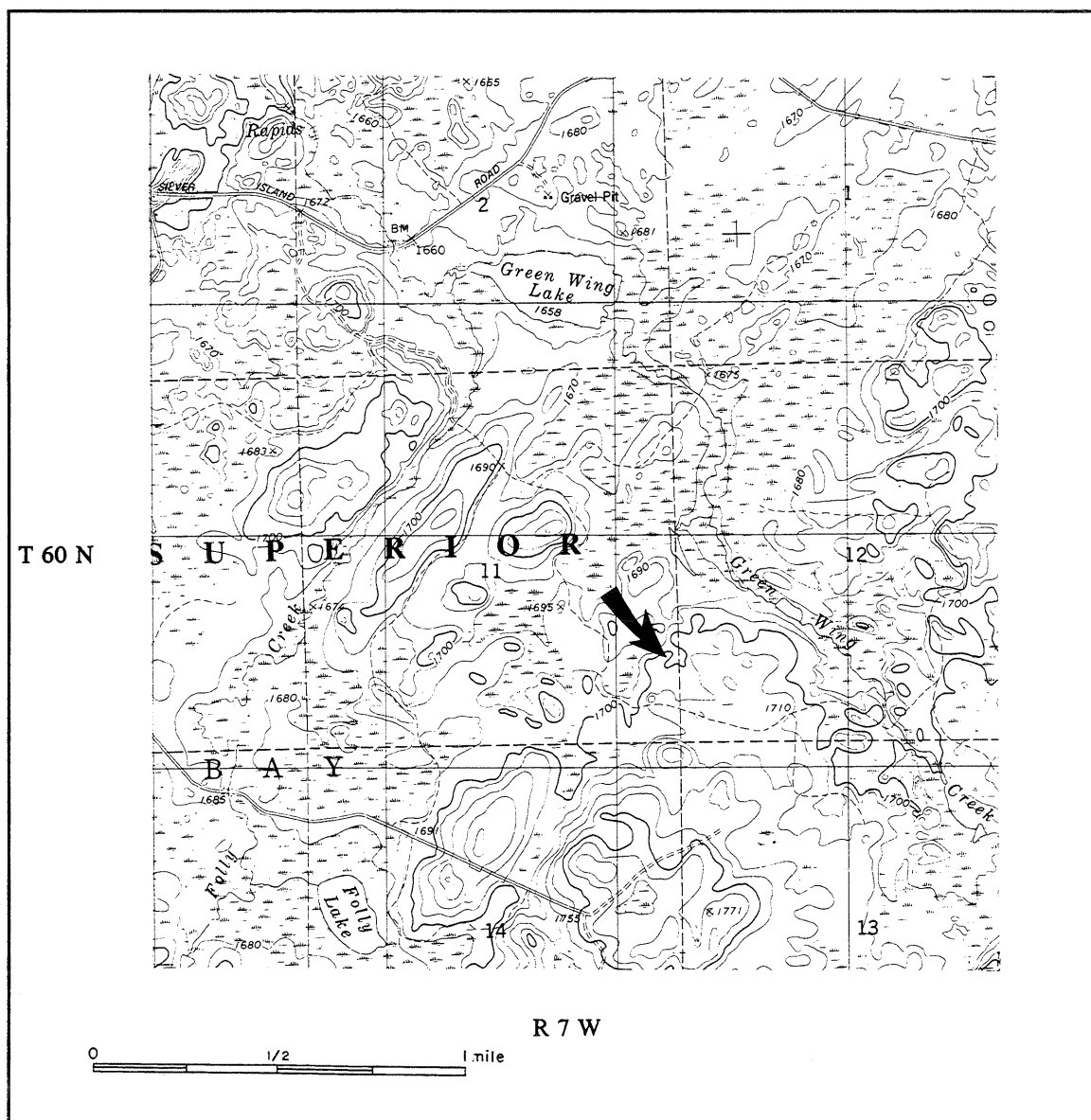


Figure 8. Site Number: Lake - 84. Base map from U.S. Geological Survey Silver Island Lake 7.5 minute quadrangle.

Site No.: Lake - 114

Commodity: Black granite

Geological Rock Name: Olivine-bearing anorthositic gabbro

County: Lake

TRS: T 60 N R 11 W Sec 6 gov. lots 11-14

UTM: 591,550 m E, 5,285,030 m N, Zone 15

USGS Quadrangle Map: Babbitt NE

Access: This site can be reached by a trail leading east from Forest Road 178.

Color: Fresh Surface - Dark gray, uniform
Weathered Surface - Light gray

Texture: Weakly laminated; subhedral; ophitic

Grain Size: Medium to coarse, uniform

Joint Pattern: Regular

Joint Intensity: Moderate to limited; joint spacings range from 1 to 20 ft (0.3 to 6 m); joint spacings of 10 ft (3 m) are common; ledges exhibit sheeting spacings of up to 6 ft (2 m).

Geological Setting: This area is underlain by Middle Proterozoic mafic intrusive rocks of the Duluth Complex.

Geology: This rock is an olivine-bearing anorthositic gabbro of uniform dark gray color. It is medium- to coarse-grained and displays a weak lamination resulting from the preferred orientation of plagioclase laths. Pyroxene and magnetite oikocrysts (crystals of pyroxene or magnetite enclosing smaller crystals of plagioclase) are seen throughout most of the exposures. Regular joint patterns are present. The dominant joint sets trend at approximately 120° with secondary joint sets trending at 40° and 60°. Joint spacings range from 1 to 20 ft (0.3 to 6 m); spacings of 10 ft (3 m) are common. Ledges exhibit sheeting spacings of up to 6 ft (2 m).

Mineralogy: Thin section study indicates a composition of approximately 72% plagioclase, 18% clinopyroxene, 8% olivine (occurs as inclusions in clinopyroxene and rimmed by clinopyroxene), 1% orthopyroxene, 1% opaque, and accessory biotite and apatite.

Other Features:

Deleterious Materials: Trace amount of sulfides

Outcrop Exposure: Poor to fair; intermittently exposed outcrops along an elongate ridge

Quarry Block Potential: Good

Surface Ownership: USA

Mineral Ownership: T 60 N R 11 W Sec 6 gov. lots 12 and 13: USA
T 60 N R 11 W Sec 6 gov. lots 11 and 14: State of MN

Photo: Yes

Use of Explosives: No

Sample No.: 2980000005

Thin Section No.: 2980000005

Polished Tile No.: L-114

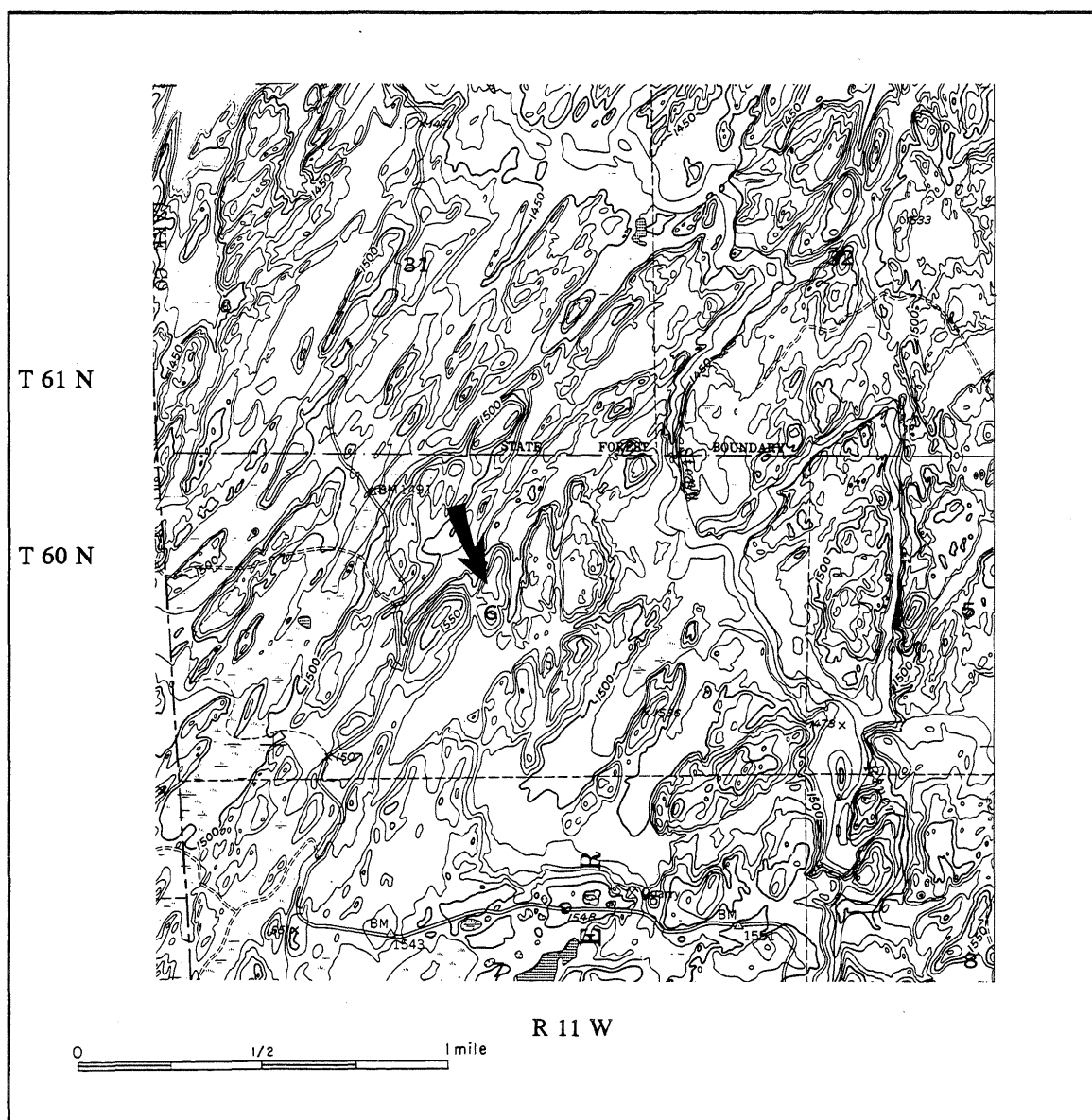


Figure 9. Site Number: Lake - 114. Base map from U.S. Geological Survey Babbitt NE 7.5 minute quadrangle.

Site No.: St. Louis - 119

Commodity: Variegated granite

Geological Rock Name: Tonalite to granite gneiss

County: St. Louis

TRS: T 65 N R 16 W Sec 36 gov. lots 1, 2, 4, 7, and NW1/4 NE1/4

UTM: 549,540 m E, 5,324,130 m N, Zone 15

USGS Quadrangle Map: Astrid Lake

Access: This site can be reached by a primitive road leading east from Forest Road 200.

Color: Fresh Surface - Light pink to beige and gray; variable
Weathered Surface - White to light pink

Texture: Gneissic, undulating bands; anhedral

Grain Size: Medium to very coarse, non-uniform

Joint Pattern: Regular

Joint Intensity: Limited; joint spacings in excess of 15 ft (4.5 m) are common, ledges exhibit sheeting spacings of up to 5 ft (1.5 m).

Geological Setting: This area is underlain by Archean rocks of the Vermilion Granitic Complex.

Geology: This rock is a light pink to beige and gray, medium- to very coarse-grained tonalite to granite gneiss. Undulating gneissic bands trending at approximately 240° are observed throughout most of the exposures. These bands are distinguished by varying color, grain size and mineral content. Pegmatitic phases are somewhat common. Regular joint patterns are present. The dominant joint sets trend at approximately 0° and 90°, secondary joint sets trend at approximately 45°. Large areas of outcrop exhibit widely spaced joints; joint spacings in excess of 15 ft (4.5 m) are common. Sheeting spacings are observed from 0.5 to 5 ft (0.15 to 1.5 m) at the surface.

Mineralogy: Thin section study indicates a composition of approximately 51-56% plagioclase, 13-27% quartz, 14-30% microcline, 3-6% biotite and chlorite, and accessory muscovite, epidote, apatite, and opaques.

Other Features: Small elongate quartz lenses trending at 160° are locally observed.

Deleterious Materials: None observed

Outcrop Exposure: Fair; large knobs and low lying outcrops

Quarry Block Potential: Good

Surface Ownership: State of MN

Mineral Ownership: State of MN

Photo: Yes

Use of Explosives: No

Sample No.: 2980000006, 2980000007

Thin Section No.: 2980000006, 2980000007

Polished Tile No.: S-119a, S-119b

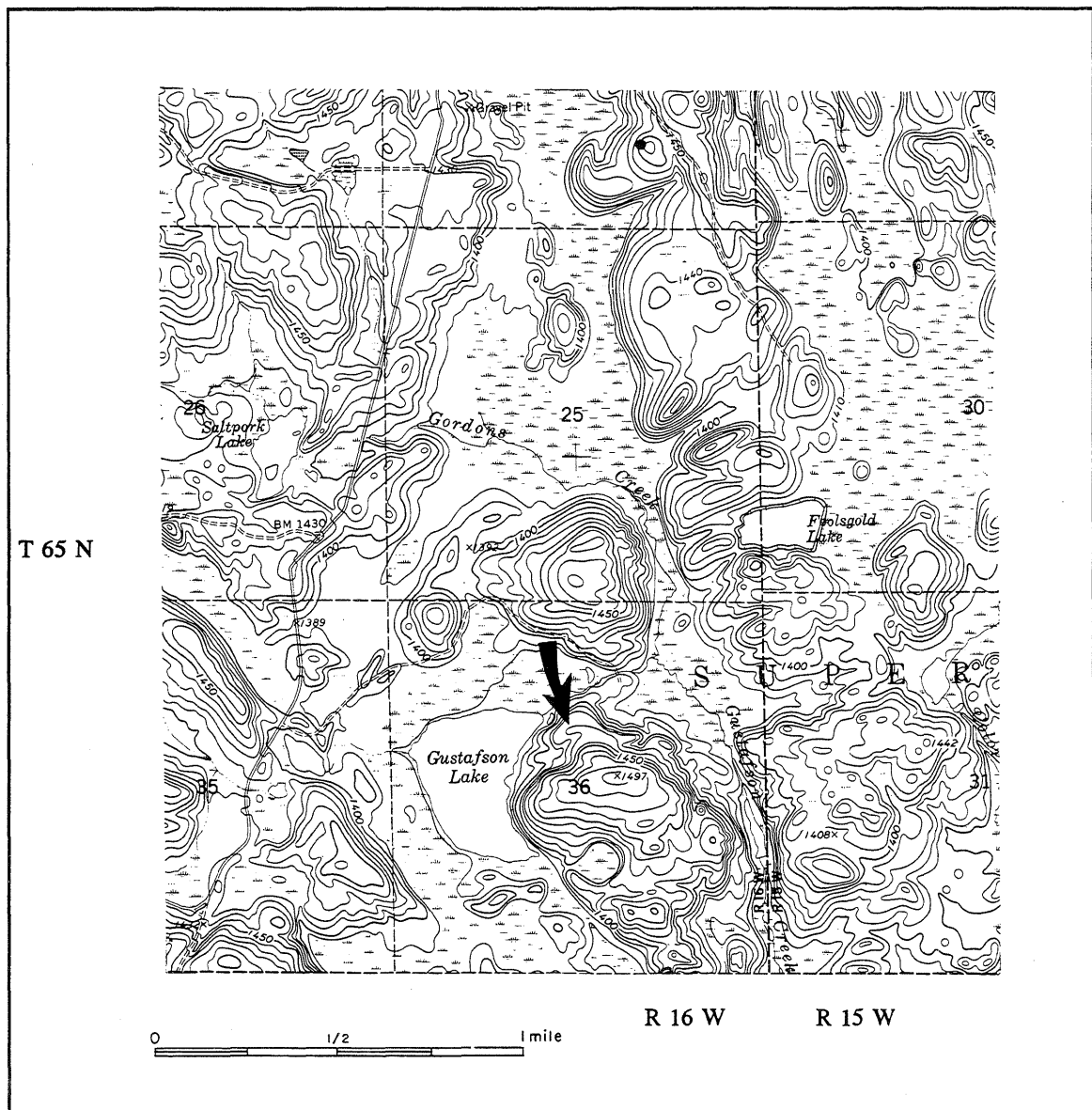


Figure 10. Site Number: St. Louis - 119. Base map from U.S. Geological Survey Astrid Lake 7.5 minute quadrangle.

Site No.: St. Louis - 190

Commodity: Grayish-pink granite

Geological Rock Name: Granite

County: St. Louis

TRS: T 67 N R 17 W Sec 27 W1/2 NW1/4

T 67 N R 17 W Sec 28 E1/2 NE1/4

UTM: 535,560 m E, 5,345,310 m N, Zone 15

USGS Quadrangle Map: Johnson Lake

Access: This site can be reached by a logging road leading northeast from Forest Road 207.

Color: Fresh Surface - Grayish pink, uniform

Weathered Surface - White to pinkish gray

Texture: Slightly porphyritic; anhedral to euhedral

Grain Size: Medium to coarse, uniform

Joint Pattern: Regular

Joint Intensity: Limited; joint spacings range from 5 to 40 ft (1.5 to 12 m); 30 ft (9 m) spacings are common.
Ledges exhibit sheeting spacings of up to 6 ft (2 m)

Geological Setting: This area is underlain by Archean rocks of the Vermilion Granitic Complex.

Geology: This rock is a granite of uniform grayish pink color. It is predominantly medium-grained but is slightly porphyritic, containing some coarse-grained feldspar crystals (phenocrysts) averaging 0.5 in. (1 cm) in length. The texture is consistent throughout most of the exposures. Regular joint patterns are present. The dominant joint sets trend at approximately 65° and 140°. Large areas of the outcrop exhibit widely spaced joints, joints spacings of up to 30 ft (9 m) are common. Some ledges exhibit sheeting spacings of up to 6 ft (2 m). Minor pegmatitic dikes and rare elongate quartz lenses were noted, but most of the rock appears to be pegmatite and quartz lense free.

Mineralogy: Thin section study indicates a composition of approximately 43% microcline, 30% plagioclase, 22% quartz, 5% biotite, and accessory opaques.

Other Features: Local pegmatitic dikes trending approximately 0° and rare elongate quartz lenses averaging 0.5 x 12 in. (1 x 30.5 cm) were noted; however, most of the rock appears to be pegmatite and quartz lense free.

Deleterious Materials: None observed

Outcrop Exposure: Good; large bald knobs and low lying outcrops

Quarry Block Potential: Very good

Surface Ownership: T 67 N R 17 W Sec 27 W1/2 NW1/4: USA

T 67 N R 17 W Sec 28 E1/2 NE1/4: USA

Mineral Ownership: T 67 N R 17 W Sec 27 NW1/4 NW1/4: State of MN

T 67 N R 17 W Sec 27 SW1/4 NW1/4: USA

T 67 N R 17 W Sec 28 E1/2 NE1/4: USA

Photo: Yes

Use of Explosives: No

Sample No.: 2980000008

Thin Section No.: 2980000008

Polished Tile No.: S-190

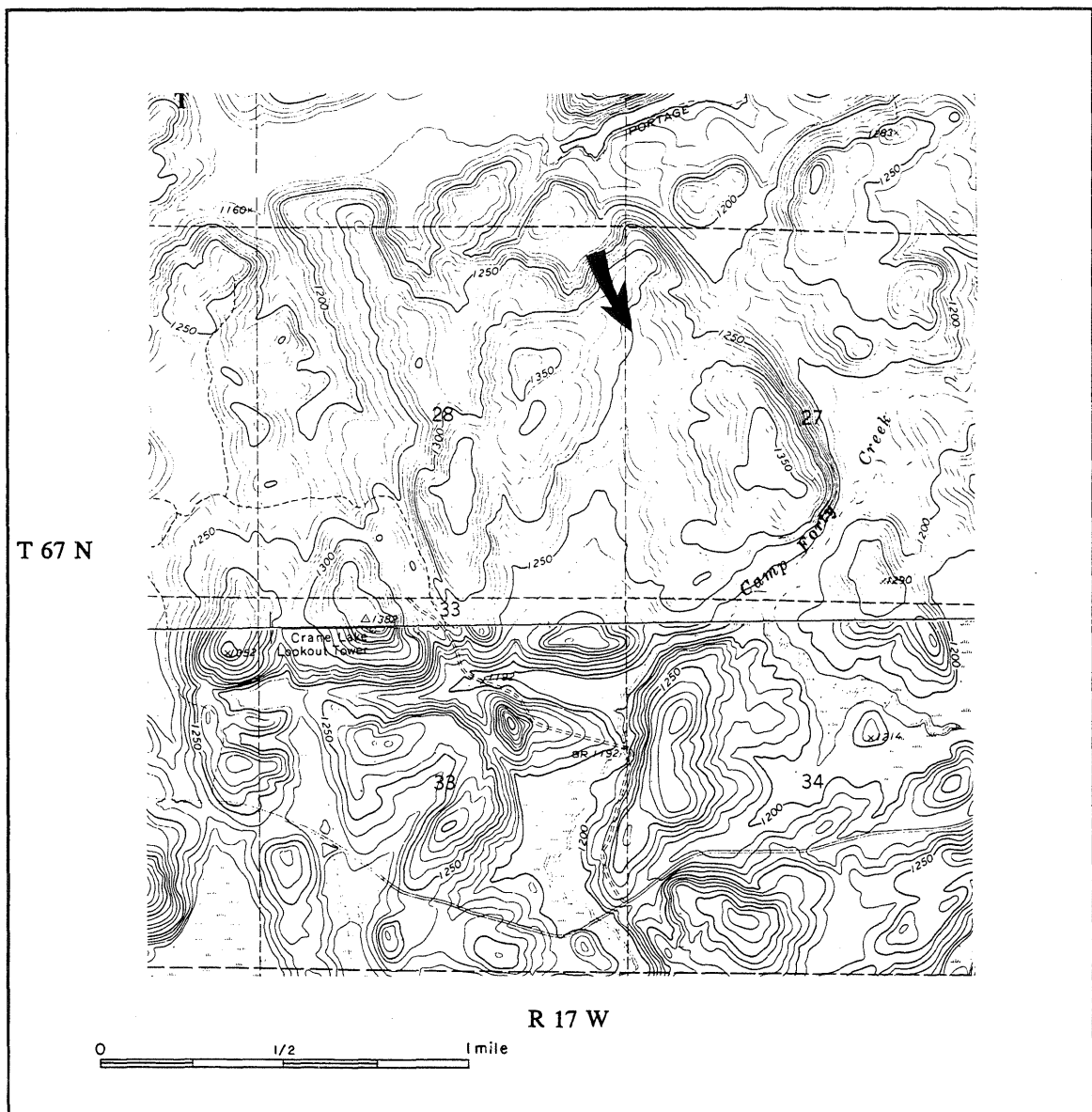


Figure 11. Site Number: St. Louis - 190. Base map from U.S. Geological Survey Johnson Lake 7.5 minute quadrangle.

Site No.: St. Louis - 196

Commodity: Grayish-pink granite

Geological Rock Name: Granite

County: St. Louis

TRS: T 67 N R 17 W Sec 27 NE1/4 NE1/4, W1/2 NE1/4, and E1/2 NW1/4

UTM: 536,770 m E, 5,345,360 m N, Zone 15

USGS Quadrangle Map: Johnson Lake

Access: This site can be reached by a snowmobile trail leading east of off Forest Road 207.

Color: Fresh Surface - Grayish pink, uniform

Weathered Surface - White to pinkish gray

Texture: Slightly porphyritic; subhedral; consistent

Grain Size: Medium to coarse, uniform

Joint Pattern: Regular

Joint Intensity: Limited; joint spacings range from 1 to 30 ft (0.3 to 9 m), ledges exhibit sheeting spacings of up to 6 ft (2 m)

Geological Setting: This area is underlain by Archean rocks of the Vermilion Granitic Complex.

Geology: This rock is a granite of uniform grayish pink color. It is predominantly medium-grained but is slightly porphyritic, containing some coarse-grained feldspar crystals (phenocrysts) averaging 0.5 in. (1 cm) in length. The texture is consistent throughout most of the exposures. Regular joint patterns are present. The dominant joint sets trend at approximately 150° and 75°. Large areas of outcrop exhibit widely spaced joints; joint spacings of up to 30 ft (9 m) are observed. Some ledges exhibit sheeting spacings of up to 6 ft (2 m). Minor pegmatitic dikes and rare mafic inclusions were noted, but most of the rock appears to be pegmatite and inclusion free.

Mineralogy: Thin section study indicates a composition of approximately 32% plagioclase, 32% quartz, 31% microcline, 5% biotite and muscovite, and accessory opaques.

Other Features: Local pegmatitic dikes and rare mafic inclusions noted; however, most of the rock appears to be pegmatite and inclusion free.

Deleterious Materials: Trace amount of sulfides

Outcrop Exposure: Good; large knobs and low lying outcrops

Quarry Block Potential: Good

Surface Ownership: T 67 N R 17 W Sec 27 NE1/4 NE1/4: USA

T 67 N R 17 W Sec 27 W1/2 NE1/4: USA

T 67 N R 17 W Sec 27 E1/2 NW1/4: USA

Mineral Ownership: T 67 N R 17 W Sec 27 NE1/4 NE1/4: State of MN

T 67 N R 17 W Sec 27 W1/2 NE1/4: USA

T 67 N R 17 W Sec 27 NE1/4 NW1/4: USA

T 67 N R 17 W Sec 27 SE1/4 NW1/4: State of MN

Photo: Yes

Use of Explosives: No

Sample No.: 2980000009

Thin Section No.: 2980000009

Polished Tile No.: S-196

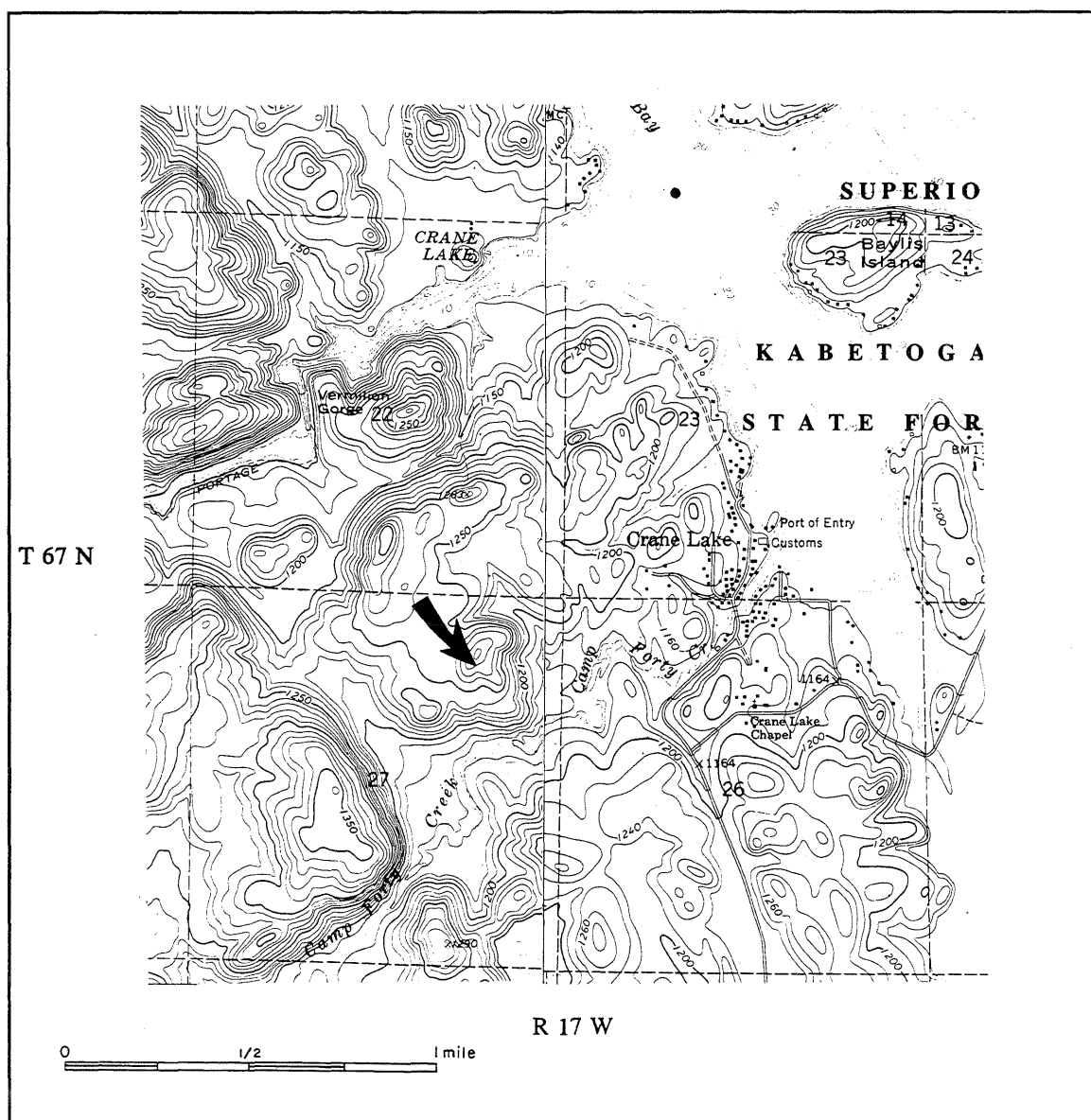


Figure 12. Site Number: St. Louis - 196. Base map from U.S. Geological Survey Johnson Lake 7.5 minute quadrangle.

Additional Information

A color insert entitled *New Dimensions in Building Stone* is available upon request from the MDNR. The insert contains photographs of polished tiles from the prospects described in this report. A brochure entitled *Minnesota Granite* is also available. The brochure contains photographs of polished tiles from selected prospects. The brochure was produced through a cooperative agreement between the Minnesota Department of Natural Resources and the Superior National Forest, USDA. The MDNR's *Dimension Stone Inventory of Northern Minnesota 1991*, report 289 is also available, this report describes the first two years of the inventory. For further information contact the MDNR Minerals offices in Hibbing (218-262-6767) or St. Paul (612-296-4807), or the Zone Geologist from the Superior National Forest in Duluth (218-720-5360).

Prospect sites have been identified on both state and federal lands. The MDNR and the Superior National Forest anticipate offering new sites for lease in the near future. Contact the above mentioned offices for further information.

During the 1993 field season, the Minerals Division will continue to evaluate outcrops in areas previously not evaluated within the original survey area. Inventory updates can be obtained from the Division's Open File Bulletins.

Summary

From September 1989 to May 1993, a total of four hundred sites have been evaluated by the MDNR's dimension stone inventory. The sites were classified into three groups: (1) **Prospects** (areas of potential), (2) **Inactive quarries** and (3) **Occurrences** (sites of little or no potential). Fifteen prospects have been identified that exhibit potential for dimension stone development.

During this phase of the inventory one hundred fifty-six sites were evaluated and seven prospects were identified. Because these deposits were evaluated primarily by surface observations, further evaluation and sampling may be required to determine if they are of suitable quality and quantity for quarrying. Information on the occurrences is not included in this report, but it is available as open-file information at the Division's Hibbing office.

An insert entitled *New Dimensions in Building Stone* is available upon request from the Minnesota Department of Natural Resources. The insert contains photographs of polished tiles from the prospects described in this report. A brochure entitled *Minnesota Granite* is also available from the Minnesota Department of Natural Resource and the Superior National Forest, USDA. The brochure contains photographs of polished tiles from selected prospects. The MDNR's *Dimension Stone Inventory of Northern Minnesota 1991*, report 289 is also available, this report describes the first two years of the inventory.

Polished tiles from the prospects and inactive quarries are available for inspection at the MDNR Minerals offices in Hibbing and St. Paul, and the Superior National Forest office in Duluth.

Acknowledgements

The author would like to thank the following agencies and individuals for their helpful suggestions:

The Minnesota Geological Survey and the Natural Resource Research Institute for providing useful information on potential areas to inventory.

The Superior National Forest and Stuart Behling (Zone Geologist) for their cooperation.

Ricco Riihiluoma for assisting in the field and office work.

Henk Dahlberg for providing the petrographic descriptions.

Pat Geiselman for assisting in the collection of samples. J.D. Lehr for generating figures 1, 2, and 5 of this report.

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