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George M. Schwartz, Director

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MINNESOTA BUILDING BRICK AND TILE

by

F. F. Grout

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Nearly every county in Minnesota has clay from which someone has tried to make brick for local use. Several proved unsatisfactory and the continuing production has gradually been restricted to a few extensive producers. At present the demand for brick and tile is strong and builders should know in detail what materials are available.

General reports on clays and shales of Minnesota were issued by the Minnesota Geological Survey as Bulletin 11, in 1914; and this was revised and reprinted by the United States Geological Survey as Bulletin 678 in 1919. A brief summary was included in the state survey's Bulletin 30 in 1943, from which the map in this paper is taken.

Definitions. Clay is a mixture of minerals composed essentially of hydrous aluminum silicates (predominantly kaolinite, $H_4Al_2Si_2O_9$) in particles which range in size from approximately 0.005 millimeter to submicroscopic. Clays are seldom pure, however, and they commonly contain various amounts of such minerals as quartz, calcite, and feldspars in a fine state of division or as silt, sand, and even gravel. Plasticity, the ability of moist clay to be fashioned into forms which the clay will retain until dried to rigidity, is a property of clay familiar to everyone.

Shale is a consolidated sedimentary rock composed of laminated clays. Shale beds are chiefly of marine origin and have been buried under other sediments.

Physical Properties. In addition to plasticity, the following properties have an important bearing on the behavior of clays.

Shrinkage. Both air shrinkage and fire shrinkage differ in different clays. Air shrinkage occurs during drying of the molded ware. In Minnesota clays linear air shrinkage may range from 3 to more than 10 percent. Fire shrinkage occurs during firing. Linear fire shrinkage may amount to several percent. Cracked or distorted products may result from excessive shrinkage.

Tensile Strength. The resistance of a mass of air-dried clay to rupture when subjected to a tensional force is its tensile strength. The tensile strength of dried Minnesota clays ranges from 30 to more than 170 pounds per square inch.

Fusibility. Fusion of clays occurs gradually with increasing temperature and takes place in three stages; namely, incipient fusion, vitrification, and viscosity. Incipient fusion occurs in some Minnesota clays at temperatures as low as 1780°F., but in the more refractory clays it may be at a temperature over 2280°F. Viscosity, or the point at which the ware softens and flows as a viscous liquid, is reached between 2200°F and 3200°F in different clays. Incipient fusion, vitrication, and viscosity are not sharply separated,

but the interval between incipient fusion and viscosity is known as the range of vitrification. Clays having a wide range are safest to use for vitrified ware, because most commercial kilns cannot be controlled within a range of a few degrees. If a clay begins to lost its shape a few degrees above incipient fusion the commercial kiln will leave a high proportion of the ware overfired or underfired.

Other Physical Properties. Color, grittiness, fineness, and specific gravity are other qualities affecting the product.

Minnesota Clays

The many surface clays of Minnesota related to the gray drift carry a good deal of calcium carbonate which causes them to have a short range of vitrification. Other clays related to marine shales of Ordovician or Cretaceous sediments and to the red drift and river and lake silts, are much more likely to produce hard products. Some residual clays from weathered rocks and loess are also good. The wide range of vitrification makes it possible to fire them without great losses.

The more important producing plants (See map) are as follows:

Face Brick and Tile

Twin City Brick Company, St. Paul.

Decorah shale is used by the Twin City Brick Company in the manufacture of its products. The bed is 74 feet thick at the plant site. The business was incorporated in 1892, and the annual production amounts to over 12,000,000 face brick. Some roofing, face, and back-up tile also are made. Thirty-three down-draft kilns are located on the property. The shale burns ordinarily to a buff or tan when vitrified; to red or brown at lower temperatures; and to a great variety of attractive colors when flashed (varying the amount of air and fuel gases during firing). Production continues throughout the year, giving employment to an average of 75 men. The company has furnished brick for residential and business buildings, schools, and other public structures in Minnesota and neighboring states. Some shipments are sent to the East, where they compete successfully with other high-grade brick.

At present 12 kilns are ready to operate producing building brick and tile with an annual capacity of about 15,000,000 brick. There is material available for several years, but no expansion of the plant is contemplated.

Important buildings in which this company's brick have been installed include:

Auditorium, St. Paul
Music Hall, University of Minnesota
Field House, University of Minnesota
Lowry Hotel, St. Paul

Schools at Anoka, Minnesota
North Dakota Agricultural College, Fargo
Homewood School, Milwaukee, Wisconsin
Dudgeon School, Madison, Wisconsin
Masonic Temple, Chicago
Daily New Building, New York City.

A. C. Ochs Brick and Tile Company, Springfield, Brown County.

The owner started molding brick by hand at Springfield in 1892. The business was incorporated in 1916, when the owner associated his three sons with him. A bank of Cretaceous shale, which burns to a red and reddish-brown color, supplies raw material. The plant is conveniently located on the Chicago and Northwestern Railway, a short distance east of Springfield. Sixteen round, down-draft kilns were operated on the property at about 75 percent capacity in 1940.

The company has recently stripped a large shale bank exposing plenty of material for continued or accelerated production. Annual capacity may be estimated at 15,000,000 brick and more than 20,000 tons of hollow structural building tile. About 80 to 90 men are employed throughout the year.

The Springfield firm sells its product both in Minnesota and elsewhere. It has furnished brick for about 150 schools in the Northwest. It is estimated that about 40 percent of the ware is hauled by truck and about 60 percent is shipped by rail.

The following buildings are examples of installations of the A. C. Ochs Company's product:

Nicollet Hotel, Minneapolis
Pioneer Hall, University of Minnesota
Veteran's Hospital, Fort Snelling
St. Cloud, Minnesota (49 buildings)
Mankato, Minnesota, Schools
Alex Johnson Hotel, Rapid City, South Dakota
First National Bank, Fargo, North Dakota

Nemadji Tile and Pottery Company.

Near Moose Lake in Carlton County, three varieties of glacial and lake clays furnish material for clay tile and brick: first, a reddish-brown clay in the S 1/2 NW 1/4 Sec. 14, T. 46 N., R. 18 W.; second, a red clay in the SW 1/4 NW 1/4 Sec. 26, T. 47 N., R. 17, W.; and third, a gray clay in Sec. 28, T. 48 N., R. 16 W. All these varieties were apparently deposited in the lakes formed when glacial ice blocked the eastern outlet of Lake Superior. The enlarged Lake Superior at one stage is referred to as Lake Nemadji. Part of the clay may have been deposited as a moraine, dropped directly from the melting ice into the lake, but the gray clays were washed into the lake from the gray drift areas to the north. The deposits are thick and cover large areas, and supplies are therefore almost unlimited. The gray clay has been used many

years at Wrenshall for light-colored building brick.

The three clays have different properties and are skillfully blended to make the products desired. The company has made red and brown floor tile since 1923, and since 1937 it has made an increasing amount of pottery in Indian styles and brilliant colors. The clay is prepared in a blunger to a slip to pour into molds. Chemicals are used to improve deflocculation and fluidity. The ware is fired without vitrification in a down-draft kiln and glazed in a muffle kiln.

The company estimates that their annual capacity for production of floor tile may be as much as 150,000 square feet if the demand continues.

Even more important, it is possible that other products may be made from the abundant available clays. The company after long experience in mixing clays to obtain products that vitrify as desired, might be able to help someone produce large tonnages of face brick.

Common Brick and Tile

Common brick and tile are produced at many plants and with a variety of equipment. In small operations soft mud machines and temporary drying sheds and kilns are used; in larger plants stiff mud and presses, continuous drying tunnels, and continuous kilns are employed. The large producers of common brick are the C. H. Klein Company of Chaska, the Wrenshall Brick Company of Duluth, the Red River Valley Brick Corporation of Grand Forks and Fertile near East Grand Forks, and the Bemidji Brick Company of Bemidji. These establishments, which produce light-colored brick for back-up purposes, operate principally in the summer, when the bricks are air-dried. Smaller plants make common brick at St. Cloud, Anoka, Sillmar, Warren, and Winona. Of these only the Winona clay burns red. The Willmar plant makes mostly tile. Several of these may be able to increase production considerably in comparison with normal records in recent years.

The Winona Brick Company with an annual capacity of 2,000,000 might increase production 50% if there was a demand. The Klein Company at Chaska with 10 kilns and an annual capacity up to 20,000,000 brick might increase production as much as 50%. The C. Flykt Brick and Tile Company at Willmar operates two kilns and can produce about 480,000 brick and 48,000 building tile. If calls for the product increase they might increase production 50%. The Red River Valley Brick Corporation at Fertile in 1941 put into production three kilns having alternate burning units. Their capacity is up to 7,500,000 brick per year and if there were a strong demand they believe that might be doubled. All of these increases are to some extent based on increased labor and equipment, which are expected to be available in the coming months.

Marketing

Minnesota ranks about 25th in the production of clay products in the United States.

Statistics concerning the clay industries of Minnesota have been compiled from the Biennial Census of Manufactures, and the United States Bureau of Mines Mineral Resources and Minerals Yearbooks, the annual statistical publication where further details may be found. For many years there have been from 10 to 20 firms manufacturing clay products in the state, all together giving somewhat seasonal employment to about 500 or more men. The common brick are valued at about $9 to $15 a thousand, at the plant.

Clay products are sold direct to consumers, through dealers and salesmen, and to contractors and jobbers.

Shipments to distant points are made principally by rail, but truck haulage is common for short distances. Long hauls are sometimes made by truck, especially if the truck would otherwise be empty on a return trip. Common brick producers cater largely to local trade, and trucking is the usual method of transportation.

The Clay Products Institute of Des Moines serves producers in the region as a sales agency, but not all the large producers in Minnesota are members. The only two manufacturers of face brick, those at Springfield and at St. Paul, compete with each other and with brick manufacturers in other states. St. Paul brick are shipped East in competition with fine face brick made in that section.

Reserves

Minnesota has vast supplies of clay suitable for the manufacture of such products as face brick, common brick, structural tile, and drain tile. Reserves of lake clays for common brick are enormous, and if they were exhausted gray drift clays of the western half of the state could supply the demand. These gray drift clays are not much used at present because they contain limestone pebbles, but the work done at Hutchinson indicates that the pebbles can be removed at a moderate cost by washing, to yield a clay that is satisfactory for making brick and drain tile.

The quarry of the brick company in West St. Paul has enough Decorah shale to last for several decades. If the shale supply at the present quarry becomes depleted, operations could be expanded laterally within the limits imposed by the value of city property. Accessible and virtually inexhaustible reserves of Decorah shale exist over many square miles in southeastern Minnesota. From St. Paul, where it is used for face brick and tile, it crops out at many places in a belt to the most southeasterly counties of the state. In several of these there are available exposures not far from thriving cities, -- Faribault, Rochester, and Cannon Falls.

There is a reserve of clay also at Coon Creek north of Minneapolis. A deposit of red drift was worked there for many years by the Minnesota Paving Brick Company. The product was very satisfactory for buildings, for the paving of railway station platforms, and for similar uses. The property was purchased and the plant was closed, but this is said to have been a matter of business competition rather than any defect in the quality or cost of production. There is probably a good deal of red drift of the same quality nearby. Nevertheless, a warning should be given prospective investors, --namely, that there are clays of several different grades near Coon Creek. The old plant used a red clay that was covered by a later gray (to brown) clay of very inferior quality--the upper clay was stripped off and discarded. There are also clays, near the river, that have been reworked from the glacial drifts into river silts. Anyone planning to use clays near Coon Creek should not only consider the market and business arrangements, but also explore the clay by sampling and testing, to make sure that he acquires control of a large body of satisfactory material.

LIGHTWEIGHT CLAY AGGREGATES FOR CONCRETE

Abstracted from U.S. Bureau of Mines Information Circular 7195

"Need for lightweight building materials was created in the later part of the nineteenth century by a radical change in building design. As size and design of the load-bearing framework are controlled chiefly by dead load, the natural result was a search for and use of lightweight materials in partitions, floors, and exterior walls. However, these thin walls created problems of heat and sound insulation, so that building materials which possessed good heat-and sound-insulating properties in addition to light weight were objects of extensive research. One group of materials developed to fill this need comprised lightweight concretes, of which some were obtained by the use of lightweight aggregates.

"Lightweight aggregates may be classified into three general groups, depending upon their source: (1) Natural, (2) byproduct, and (3) specially processed materials; the third group contains the expanded shales or clays and slags, nearly all of which are marketed under patented trade names. All lightweight aggregates impart essentially the same characteristics in varying degrees to the finished concrete in which they are used. Light weight, availability, ease of cutting or channeling and adequate heat- and sound-insulation of the finished work are the principal desirable properties.

"All expanded shale or clay aggregates are made by the same basic process, which essentially is the rapid elevation of the temperature of a prepared raw material to a point between its incipient and complete vitrification temperatures. In this temperature range, which is reached just before discharge from the kiln, the shale or clay softens, becomes sticky, and tends to trap evolved gases. The material is discharged in this condition and cooled rapidly to retain the cellular structure. Since raw shale or clay particles ranging in size from 48 mesh to 1 1/2 inches are fired together and all show the same degree of expansion, it is evident that the bloating occurs only after the material passes its temperature of incipient vitrification. Also, at this temperature the evolved gases are given off more

rapidly than immediately prior to incipient vitrification, thereby indicating new source compounds from which the gases are derived. In the burning of bricks and formed clay products, it has been shown that black-coring and bloating, or expansion, are due to the carbon, iron, and sulfur contents of the raw materials. Sulfur is claimed to be the final or actual cause of the swelling, chiefly by the reactions of sulfides, sulfates, and silicates, to release sulfurous gases.

"As demand for lightweight concretes is centered almost entirely in building construction, it is natural that facilities to produce lightweight aggregates would be located in or near the centers of building activity, which are the densely populated metropolitan areas. This segregation of production has set up well-defined market areas in which generally two or more light-weight aggregates are available and competing with each other."

Minnesota has many deposits of clays that swell viscously on rapid heating. Notes were made of this behavior in Bulletin 11 of the Minnesota Geological Survey and in the revised edition of the paper published as Bulletin 678, of the U. S. Geological Survey, on Clays and Shales of Minnesota. The following counties have such clays that expand enormously on heating; the page references are to Bulletin 678. Aitkin County, page 112; Anoka County, pages 114 and 116; Blue Earth County, page 125; Brown County, pages 129, 133, and 134; Carlton County, pages 137 and 139; Dakota County, page 151; Douglas County, page 155; Faribault County, page 156; Fillmore County, page 159; Goodhue County, pages 165 and 167; Itasca County, page 177; Koochiching County, page 183; Nicollet County, page 204; Olmsted County, page 207; Rice County, page 223; St. Louis County, page 226; Stearns County, page 235.

Competitive Products

While clay products are likely to be in great demand until the need for housing is satisfied, makers of clay brick are keenly aware that other brick and building blocks are being used in large numbers. The most direct competition comes from (1) sand-lime brick and (2) concrete blocks. These are perfectly satisfactory for certain places in a building, but few take the place of face-brick on the outside of a house. At a sand pit near Chaska in 1946, about 24,000,000 sand-lime brick were produced. Concrete blocks are made at many villages and towns, as needed. The proposed portland cement plant to be started near Monticello may give local users of cement a stimulus to increased manufacture of cement blocks. The use of clay products will continue, however, and most builders seem to expect that the demand will be heavy for several years.