FIELD TRIP GUIDE

ST. CLOUD GRANITE DISTRICT
CENTRAL MINNESOTA

by

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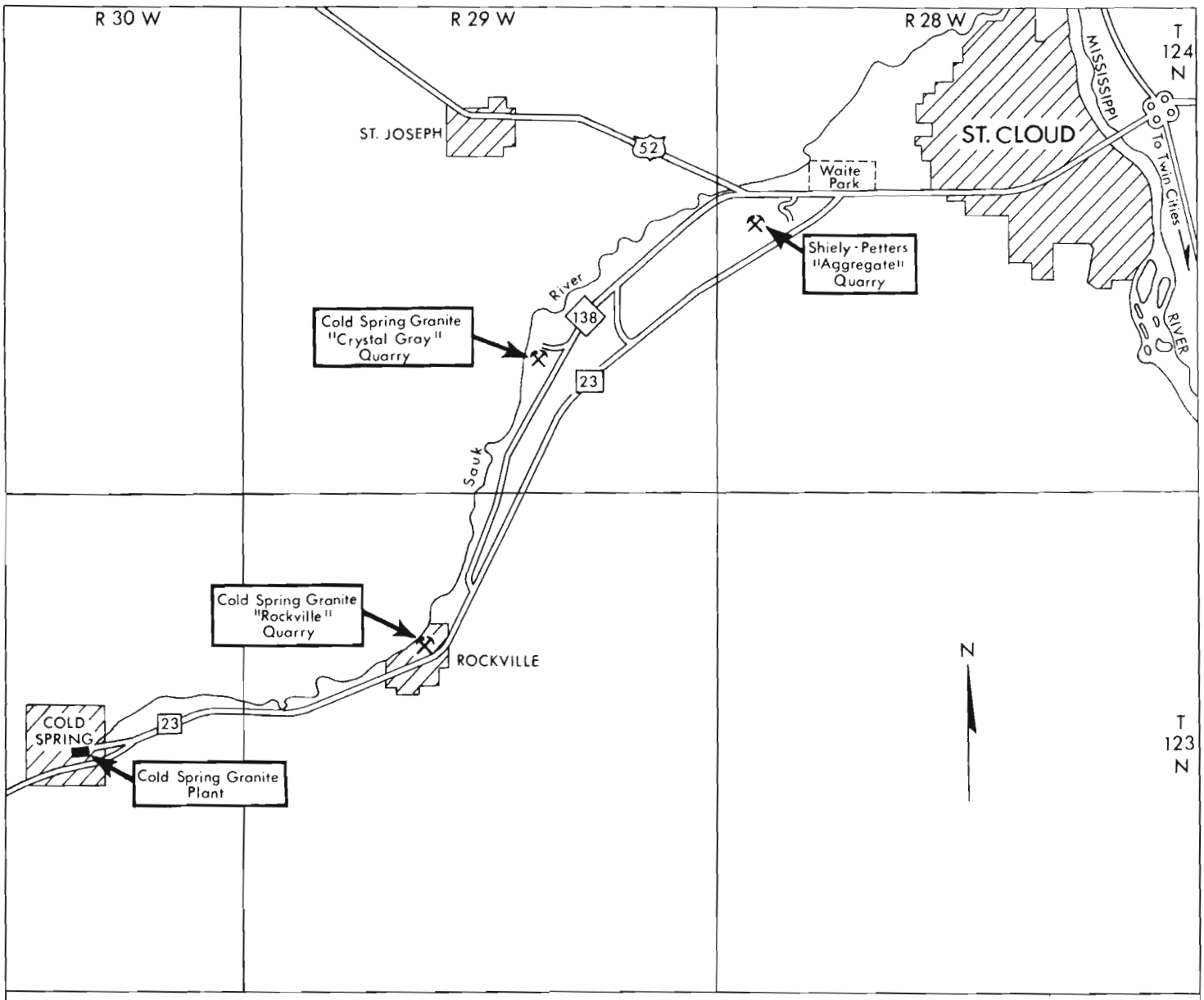

ROUTE OF FIELD TRIP

(Modified from Minnesota Highway Dept. Map)

Scale 1:11,160

INTRODUCTION

The purpose of this field trip is primarily to see the quarrying and processing operations of granite dimension stone in the St. Cloud district of central Minnesota. The Cold Spring Company will host the tour of their plant at Cold Spring. Leaders for the field trip will be D. H. Yardley and R. K. Hogberg.

Production History

Quarrying began in the St. Cloud district in 1868, near the site of the present town of Sauk Rapids. The first salable products were rough dimension stones and paving blocks. From the late 1880's until the late 1920's the sale of dimension stone rose steadily and reached a peak of $4,281,700 annually in 1923. The major demand was for dimension stones obtained from St. Cloud Red, St. Cloud Gray, and Rockville "granites." From 1929 until the end of World War II sales were depressed and reached a low of $396,800 in 1943.

The processing plants for dimension stone have decreased in number and increased in size since the early 1900's. At present (1965) there are about 20 small granite processing plants, whereas in 1915 a record of 89 finishing plants were operated in Minnesota. However, due to consolidations and increased automation three of the plants--two of which are located in the St. Cloud district--account for nearly all of the sales. One of the largest such plants in the world--that of the Cold Spring Granite Company--is our first stop.

The "hard" dimension stone industry of Minnesota has centered in the St. Cloud district. Those commercial quarries outside of the district--in the Minnesota River valley and near Lake Mille Lacs--are operated by St. Cloud-based firms.

Sales of "granite" in the State in the decade 1952-1962 averaged about $3,327,000 annually. The Rockville and the St. Cloud Gray "granites" constitute most of the present sales from the St. Cloud district.

Research by the Industry

In recent years research by the industry has been largely confined to the field of product development. The results have been quite successful, and have resulted in the development of many new uses of dimension "granites" in building construction. Among the new uses are: (1) precast monolithic wall units composed of a regular mosaic of "granite" blocks or, "granite" chips, in random arrangement, both set in a cement base; (2) floor tiles or patio-type pavements composed of granitic slabs with split or broken joints; (3) built-up veneer walls of split face ashlar or "tumble stone," and (4) various types of window unit facings composed of granite veneer.

Granite facings, the bread and butter of the industry, are now specified in larger and thinner units than previously; as a result, the quarry blocks must be extremely large and free of fractures.

GENERAL GEOLOGY

The available geologic data on the St. Cloud district was largely obtained by Margaret Skillman Woyski in 1945 and 1946. Her work resulted in a Ph.D. dissertation in 1946 and a published paper in the Bulletin of the Geological Society of America in 1949. In 1961, Goldich and others (Minn. Geol. Survey Bull. 41) published K/Ar and Rb/Sr ages on rocks of the district and reviewed the current state of knowledge of the geology of the region.

As a result of expansion of old quarries and opening of new quarries--especially the Shiely-Petters "aggregate" quarry--excellent exposures are now available to observe the geologic relationships of the district.

The commercial rock types of the district have been given informal names such as St. Cloud Red, St. Cloud Gray, Rockville, etc. These names have been used in the published literature (Woyski, 1949; Goldich and others, 1961) and are now well established. In addition, each of the companies has assigned many trade names to the dimension stones they sell.

Figure 1

Generalized Geologic Section - St. Cloud District

Era	System and Period	Age (millions of years)	Character and Distribution
Cenozoic	Quaternary	0.01 to 0.035	Stratified drift; sandy and clayey till
	unconformity		
Mesozoic	Upper Cretaceous	90	Small "pockets" of sandy, clayey, shaly and less commonly lignitic sediments
	unconformity		
Middle Precambrian	Penokean Intrusive Rocks	?	(basalt and granite porphyry dikes)
		1,640	Younger granites (St. Cloud Red, Rockville, Crystal Gray, and quartz latite dikes)
		1,780	Older granodiorite and related rocks (St. Cloud Gray Granodiorite)
	unconformity		
	Animikie Group		Thomson Formation (slate, graywacke and schist)

The rocks that have been quarried for dimension stone in the St. Cloud district are igneous rocks of intermediate and felsic composition that are Penokean (post-Animikian) in age (Goldich and others, 1961, p. 101-122). They intrude pelitic sedimentary rocks, now metamorphosed to medium-grade schists, and apparently were emplaced subsequent to the peak of deformation in the Penokean orogeny. The intrusive rocks distinguished by Woyski (1949)

can be grouped according to age relations observed in the field into three classes: (1) older granodiorite and related rocks, (2) younger granites, and (3) basalt and granite porphyry dikes.

Within the district, the older intrusive rocks are represented by the St. Cloud Gray Granodiorite. This rock underlies a roughly circular area at least three miles in diameter that lies south of St. Cloud. The rock has been dated by the K/Ar method at 1.78 b.y. (Goldich and others, 1961, p. 104).

The younger granites comprise several types of intrusive rocks of intermediate to felsic composition. The major facies that were distinguished by Woyski (1949) are the St. Cloud Red Granite, Rockville Porphyritic Granite, and quartz latite porphyry. The St. Cloud Red Granite is a coarse-grained augite-hornblende granite. The Rockville Porphyritic Granite is a fine- to medium-grained microcline-quartz monzonite. The quartz latite porphyry has phenocrysts of hornblende and plagioclase in a felsitic groundmass. All the rocks of this group are altered to some degree by late-stage deuteric and hydrothermal solutions. The sequence of alteration as recognized by Skillman (1946) was albitization, formation of chlorite-epidote-calcite, and silicification.

The late intrusive rocks include basaltic dikes and granite porphyry dikes that dominantly occupy N. 50° E.-trending fractures in the older rocks. Preliminary results on K/Ar dating of hornblende (G. N. Hanson, oral communication, 1965) from a basaltic dike from the Diamond Pink quarry, three and one-half miles southeast of St. Cloud, indicate that the dikes are somewhat younger than the Penokean rocks dated by Goldich and others (1961) but older than Keweenawan.

The St. Cloud district was a positive area from late Middle Precambrian to late Cretaceous time. In the early Cretaceous(?) (Sloan, 1964) a thick

kaolinitic regolith was developed on the bedrock surface. Reworking of the regolith by the late Cretaceous sea resulted in the relatively thin succession of sandy, clayey and shaly sediments found in isolated pockets throughout the district. Pleistocene drift consisting of sandy and clayey till and stratified silts, sands, and gravels mantles the irregular Precambrian rock surface. The greatest thickness of drift known in the district is a north-trending sandy moraine that crosses highway 23 between Rockville and Cold Spring.

Quarries in the older granodiorite and younger granites are located in a swampy area within and south of St. Cloud, where "highs" on the undulating Middle Precambrian bedrock surface form low knobby outcrops and "lows" are filled by a thin mantle of glacial outwash materials. Outcrops of younger granites that protrude from the glacial outwash sands and gravels in the valley of the Sauk River and its tributaries are the sites of several other quarries.

ROCKVILLE QUARRY
Cold Spring Granite Company

The Rockville quarry, within the Rockville Porphyritic Granite, has been the largest producer of dimension stone in Minnesota for many years. The relatively wide spacings of the joints and the general consistency of color, grain-size, and texture enable the operators to meet the demand for quarry blocks of consistent quality.

The shape and limits of the quarry are governed by two steeply-dipping intersecting fracture sets, which strike respectively N. 35°-45° W. and N. 55° E. The spacing between fractures ranges from 25 to 55 feet. A N. 5°-10° E.-trending fracture that dips 60°-70° NW. cuts diagonally across the quarry. A sheeting that dips gently to the southwest has a spacing that ranges from 5 feet near the top to 30 feet near the bottom of the quarry.

The quarry is located within a belt of outcrops of the Rockville that extends from St. Cloud southwestward to Richmond. The Rockville crosscuts the St. Cloud Gray Granodiorite and has irregular contact with the St. Cloud Red Granite to the north and east of the quarry. Inclusions of schistose material are quite abundant in the Rockville within the upper part of the quarry.

The Rockville is a pink to reddish-gray porphyritic microcline quartz monzonite. The potassic feldspar is perthitic and forms large crystals 1-6 cm. in length. The groundmass is fine- to medium-grained and is composed of about equal quantities of gray quartz and white plagioclase (andesine-oligoclase) and contains about 10 percent biotite. Easily recognized accessory minerals are hornblende, plagioclase and magnetite. Myrmekitic quartz, replacement rims of early plagioclase, and some pyrite-bearing epidote veinlets are thought to represent late stage deuteric and hydrothermal activity. Aplite dikelets commonly less than 5 cm. wide fill late-stage fractures.

CRYSTAL GRAY GRANITE QUARRY
Cold Spring Granite Company

The Crystal Gray quarry, which is 100-150 feet east of the Sauk River, was opened about 25 years ago by the Pyramid Quarry Company. It was purchased about 10 years ago by the Cold Spring Company who has operated it since that time. The quarry was completely flooded by overflow of the Sauk River in early April, 1965.

The quarry is bounded on the north and south by vertical fractures that strike N. 45° W. and on the east and west by vertical fractures that strike N. 45° E. A fracture set that strikes N. 80° W. and and dips 80° NE., and a five-foot basalt dike that strikes N. 60° E. and dips 80° NW., cross the quarry diagonally. The fractures have a 5- to 30-foot separation.

The sheeting fractures have approximately a 5-foot separation in the upper part and a greater separation in the lower part of the quarry. A prominent sheeting fracture which is 20-35 feet below the quarry rim strikes N. 45° W. and dips 10°-15° SW. towards the Sauk River.

The Crystal Gray is a porphyritic quartz monzonite that has somewhat smaller phenocrysts than the Rockville. It is a distinctively purplish to greenish-gray facies of the younger granites and is known only at this quarry. The pinkish-gray potassic feldspar phenocrysts are perthitic and average 10 mm. in length. The medium-grained groundmass consists of approximately 30 percent opalescent quartz, 30 percent greenish-gray plagioclase (andesine to oligoclase), and 10 percent biotite. Observable accessory minerals are magnetite, plagioclase, and hornblende.

The Crystal Gray appears to have had a crystallization history similar to the Rockville. Skillman (1946) suggests that the gray coloring is due to the almost complete assimulation of xenoliths of St. Cloud Gray Granodiorite. Alteration is strong along fractures in the rock, and is indicated by the presence of pyrite, chlorite, and reddish feldspars.

On the west side of the quarry, bedrock is overlain by 5-10 feet of stratified glacial drift. On the east side the bedrock capping consists of about ~~20~~ 10 feet of kaolinite-rich regolith, about 10 feet of Cretaceous sandy shale and clay, and a 3- 5-foot layer of sand and gravel.

SHIELY-PETTERS AGGREGATE QUARRY

Introduction

The Shiely-Petters quarry was opened in 1949, after the operating company abandoned an attempt to use nearby waste rock, from former quarry operations, for production of aggregate. Approximately half the production from the plant is sold for railroad ballast; the remainder is shipped to markets that require high-grade aggregate. The quarry is approximately 850

feet long in an east-west direction and 300-450 feet wide in a north-south direction; it is 40-60 feet deep.

The rocks within the quarry are intensely fractured, in contrast to those in the quarries examined at the previous stops. In addition to three steeply-dipping fracture sets that trend northwest, north, and east respectively, sheeting fractures strike N. 80° W. and dips 70° NE. The sheeting is spaced at intervals of about five feet near the surface; the spacing increases to about 25 feet in the lower part of the quarry.

St. Cloud Gray Granodiorite

The St. Cloud Gray is exposed in the east and west ends of the quarry. Commonly it is pinkish-gray, somewhat altered, and contains abundant dark gray to black hornblende and biotite-rich inclusions. The unaltered rock is a medium- to fine-grained augite hornblende granodiorite, consisting of approximately 50 percent bluish-gray plagioclase (andesine-oligoclase), 15 percent hornblende and augite, 15 percent blue or gray quartz, and 10 percent pink potassic feldspar. Easily identifiable accessory minerals are magnetite-illmenite, pyrite, and chalcopyrite. The quantity of quartz and potassic feldspar in the rock is thought to reflect the degree of metasomation by the younger granites (Skillman, 1946). A late stage hydrothermal alteration, which emanated from the younger granites, resulted in pink to red to mottled greenish-black alteration halos that surround veinlets in the St. Cloud Gray.

St. Cloud Red Granite

The St. Cloud Red can be seen as small irregular masses and dike-like stringers associated with microcline quartz monzonite along the north wall and in the St. Cloud Gray in the west wall of the quarry. It is a coarse-grained pink to red augite-hornblende granite, and consists of about 50

percent perthitic potassic feldspar, 30 percent quartz, 10 percent white plagioclase (andesine-oligoclase), and 10 percent biotite. Easily identifiable accessory minerals are hornblende, magnetite, and hematite.

The crystallization history probably was similar to that of other facies of the younger granites. Skillman (1946) suggests that the St. Cloud Red differs from the other younger granites mainly in having incorporated substantial quantities of the earlier-crystallized St. Cloud Gray Granodiorite. She attributes the pronouncedly red color to intense alteration by late-stage hydrothermal solutions. The sequence of hydrothermal alteration as recognized by Skillman (1946) was albitization, formation of chlorite-epidote-calcite, and silicification. The intense albitization of potassic feldspars released iron as hematite. A less intense alteration marked by chlorite-epidote-calcite is shown by irregularly colored green rocks that are adjacent to closely spaced fractures.

Quartz Latite Porphyry

Quartz latite porphyry is exposed as massive rock units in the north wall of the quarry. Skillman (1946, p. 81) says the quartz latite porphyry is later than the St. Cloud Gray and St. Cloud Red. Phenocrysts of hornblende and bluish-gray plagioclase occur in a dark pink felsitic groundmass. Potassic feldspar and quartz in the rocks are thought to have been introduced by late-stage deuteric solutions.

Basalt and Granite Porphyry Dikes

The late intrusive rocks exposed in the quarry consist of basaltic dikes and granite porphyry; minor pegmatite, quartz veins, and chlorite-epidote-calcite veinlets cut the rocks.

The basaltic dikes range in width from 1 to 50 feet and average about 5 feet. They occupy three joint sets: (1) N. 35°-50° W., 70°-80° NE.,

(2) N. 10°-20° E., 70°-90° NW., and (3) N. 50°-70° E., 75°-90° NW. Most dikes are massive; some have rudimentary horizontal columnar jointing and conjugate joints 60° to the wall contacts. Post-basalt fractures are hematite-stained mylonitized zones that contain some gypsum and trend N. 35°-40° W. and dip 70°-80° NE.

The dikes vary in composition from a normal basalt to more acidic rock containing anomalous amounts of sodic plagioclase and bluish-green amphiboles. They have chilled margins composed of approximately equal proportions of basaltic glass, magnetite, and plagioclase; the cores consist of various mixtures of augite, uralite and olivine, and plagioclase (zoned andesine).

Very narrow granite porphyry dikelets fill the post-basalt fractures. The phenocrysts consist of perthitic potassic feldspar, quartz, oligoclase, biotite, hornblende, and aggregates of some of these, and are set in a granulitic groundmass.

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