

DIMENSION STONE INVENTORY

of Northern Minnesota

1995

**REPORT
298-2**



Minnesota Department of Natural Resources
Division of Minerals

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Dimension Stone Inventory of Northern Minnesota 1995

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

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Abstract

This report presents the results of the fifth and sixth years of the Minnesota Department of Natural Resources' (MDNR) dimension stone inventory, including descriptions of seven new prospects. 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 thirty-six new sites were evaluated for dimension stone potential. Outcrop evaluations were based on surface observations with respect to joint spacing, color, texture, and deleterious minerals.

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

Results of the first four years of the dimension stone inventory are described in two previous reports, Dimension Stone Inventory of Northern Minnesota 1991 (Report 289), and Dimension Stone Inventory of Northern Minnesota 1993 (Report 298).

To date, five hundred and twenty-seven sites have been evaluated of which twenty-two have been identified as prospects. Cold Spring Granite Company has acquired three quarry prospect sale areas from the Superior National Forest's public sale held in 1991. Quarry development has begun at one of the sites and operating plans have been submitted to the Superior National Forest for one other site.

Polished tiles from the prospects can be examined at the MDNR Minerals offices 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 color photographs of polished tiles from selected prospects. Two color inserts are available from the Minnesota Department of Natural Resources: *New Quarry Prospects* contains photographs of polished tiles from the prospects described in this report; *New Dimensions in Building Stone* contains photographs of polished tiles from the prospects described in report 298.

Introduction

This report presents the results of the fifth and sixth 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 1993 and spring through fall of 1994. Results of the first four years of the inventory are described in two previous reports, Dimension Stone Inventory of Northern Minnesota 1991 (Report 289) and Dimension Stone Inventory of Northern Minnesota 1993 (Report 298). 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 four years of the inventory have led to strong industry support. Cold Spring Granite Co. has acquired three quarry prospect sale areas offered by the Superior National Forest's public sale in 1991. Quarry development has begun at one of the sites and operating plans

have been submitted to the Superior National Forest for one other site. A number of firms, including both domestic and multinational, have requested information about the inventory. The MDNR anticipates offering state-owned 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 and 5). Field investigations were conducted by one field crew, which consisted of a geologist and field technicians.

Regional Geologic Setting

The study area is underlain by Middle Proterozoic (Keweenawan) rocks (ca. 1100 m.y.) and Archean (ca. 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 focused upon the following rock units: (Fig. 2):

Middle Proterozoic (Keweenawan) 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).

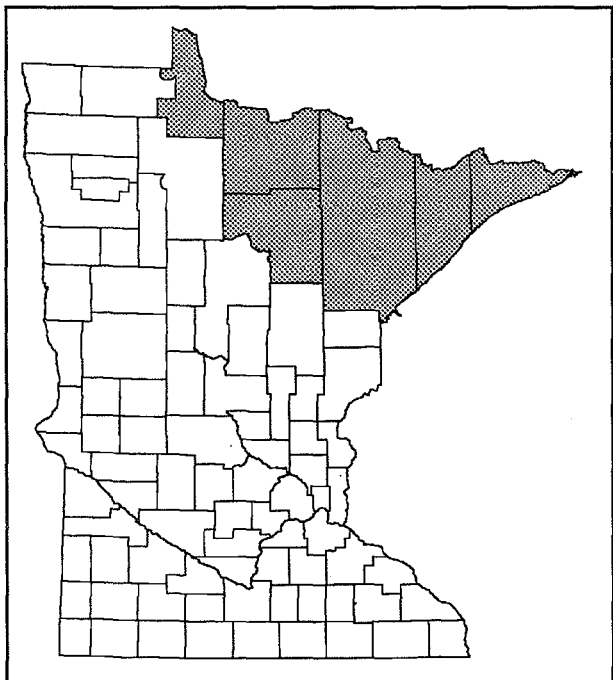


Figure 1. Dimension stone inventory study area.

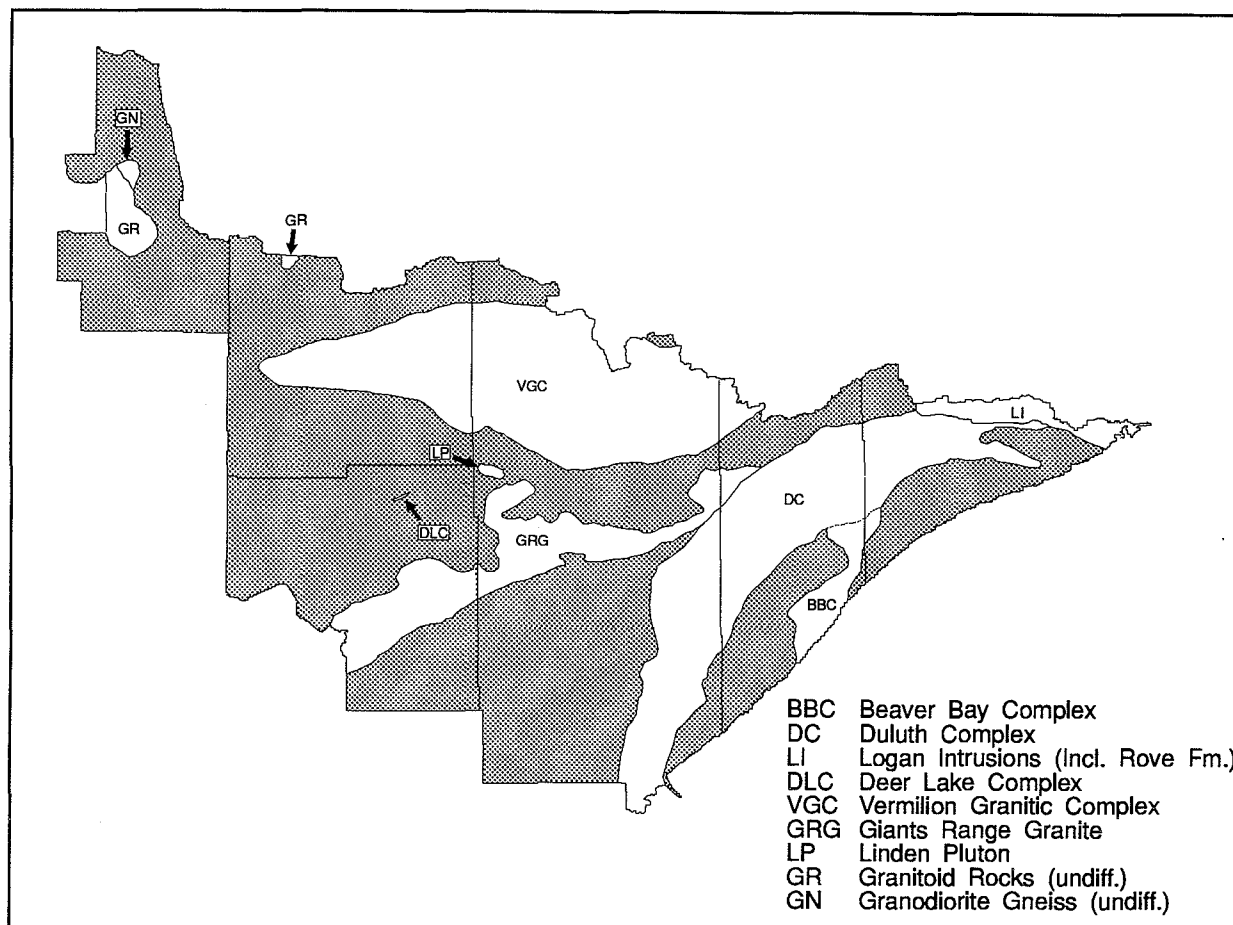


Figure 2. Generalized bedrock geology map showing rock units investigated (white). Adapted from Morey and others, 1982; Sims and others, 1970; Day and Klein, 1990; and Phinney, 1972a.

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 stages of work included site selection, field work, and analysis of field data and samples.

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), and 1993 (Report 298) for results of first four 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 and Samples

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 and stereo microscope study at the MDNR office in Hibbing. Geologic rock names were assigned using Phinney's (1972) classification for the mafic rocks and Streck-eisen'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 geologists. The commercial stone term "granite" includes most crystalline igneous rocks and some metamorphic rocks, whereas the geologic definition of granite is very specific (see Fig. 4).

To determine if a specific prospect is of suitable quality and quantity for quarrying further evaluation is recommended. Additional 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; the removal of overburden adjacent to outcrops and core 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 private industry.

Results

During this phase of the inventory 136 new sites were evaluated within Cook, Koochiching, Lake, and St. Louis counties. 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 and quality of quarry blocks cannot be definitely determined until stone has been removed.

The 129 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. These descriptions are available for review as open-file information at the Division's Hibbing office.

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 - 128. Exposures of this black granite commonly display joint spacings of 12 ft (3.6 m). The depth of weathering may be of concern at this site.

Site No.: Lake - 144. Exposures of this black granite display joint spacings of 10 ft (3 m).

Site No.: Lake - 153. This greenish-gray stone exhibits a unique color and texture. Joint spacings of 10 ft (3 m) are common.

Site No.: Lake - 159. This stone displays a greenish-gray hue and porphyritic texture. Joint spacings of 12 ft (3.6 m) are common. Healed fractures are noted at this site.

Site No.: Lake - 162. This stone displays a greenish-gray hue and porphyritic texture. Few joints are observed in the intermittently exposed outcrops; joint spacings of up to 20 ft (6 m) were noted.

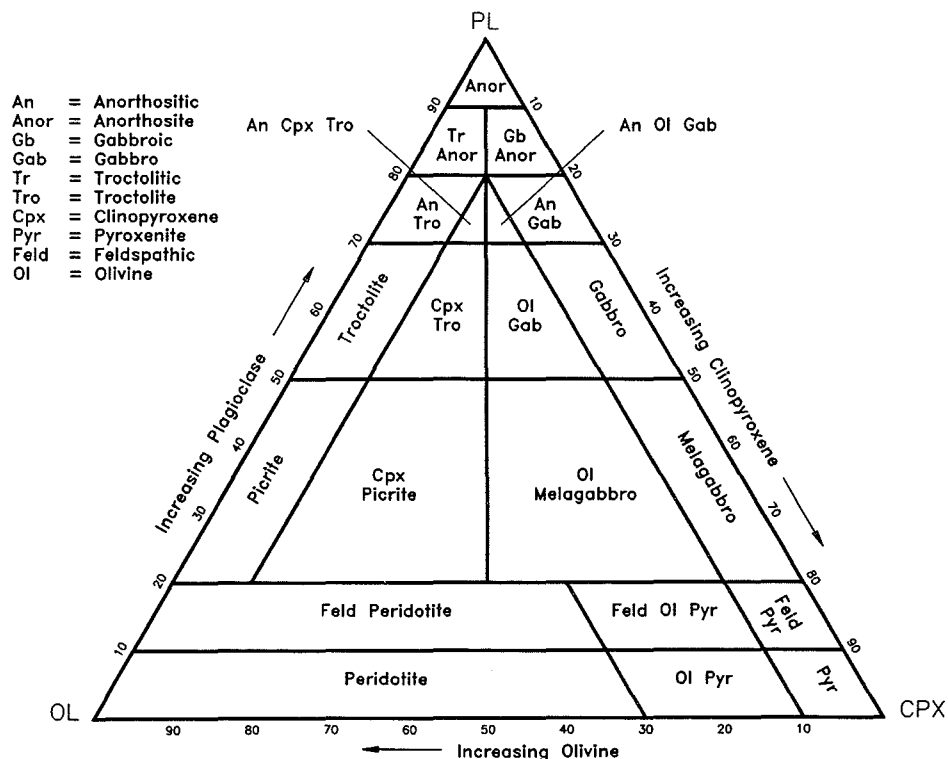


Figure 3. Classification for mafic rocks (from Phinney, 1972). $PL+OL+CPX=100$

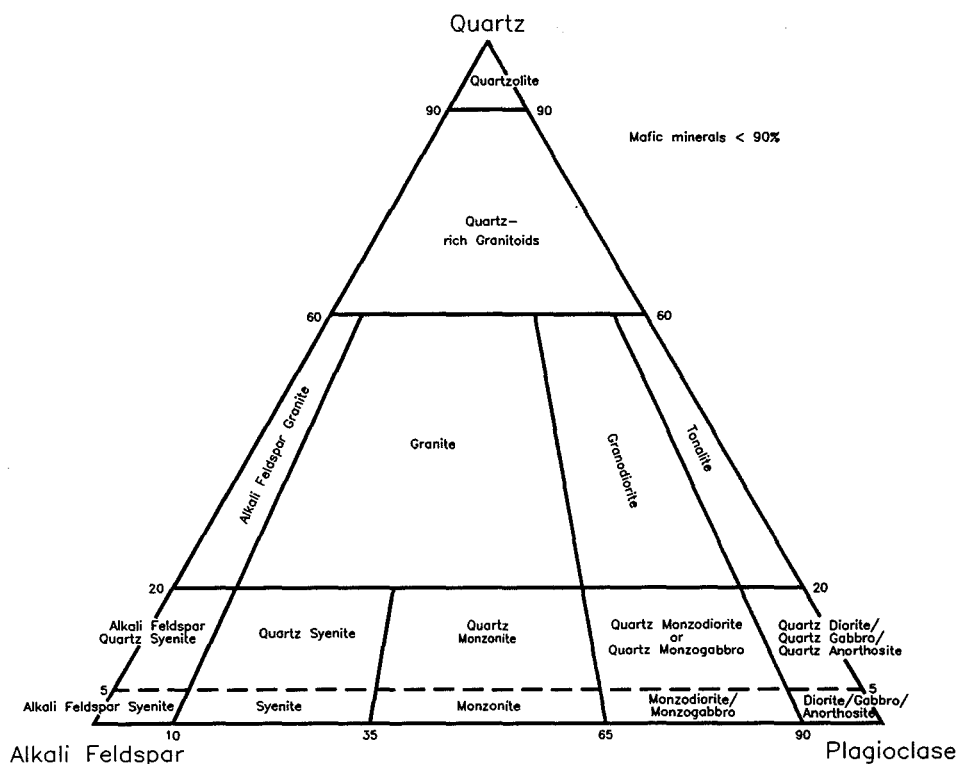


Figure 4. Classification for granitic rocks (from Streckeisen, 1973). Qtz+Ksp+Plag=100.

Site No.: Lake - 167. This is the darkest black granite prospect located to date. Joint spacings of 15 ft (4.6 m) are common.

Site No.: Lake - 174. This mottled light and dark gray colored stone commonly exhibits joint spacings of 12 ft (3.6 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

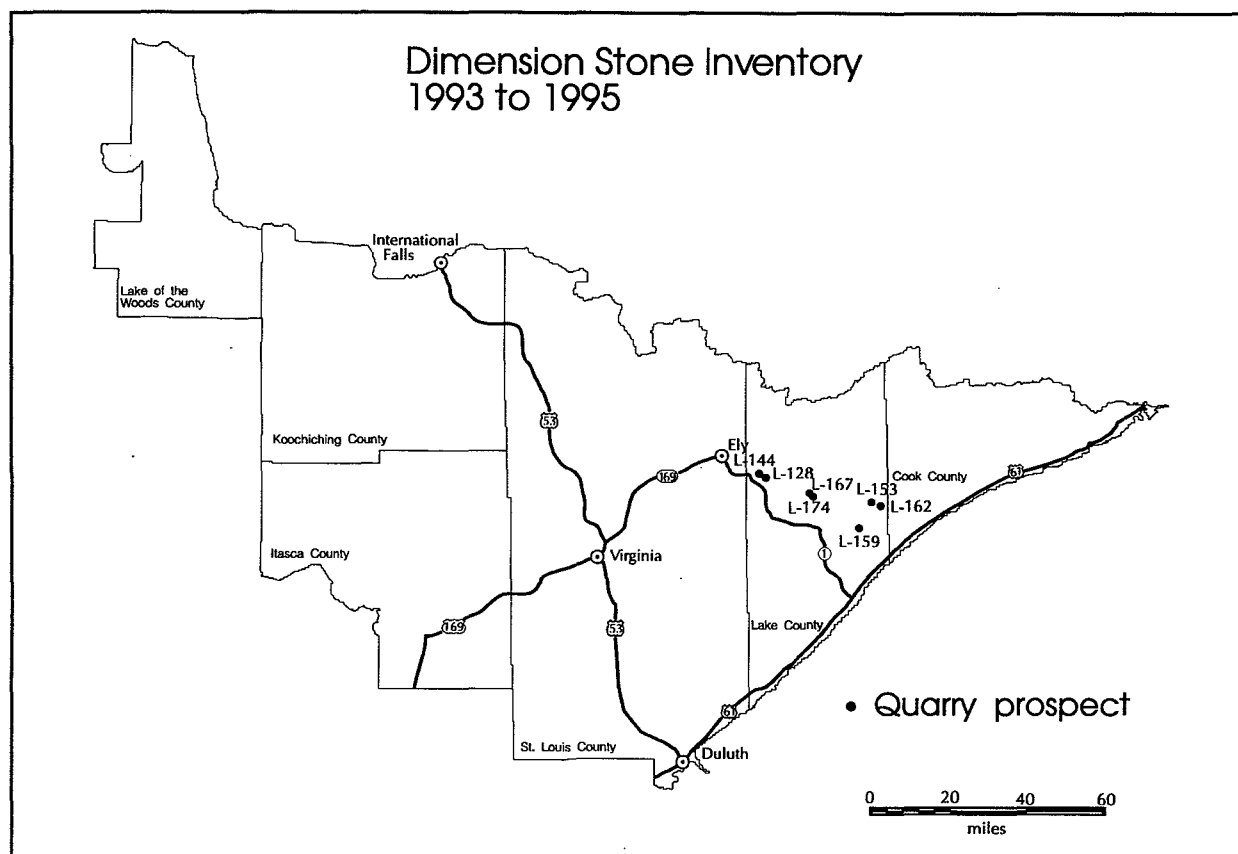


Figure 5. Location of new quarry prospects (1993 to 1995) with site reference numbers.

Mineralogy: determined by thin section and stereo microscope study

Polished Tile No.:

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

Location Map:

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

Site No: L-128

Commodity: Black granite

Geologic Rock Name: Troctolitic anorthosite

County: Lake

TRS: T 62 N R 11 W Sec 35 NW1/4 SW1/4

UTM: 597200m E, 5295850m N, Zone 15

USGS Quadrangle Map: Bogberry Lake

Access: This site is located east of a logging road leading south from Forest Road 181.

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

Texture: Weakly laminated; anhedral to euhedral

Grain Size: Medium to coarse, uniform

Joint Pattern: Regular

Joint Intensity: Moderate to limited; joint spacings range from 3 to 20 ft (1 to 6 m); joint spacings of 12 ft (3.6 m) are common; sheeting spacings of up to 10 ft (3 m) are observed on vertical exposure

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

Geology: This rock is a troctolitic anorthosite of uniform gray color. It is medium- to coarse-grained and displays a weak lamination resulting from the preferred orientation of plagioclase laths. Regular joint patterns are present. The dominant joint sets trend at approximately 120° with secondary joints sets trending at 0°. Joint spacings range from 3 to 20 ft (1 to 6 m); joint spacings of 12 ft (3.6 m) are common. Ledges exhibit sheeting spacings of up to 10 ft (3 m). Surface weathering was observed in samples collected to a depth of 1 ft (0.3 m), the depth of weathering is undetermined.

Mineralogy: Thin section and stereo microscope study indicates a composition of approximately 80% plagioclase, 10% olivine, 8% clinopyroxene, 2% opaques, and accessory biotite, apatite, amphibole and sulfide.

Other Features:

Deleterious Materials: Trace amount of sulfide

Outcrop Exposure: Fair; elongated ridge with vertical faces and bald knobs

Quarry Block Potential: Good

Surface Ownership: USA

Mineral Ownership: USA

Photo: Yes

Use of Explosives: No

Sample No: 2982000001

Thin Section No: 2982000001

Polished Tile No: L-128

Remarks: The depth of weathering may be of concern at this site.

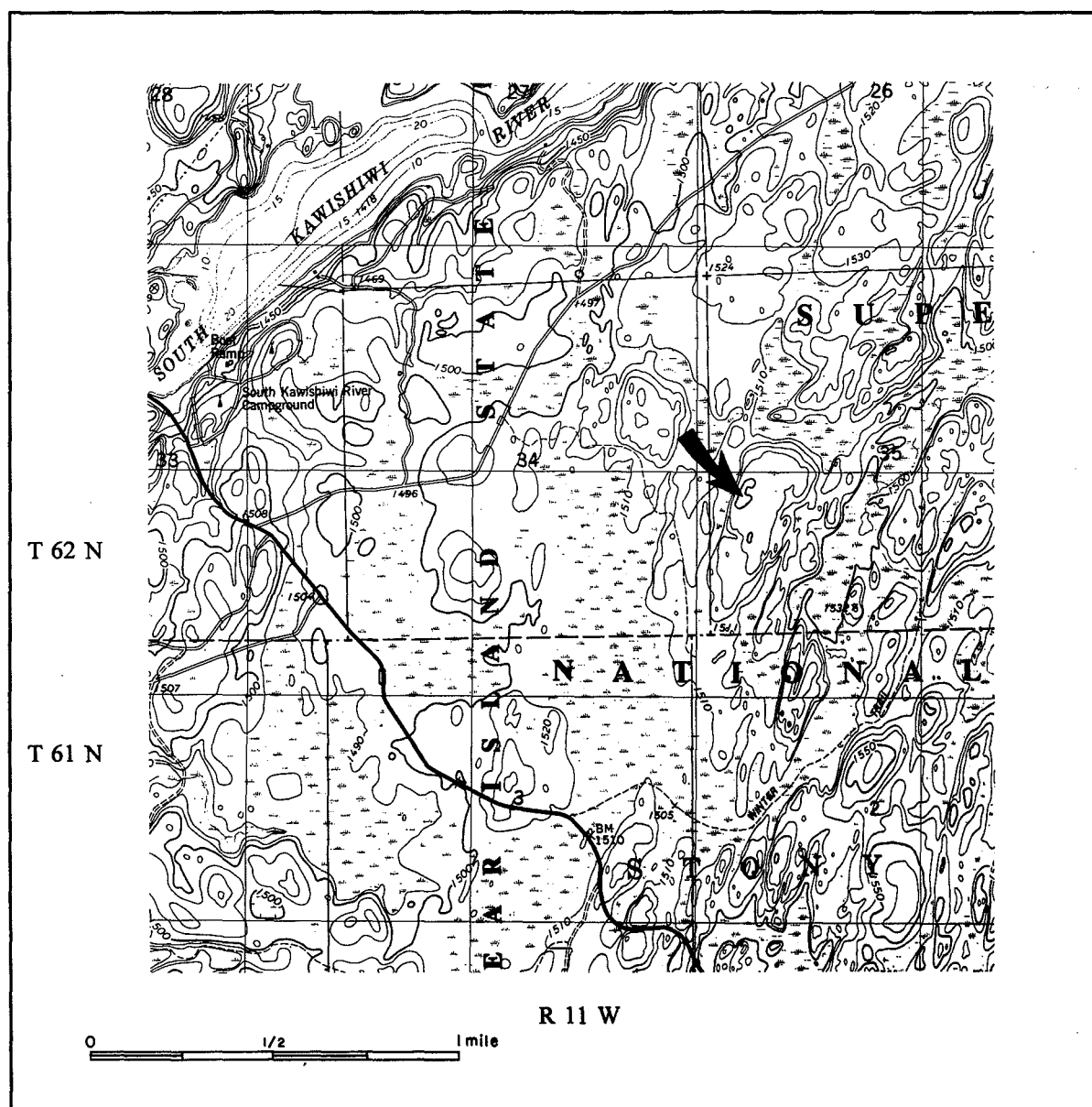


Figure 6. Site Number: Lake - 128. Base map from U.S. Geological Survey Bogberry Lake 7.5 minute quadrangle.

Site No: L-144

Commodity: Black granite

Geologic Rock Name: Troctolitic anorthosite

County: Lake

TRS: T 62 N R 11 W Sec 34 SE1/4 NE1/4 and NE1/4 SE1/4

UTM: 596830m E, 5296100m N, Zone 15

USGS Quadrangle Map: Bogberry Lake

Access: This site can be reached by a logging road leading south from Forest Road 181.

Color: Fresh Surface - Gray, uniform

Weathered Surface - Light gray

Texture: Weakly laminated; anhedral

Grain Size: Medium to coarse, uniform

Joint Pattern: Regular

Joint Intensity: Intense to limited; areas of limited jointing observed in intermittently exposed outcrops

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

Geology: This rock is a troctolitic anorthosite of uniform dark gray color. It is medium- to coarse-grained and exhibits a weak lamination resulting from the preferred orientation of plagioclase laths. The joint spacings that are exposed range from 1 to 20 ft (0.3 to 6 m). Joint spacings of 10 ft (3 m) are common. The dominant joint sets trend at approximately 120°. The poor outcrop exposure prevents a complete analysis of joint patterns and the extent of uniform rock.

Mineralogy: Thin section and stereo microscope study indicates a composition of approximately 82% plagioclase, 8% olivine, 3% biotite, 3% orthopyroxene, 1% clinopyroxene, 3% opaques, and accessory apatite and sulfide.

Other Features:

Deleterious Materials: Trace amount of sulfide

Outcrop Exposure: Poor; intermittently exposed outcrops in clearcut area

Quarry Block Potential: Good to fair

Surface Ownership: USA

Mineral Ownership: USA

Sample No: 2982000002

Thin Section No: 2982000002

Polished Tile No.: L-144

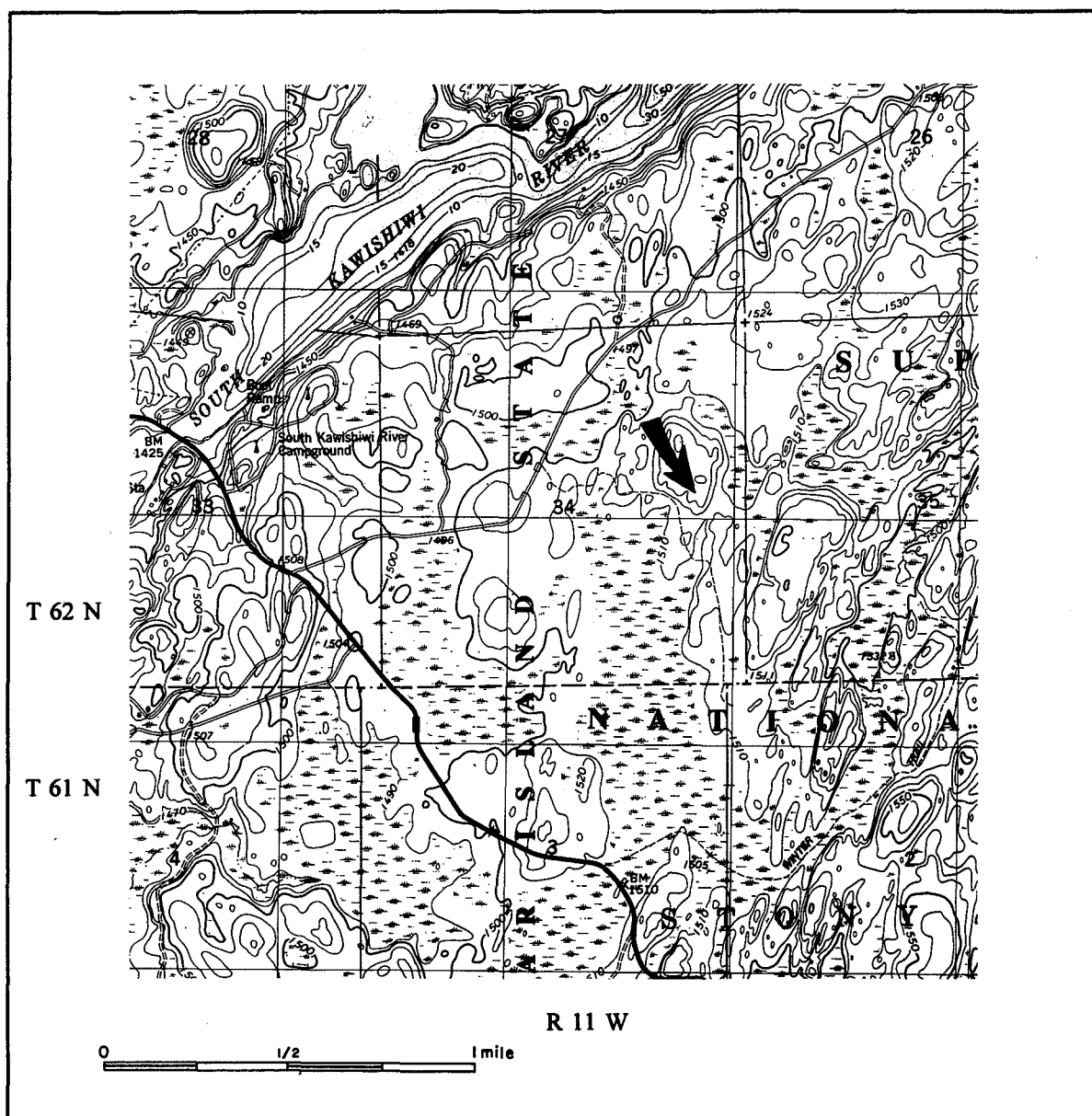


Figure 7. Site Number: Lake - 144. Base map from U.S. Geological Survey Bogberry Lake 7.5 minute quadrangle.

Site No: L-153

Commodity: Greenish gray granite

Geologic Rock Name: Gabbroic anorthosite

County: Lake

TRS: T 60 N R 6 W Sec 4 N1/2

T 61 N R 6 W Sec 33 SW1/4

UTM: 642690m E, 5286010m N, Zone 15

USGS Quadrangle Map: Wilson Lake

Access: This site can be reached by a primitive logging road leading east from County Road 7 (Windy Lake Road)

Color: **Fresh Surface** - Gray with slight greenish hue

Weathered Surface - Gray

Texture: Subophitic; very weakly laminated

Grain Size: Medium to coarse

Joint Pattern: Regular and irregular

Joint Intensity: Moderate to limited; Joint spacings range from 3 to 25 ft (1 to 7.6 m); joint spacings of 10 ft (3 m) 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 greenish gray color. It is medium- to coarse-grained and displays a very weak lamination resulting from the preferred orientation of plagioclase laths. Gray plagioclase crystals exhibiting a slight greenish hue are partially enclosed by black crystals of pyroxene. The color and texture that make this rock unique appears to be confined to the small scattered exposures located in the center of the north half of section 4. The grain size increases and the rock appears to be more weathered as one moves away from this area. The dominant joint sets trend at approximately 150° and 80°. Joint spacings range from 3 to 25 ft (1 to 7.6 m); joint spacings of 10 ft (3 m) are common. The limited exposure prevents a complete analysis of joint patterns and the extent of uniform rock. Local healed fractures (black lines) were noted in some areas of the outcrop.

Mineralogy: Thin section and stereo microscope study indicates a composition of approximately 82% plagioclase, 10% clinopyroxene partly altering to amphibole and chlorite, 3% granophyric intergrowths (K-feldspar and quartz), 3% opaques, 2% olivine, and accessory sulfide.

Other Features:

Deleterious Materials: Trace amount of sulfide

Outcrop Exposure: Poor; intermittently exposed outcrops along primitive logging road and clearcut

Quarry Block Potential: Good

Surface Ownership: USA

Mineral Ownership: USA

Photo: Yes

Use of Explosives: No

Sample No: 2982000003

Thin Section No: 2982000003

Polished Tile No.: L-153

Remarks: Unique color and texture

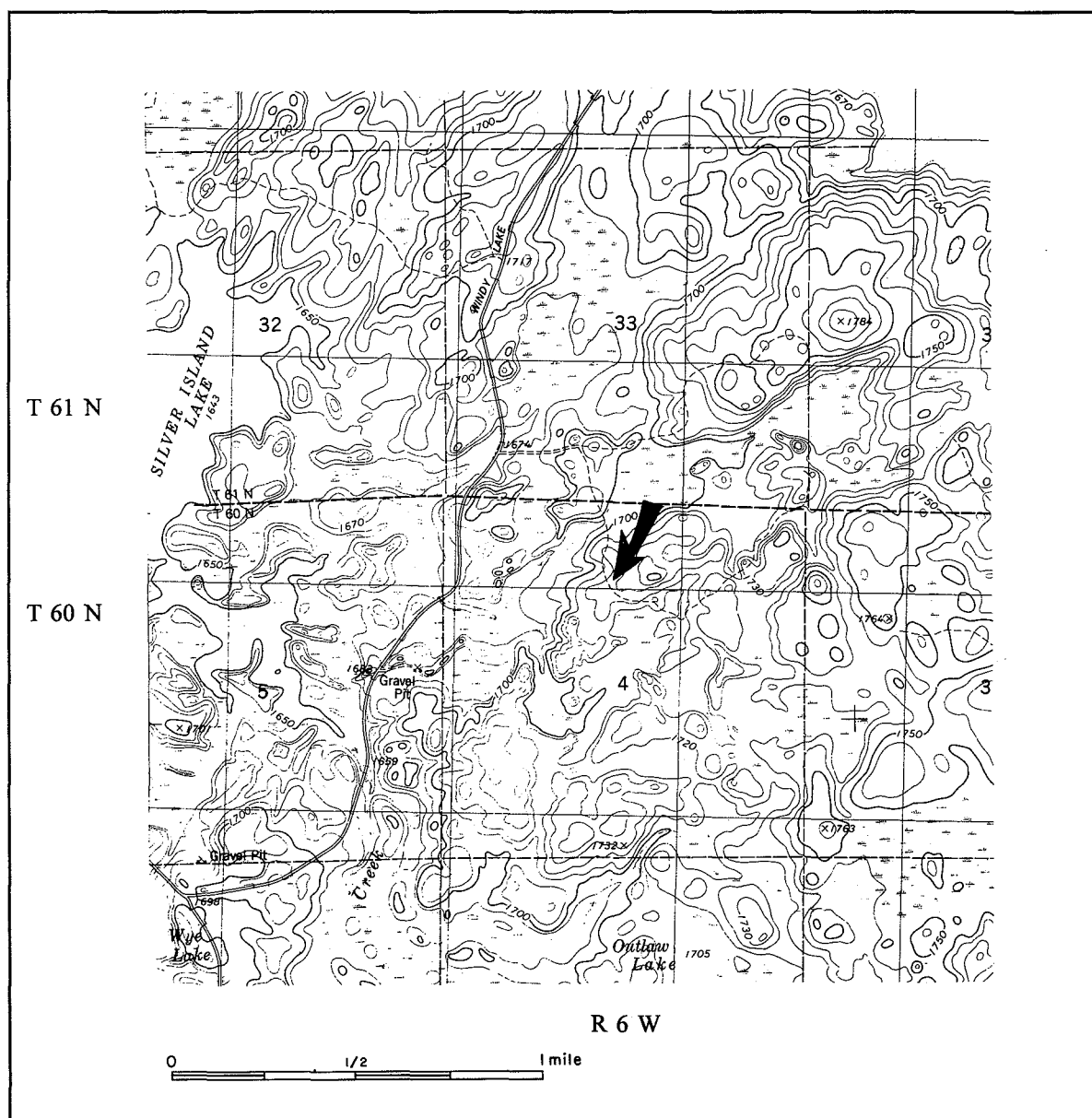


Figure 8. Site Number: Lake - 153. Base map from U.S. Geological Survey Wilson Lake 7.5 minute quadrangle.

Site No: L-159

Commodity: Green granite

Geologic Rock Name: Porphyritic gabbroic
anorthosite

County: Lake

TRS: T 60 N R 7 W Sec 36 gov. lots 6, 7, 8, and 9

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

UTM: 637900m E, 527610m N, Zone 15

USGS Quadrangle Map: Silver Island Lake

Access: This site is located east of a primitive logging road leading south from Forest Road 172 (Wanless Road).

Color: Fresh Surface - Greenish gray

Weathered Surface - Whitish gray

Texture: Porphyritic

Grain Size: Medium to very coarse

Joint Pattern: Regular

Joint Intensity: Moderate to limited; joint spacings range from 3 to 25 ft (1 to 7.6 m); joint spacings of 12 ft (3.6 m) are common. Sheeting spacings of up to 12 ft (3.6 m) are observed on vertical exposures

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 very coarse-grained porphyritic gabbroic anorthosite. Light greenish gray, coarse- to very coarse-grained plagioclase crystals (phenocrysts) are distributed in a dark green ground mass. The color and texture appears to be consistent throughout the exposures. The joint patterns are regular. The dominant joint sets trend at approximately 40°. Joint spacings range from 3 to 25 ft (1 to 7.6 m); joint spacings of 12 ft (3.6 m) are common. Sheeting spacings are observed up to 12 ft (3.6 m). Healed fractures appearing as white lines on the outcrop faces were noted. The healed fractures are difficult to identify on the vertical exposures, but are more apparent on the large blocks that have separated from the vertical face. Because of the difficulty in identifying the healed fractures on the vertical exposures stripping of overburden may be required to determine their intensity.

Mineralogy: Thin section and stereo microscope study indicates a composition of approximately 80% plagioclase, the plagioclase crystals appear fractured and exhibit sericite alteration, 15% pyroxene altering to amphibole, 3% opaques, 2% interstitial granophyric intergrowths (K-feldspar and quartz), and accessory sulfide.

Other Features:

Deleterious Materials: Trace amount of sulfide

Outcrop Exposure: Fair; elongate ridges and knobs, exposed primarily along vertical faces of 5 to 20 ft (1.5 to 6 m) high ridges

Quarry Block Potential: Good

Surface Ownership: T 60 N R 7 W Sec 36 gov. lots 6-9: State of MN
T 59 N R 7 W Sec 1 gov. lots 1-4: USA

Mineral Ownership: T 60 N R 7 W Sec 36 gov. lots 6-9: State of MN
T 60 N R 7 W Sec 1 gov. lots 1-4: State of MN

Sample No: 2980200004, 2980200009

Thin Section No: 2980200004

Polished Tile No: L-159

Remarks: The healed fractures (white lines) observed on the large blocks at the base of the outcrop face are a concern at this site.

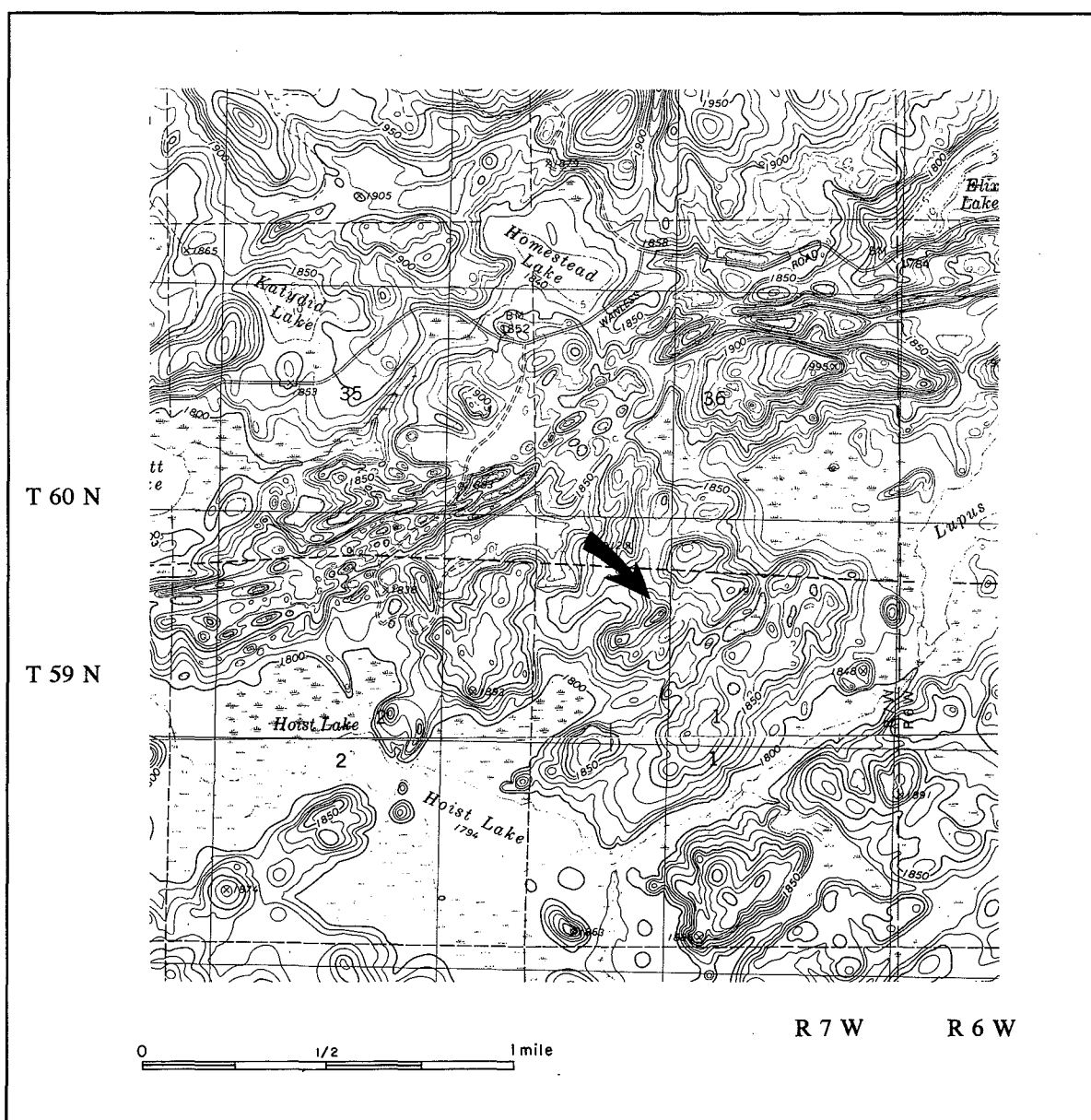


Figure 9. Site Number: Lake - 159. Base map from U.S. Geological Survey Silver Island Lake and Cabin Lake 7.5 minute quadrangles.

Site No: L-162

Commodity: Green granite

Geologic Rock Name: Porphyritic gabbroic
anorthosite

County: Lake

TRS: T 60 N R 6 W Sec 2 SW1/4

UTM: 645390m E, 5285320m N, Zone 15

USGS Quadrangle Map: Wilson Lake

Access: This site can be reached by a primitive logging road leading west from Forest Road 348 (old 357).

Color: **Fresh Surface** - Greenish gray
Weathered Surface - Gray

Texture: Porphyritic

Grain Size: Medium to very coarse

Joint Pattern: Regular and irregular

Joint Intensity: Moderate to limited; few joints observed in intermittently exposed outcrops along a primitive logging road

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

Geology: This rock is a medium- to very coarse-grained porphyritic gabbroic anorthosite. Light greenish gray, medium- to very coarse-grained plagioclase crystals (phenocrysts) are distributed in a dark green groundmass. The color and texture appear to be consistent throughout the exposures. The dominant joint sets trend at approximately 340° and 60°. Few joints are observed in the intermittently exposed outcrops. Joint spacings of up to 20 ft (6 m) are observed. Sheeting is difficult to assess due to the low lying nature of the exposures. Local healed fractures (black lines) trending at approximately 360° were noted. The poor outcrop exposure prevents a complete analysis of joint patterns and the extent of uniform rock.

Mineralogy: Thin section and stereo microscope study indicates a composition of approximately 78% plagioclase, the plagioclase crystals appear fractured and exhibit sericite alteration, 17% pyroxene altering to amphibole, 3% oxides, 2% olivine, and accessory sulfide.

Other Features:

Deleterious Materials: Trace amount of sulfide

Outcrop Exposure: Poor; scattered outcrops along logging road

Quarry Block Potential: Good

Surface Ownership: USA

Mineral Ownership: USA

Photo: Yes

Use of Explosives: No

Sample No: 2982000005

Thin Section No: 2982000005

Polished Tile No: L-162

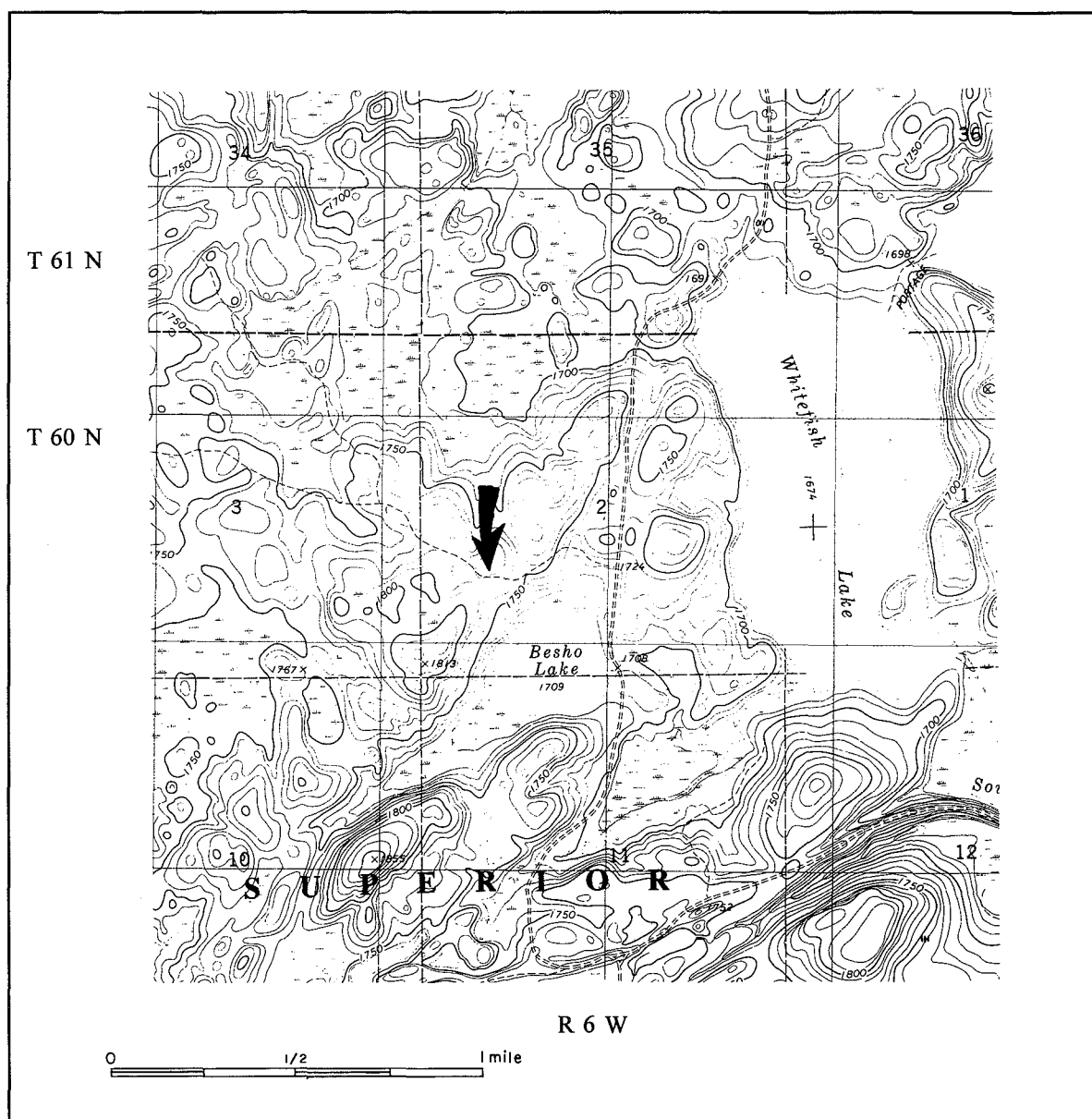


Figure 10. Site Number: Lake - 162. Base map from U.S. Geological Survey Wilson Lake 7.5 minute quadrangle.

Site No: L-167

Commodity: Black granite

Geologic Rock Name: Gabbroic anorthosite

County: Lake

TRS: T 61 N R 8 W Sec 30 S1/2 NE1/4 and N1/2 SE1/4

UTM: 620580m E, 5288010m N, Zone 15

USGS Quadrangle Map: Mitawan Lake

Access: This site can be reached by Forest Road 373 (Northwest Road).

Color: **Fresh Surface** - Dark gray, uniform; black when polished

Weathered Surface - Gray

Texture: Ophitic

Grain Size: Coarse

Joint Pattern: Regular

Joint Intensity: Limited; joint spacings of up to 30 ft (9 m) observed; joint spacings of 15 ft (4.6 m) are common; ledges exhibit sheeting spacings of up to 6 ft (2 m)

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

Geology: This rock is an ophitic gabbroic anorthosite of uniform dark gray color. It is coarse-grained. Black pyroxene oikocrysts (large crystals of pyroxene enclosing smaller crystals of plagioclase) are seen consistently throughout the exposures. Regular joint patterns are observed. The dominant joint sets trend at approximately 0° and 115°. Joint spacings of up to 30 ft (9 m) are present, joint spacings of 15 ft (4.6 m) are common. Ledges exhibit sheeting spacings of up to 6 ft (2 m). Local healed fractures (black lines) were noted.

Mineralogy: Thin section and stereo microscope study indicates a composition of approximately 88% plagioclase, 10% pyroxene, 2% olivine, and accessory opaques and sulfide.

Other Features:

Deleterious Materials: Trace amount of sulfide

Outcrop Exposure: Fair to good; intermittently exposed knobs

Quarry Block Potential: Good

Surface Ownership: USA

Mineral Ownership: USA

Photo: Yes

Use of Explosives: No

Sample No: 2982000006

Thin Section No: 2982000006

Polished Tile No: L-167

Remarks: Darkest black granite prospect to date

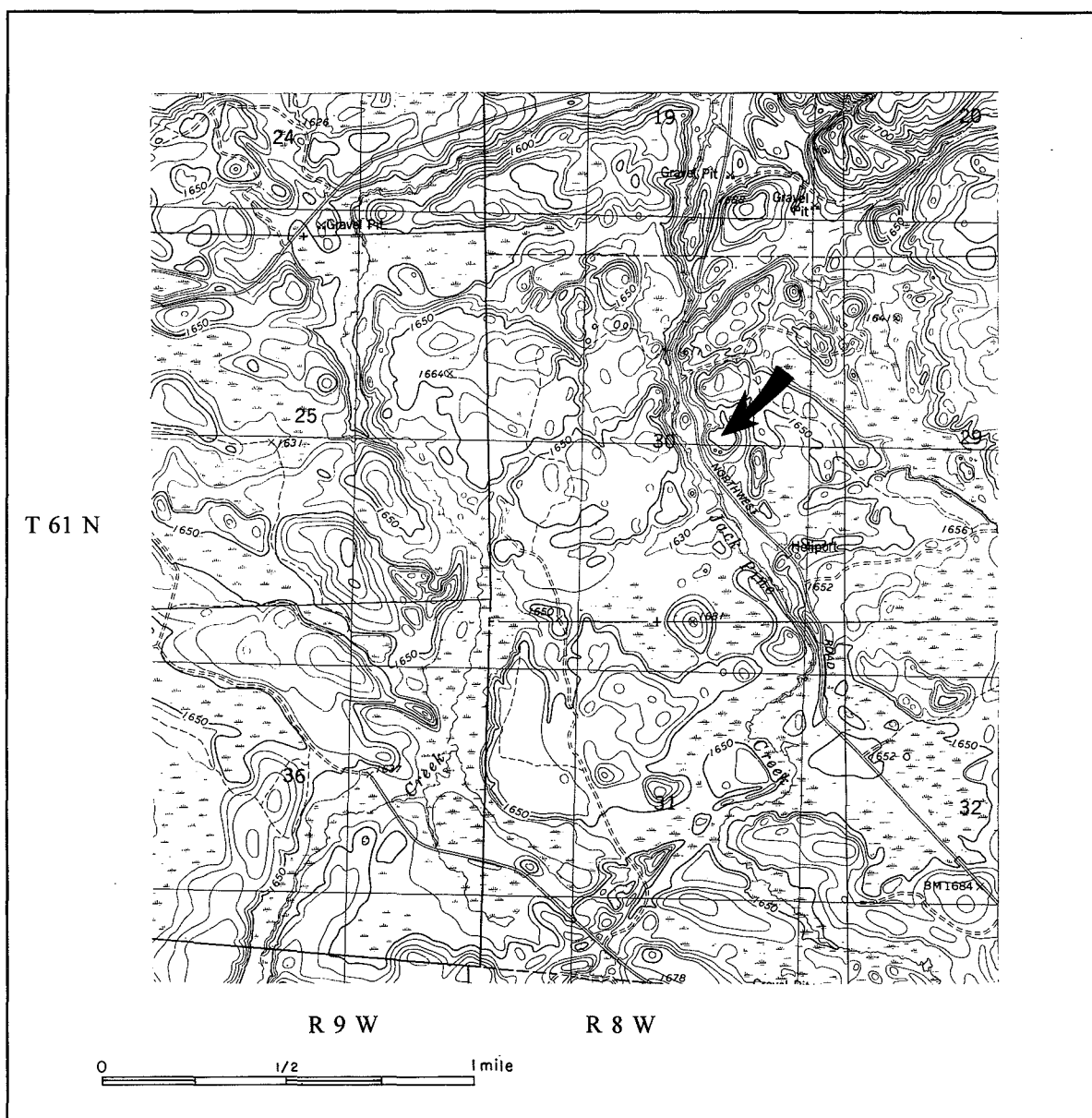


Figure 11. Site Number: Lake - 167. Base map from U.S. Geological Survey Mitawan Lake 7.5 minute quadrangle.

Site No: L-174

Commodity: Black granite

Geologic Rock Name: Gabbroic anorthosite

County: Lake

TRS: T 61 N R 8 W Sec 29 SW1/4

UTM: 621550m E, 5287790m N, Zone 15

USGS Quadrangle Map: Mitawan Lake

Access: This site can be reached from a trail leading northwest from a logging road leading east from Forest Road 373 (Northwest Road).

Color: **Fresh Surface** - Mottled, light and dark gray
Weathered Surface - Gray

Texture: Ophitic

Grain Size: Medium to coarse

Joint Pattern: Regular

Joint Intensity: Limited; joint spacings of 12 ft (3.6 m) are common, ledges exhibit sheeting spacings of up to 6 ft (2 m)

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

Geology: This rock is a gabbroic anorthosite of mottled light and dark gray color. It is medium- to coarse-grained and displays a weak lamination resulting from the preferred orientation of plagioclase laths. Black pyroxene oikocrysts (large crystals of pyroxene enclosing smaller crystals of plagioclase) are seen consistently throughout the exposures. Regular joint patterns are present. The dominant joint sets trend at approximately 40° and 80°. Joint spacings of 12 ft (3.6 m) are common. Ledges exhibit sheeting spacings of up to 6 ft (2 m). Surface weathering was observed in samples collected to a depth of 1 ft (0.3 m).

Mineralogy: Thin section and stereo microscope study indicates a composition of approximately 86% plagioclase, 8% pyroxene, 3% opaques, 3% olivine, and accessory chlorite and sulfide.

Other Features:

Deleterious Materials: Trace amount of sulfide

Outcrop Exposure: Fair to poor; intermittently exposed low lying outcrops along primitive logging road and exposures along steep faced ridge.

Quarry Block Potential: Good

Surface Ownership: USA

Mineral Ownership: USA

Photo: Yes

Use of Explosives: No

Sample No: 2982000007

Thin Section No: 29820000007

Polished Tile No: L-174

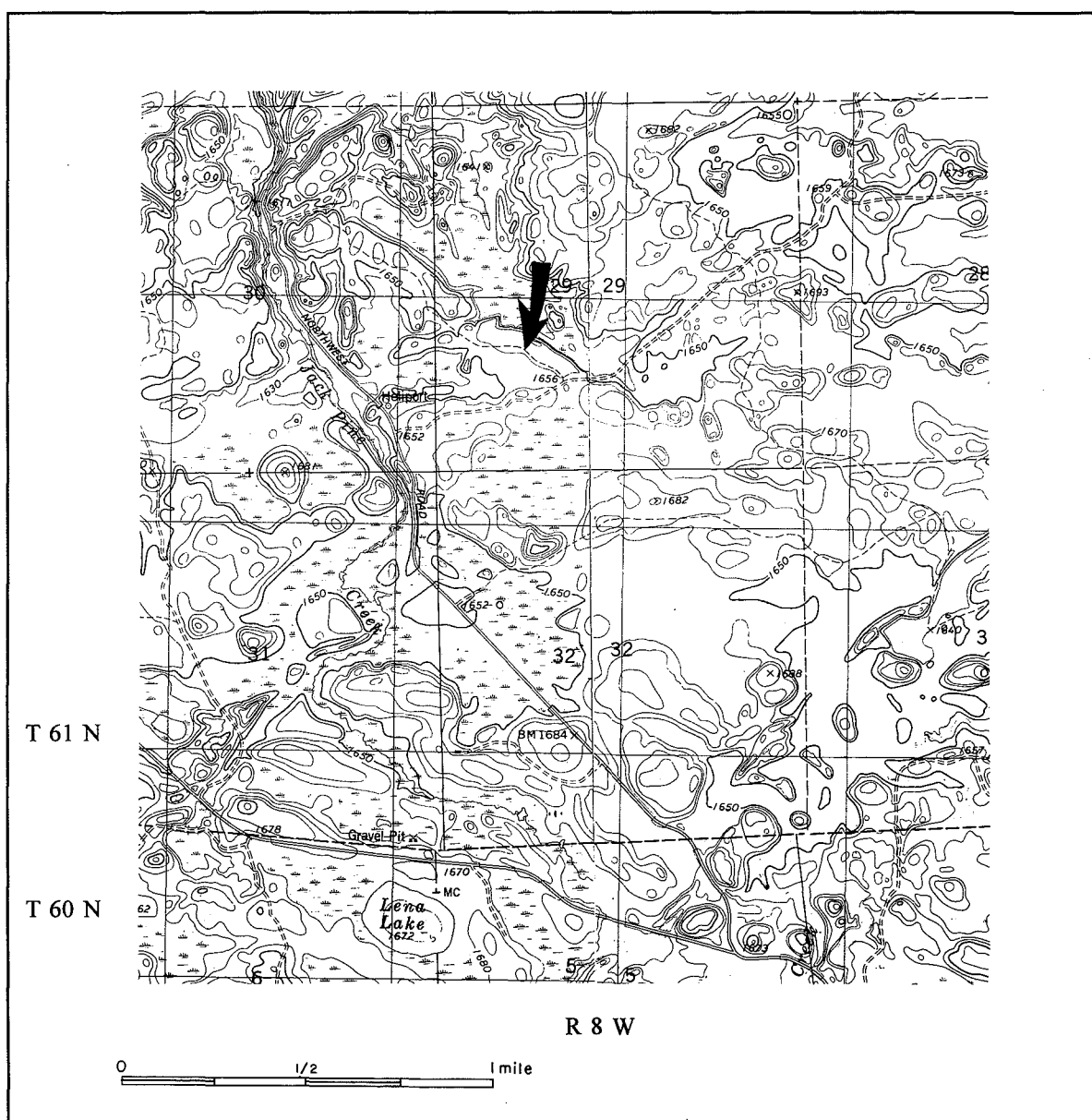


Figure 12. Site Number: Lake - 174. Base map from U.S. Geological Survey Mitawan Lake and Sawbill Landing 7.5 minute quadrangles.

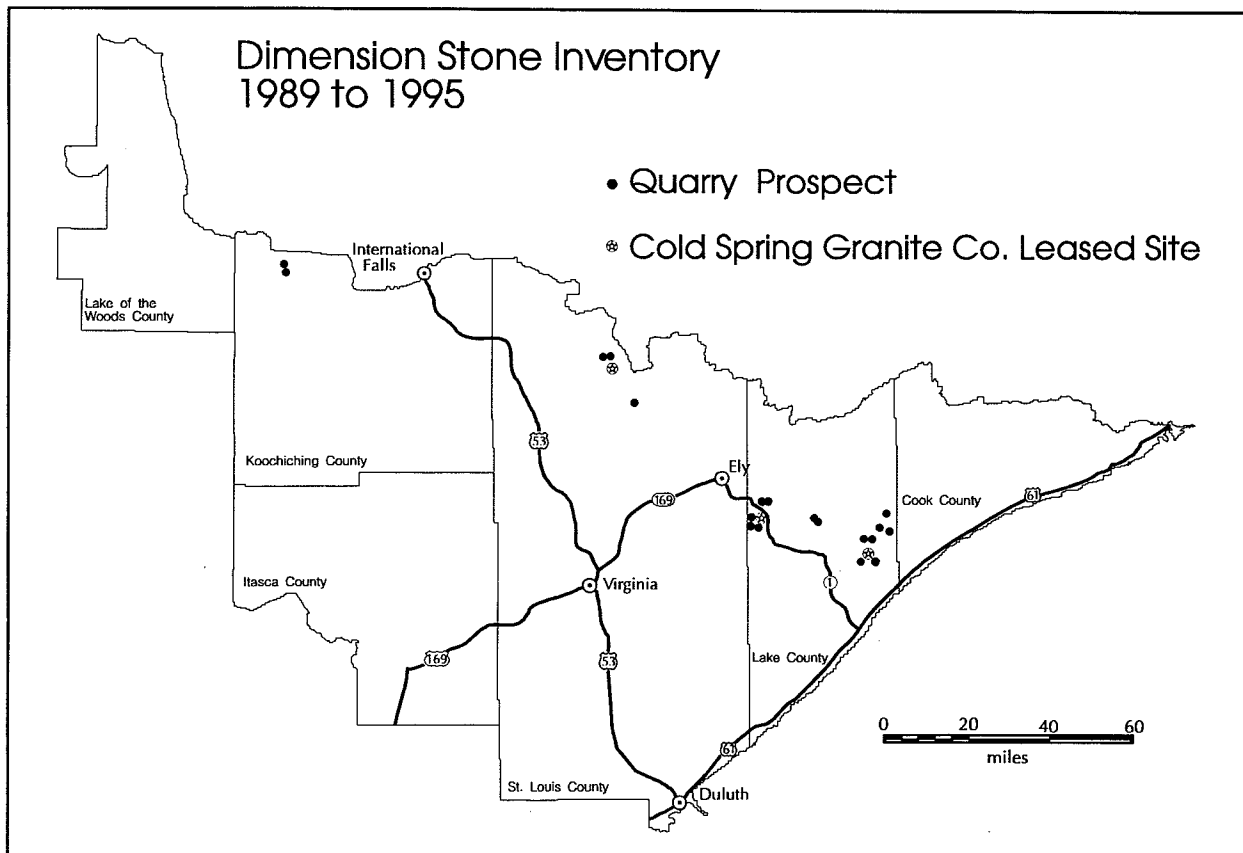


Figure 13. Location of quarry prospects identified by the dimension stone inventory (1989 to 1995) including prospects leased by Cold Spring Granite Co.

Discussion and Summary

From September 1989 to November 1994, a total of five hundred and twenty-seven 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). Twenty-two prospects have been identified that exhibit potential for dimension stone development (see Fig. 13). Sixteen prospects are located in rocks of the Duluth Complex, four are in rocks of the Vermilion Granitic Complex, and two are in a granitoid rock unit (see Fig. 2).

Cold Spring Granite Co. has acquired three quarry prospect sale areas offered by the Superior National Forest's public sale in 1991. Quarry development has begun at one of the sites and operating plans have been submitted to the Superior National Forest for one other site.

During this phase of the inventory one hundred thirty-six sites were evaluated and seven new 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 are not included in this report, but are available as open-file information at the Division's Hibbing office.

Northern Minnesota offers excellent potential for high quality quarry stone. The inventory has located unique and beautiful black, beige, pink, gray and multi-colored "granites" in a variety of textures.

The MDNR anticipates offering state-owned sites for lease in the near future.

Additional Information

The MDNR reports entitled Dimension Stone Inventory of Northern Minnesota 1991 (report 298), and Dimension Stone Inventory of Northern Minnesota 1993 (report 298) are available upon request. These reports describe the first four years of the inventory. Inventory updates can be obtained from the Division of Minerals' Open-File Bulletins.

Two color inserts are also available from the MDNR: *New Quarry Prospects* contains photographs of polished tiles from the prospects described in this report; *New Dimensions in Building Stone* contains photographs of polished tiles from the prospects described in report 298.

A color brochure entitled *Minnesota Granite* is available from the Minnesota Department of Natural Resources and the Superior National Forest, USDA. The brochure contains color photographs of polished tiles from selected prospects. The brochure was produced through a cooperative agreement between the MDNR and the Superior National Forest, USDA.

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

Prospect sites have been identified on both state and federal lands. The MDNR anticipates offering state owned sites for lease in the near future.

A guide book entitled *Dimension Stone Quarrying, A Guide to Environmental Review and Permitting* is available from the MDNR Minerals offices. The guide book summarizes the environmental review process and briefly describes the applicable federal, state, and local environmental permits that may be required for quarry development.

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).

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