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MEMORIAL STONE

BY OLIVER BOWLES

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UNITED STATES DEPARTMENT OF THE INTERIOR
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INTRODUCTION

From the most remote periods of civilization stone has been used to perpetuate the memory of individuals or to immortalize their noble achievements. Ancient memorials ranged from simple piles of stone (cairns), or single markers, to great obelisks and pyramids or magnificent mausoleums. The Taj Mahal at Agra, India, built of white marble by Shah Jehan in memory of the Empress Mumtaz Mahal, is one of the most beautiful and costly memorials ever built. It was erected between 1632 and 1650 at an estimated cost of \$50,000,000 or more and is today an object of unusual interest for travelers. Other magnificent memorials both ancient and modern are to be found in many lands.

No sharp line can be drawn between buildings and monuments, because the larger types of memorials such as the Bok Singing Tower, Lincoln and Jefferson Memorials, and mausoleums of various types have features in common with buildings. However, great care must be exercised in selecting a site for a quarry that will produce acceptable monumental stone because appearance as well as quality is of prime importance. The deposit must be of uniform texture and attractive color and must be notably free of knots, hairlines, impurities, incipient seams, or other defects. Many memorials are of polished stone, and spots or streaks that might be virtually invisible on a natural rock face will appear distinctly on a polished surface. Hence, stone to be polished must be selected with unusual care. However, less flawless stone may be used for hammered surfaces.

Stone containing certain natural impurities must be avoided for either polished or unpolished use. For instance if crystals of the iron sulfides, pyrite or marcasite, are present they may oxidize by weathering and form rusty stains.

Memorials with few exceptions consist of granites and related rocks or marbles. The United States is well supplied with high-quality rock types eminently adapted to all memorial uses.

The accompanying table shows the magnitude of production during recent years. Statistics for other years may be found in the Stone chapter of the Minerals Yearbook published annually by the Bureau of Mines.

TABLE 1. - Memorial stone produced in the United States 1948-52

Year	Granite		Marble		Total	
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
1948	3,326,990	\$16,458,601	397,260	\$4,082,470	3,724,250	\$20,541,071
1949	2,772,580	15,100,149	352,720	3,657,710	3,125,300	18,757,859
1950	2,666,710	14,946,508	296,120	2,878,374	2,962,830	17,824,882
1951	2,609,134	14,606,453	242,553	2,244,771	2,851,687	16,851,224
1952	2,508,994	14,458,426	284,695	2,658,634	2,793,689	17,117,060

MEMORIAL GRANITES

Granites have generally been classed as igneous rocks derived from molten masses or magmas, but there is wide evidence that the origin of some granites may be attributed to regional metamorphism of preexisting rocks, rearrangement and recrystallization taking place without the need of a liquid or molten stage. In any case granitization is a slow, deep-seated process, which results in the creation of medium- to coarse-grained rocks. Granites consist essentially of feldspars (chiefly orthoclase or microcline), quartz, and some dark mineral such as biotite (black mica) or hornblende.

White, gray, pink, and red are the more common colors, but green, mahogany, and other colors are produced in some localities. Varieties known commercially as black granites are not true granites, they are diorites, gabbros, or similar dark igneous rocks. They generally contain lime-soda feldspars rather than the potash feldspar, orthoclase, and hornblende or pyroxene, and they contain less quartz than true granites.

Granites are generally named according to the most prominent dark mineral present, for instance, biotite or hornblende granite.

Distribution of Deposits

The more prominent centers of memorial granite production are described briefly, by States, in alphabetical order as follows. Memorials of commercial quality are produced at times in other localities.

California. - A light-gray, fine- to medium-grained memorial granite is quarried near Rocklin, Placer County. Gray granite is produced also near Lakeside and Escondido, San Diego County. A light-gray granite specked with black mica crystals is quarried at Raymond, Madera County, for both buildings and monuments. Hornblende diorites, classed as black granites are, or have been, quarried at Porterville, Tulare County, near Perris, Riverside County, and at other points.

Connecticut. - The more important quarry centers for memorial stone in Connecticut are in southern New London County, chiefly at East Lyme, Niantic, and Waterford. Pinkish-gray granite occurs near the first and second of these locations. The Waterford stone is dark gray.

Georgia. - A medium-grained, light-gray granite, a fine-grained, dark granite, and a brownish-pink granite are quarried extensively near Elberton, Elbert County, for memorial uses. Several companies operate well-equipped quarries and finishing mills in the area. Georgia produces larger quantities of memorial granite than any other State.

Maine. - Most of the granite produced in Maine is used for building or curbing, but some of the even-grained gray biotite granites with pinkish or lavender tint quarried on Deer Isle and Crotch Island, Hancock County, are used for memorials.

Massachusetts. - A granite ranging from greenish gray to dark bluish gray is quarried near Quincy, Norfolk County. Some years ago Quincy was one of the leading sources of memorial granite in the United States, but the rock is quarried on a relatively small scale at present. A uniform gray granite is quarried extensively in the West Chelmsford, Westford, and Graniteville district of Middlesex County. The West Chelmsford stone is used more extensively as a building stone than for

monumental purposes. Memorial stones are quarried at times in several other places in Massachusetts.

Minnesota. - The St. Cloud district, Stearns County, has long been recognized as a prominent source of memorial granite. The principal product is a medium- to coarse-grained red granite, but gray granite is also quarried. Most of the output is milled into cut and polished monument stock in well-equipped establishments in and near St. Cloud. At Ortonville, North Redwood, and other points in the Minnesota River Valley (Big Stone, Redwood, and Renville Counties) pink and red granites are quarried. A granite-gneiss quarried at Morton (Renville County) is used more extensively for building than for memorials. Red and pink granites are produced also near Mountain Iron, St. Louis County.

North Carolina. - A white to light-gray granite of medium texture is quarried at Mt. Airy, Surry County, chiefly for building purposes but some is used for memorials. Both gray and pink granites are quarried near Salisbury, Rowan County. The pink rock is used for memorials.

Oklahoma. - Medium-grained red and pink granites have been quarried for many years at Granite, Greer County. Another granite area developed at a later time is near Snyder, Kiowa County. The prevailing type is a mottled pink and gray, fine- to medium-grain hornblende granite.

Pennsylvania. - Diabase and gabbro classed as black granites are quarried in the Coopersberg district of northern Bucks County and at St. Peters, Chester County.

Rhode Island. - Two types of memorial stone are quarried near Westerly, Washington County - a pinkish or buff biotite granite, and a bluish-gray biotite granite, both of fine-grained, uniform texture. These rocks are in the form of massive dikes 50 to 150 feet thick intruded into the older granite gneiss. The relatively rapid cooling of the intruded magmas probably accounted for their fine-grained texture.

South Dakota. - The granite belt of Big Stone and Renville Counties of the upper Minnesota River valley extends from Minnesota into Grant County, S. Dak., where it is quarried for memorial uses near Milbank. The rock is similar to that at Ortonville, Minn., except that the color is mahogany rather than red.

Vermont. - Barre granite sales are greater in total dollar value than those of any other region. The rock is a fine- to medium-grained, gray to white biotite granite of uniform texture. Light and dark shades are marketed. The darker varieties are most in favor for monuments and the lighter for buildings, mausoleums, and monument bases. The quarries are located on Millstone Hill a few miles from Barre. Both quarries and mills are well equipped with modern machinery. Much of the stone is sold as rough blocks, which are fabricated into finished monuments by manufacturing companies, many of which are located in and near Barre.

Wisconsin. - Several types of memorial granite are available in the well-known Wausau district of Marathon County, but the reddish brown to brilliant red are the most popular. A coarse-grained, red to pale-pink stone is quarried near Amberg, Marinette County. Fine-grained, grayish-red and bright-red granites are produced at Montello, Marquette County.

Other States. - Dark-red granite is quarried at Graniteville, Iron County, Mo.; a fine-grained, blue-gray stone near Milford, Hillsboro County, N. H.; a fine-grained, gray biotite granite at Rion, Fairfield County, S. C.; and a fine- to medium-grained,

light- to dark-gray granite near Llano, Llano County, Tex. Monumental stone is produced at times in various other localities.

MEMORIAL MARBLES

Marbles are regarded as metamorphic rocks resulting from the recrystallization of limestones. Commercially all calcareous rocks capable of taking a polish are classed as marbles. Furthermore, serpentine rocks if attractive in appearance and capable of taking a good polish are commercially classed as marbles (verd antique), even though they contain little calcium or magnesium carbonates.

Marbles consisting of pure calcite or dolomite are white, but the color may be modified by impurities. Black or gray colors generally are due to the presence of carbonaceous matter and yellow-brown, yellow, or cream to iron oxides. Marbles may be uniformly colored or the impurities may be present in bands or streaks giving clouded marbles.

Marbles for monuments or other exterior use should be of uniform texture, close-grained, of low absorption, and free from impurities that may stain or corrode the surface.

Distribution of Deposits

Descriptions of deposits that follow are confined to those that supply significant quantities of memorial stone.

Alabama. - The most important marbles of Alabama pass through southern Talladega and northern Coosa Counties in a continuous belt about 35 miles long with a maximum width of 1-1/2 miles. The beds are 200 feet thick in places and usually dip about 30° southeast. Most of the Alabama marbles are white and fine grained. They are of low porosity and consist of 98 to more than 99 percent of calcium carbonate. The largest quarries are near Sylacauga. The rock is fabricated in fully equipped mills.

Georgia. - The marbles of Georgia are confined almost exclusively to a series of narrow belts in Pickens County. They are quarried extensively in an area near Tate and Marble Hill. White, light- and dark-gray, clouded, and pink marbles are produced. They consist of 93 to 99 percent calcium carbonate and are of very low porosity. Several large quarries and finishing mills supply both building and memorial marble.

Missouri. - The most important marble district of Missouri is the Carthage area, Jasper County. The rock is coarsely crystalline and white to light gray with a bluish tint. The highest quality rock produced is used for monument stock. Marble quarried at Phenix, Greene County, is of the same geologic age as that at Carthage (lower Carboniferous) and is similar to it in many respects.

North Carolina. - Marble is produced near the town of Marble, Cherokee County. Two types are available - a dark bluish gray some of which is streaked with white and a white variety.

Tennessee. - The marble belt of east Tennessee is extensive. It lies in the Tennessee River Valley in an area 12 to 16 miles wide and 125 miles long. Knoxville is about the center of the belt. The marbles are not highly metamorphosed. Many of them contain crinoid fossils that show no distortion, but the rock is so completely

crystallized that it takes a good polish. Gray and pink varieties are widely used. Several companies have extensive quarries and large mills, but only a relatively small part of the output is used for memorials.

Vermont. - The marble belt of western Vermont, which is about 80 miles long, lies chiefly between the Green Mountains and the parallel Taconic Range 1 to 4 miles to the west. The rocks have been intensely folded and are commonly so steeply inclined that underground mining has to be followed. Many of the marbles are of high purity ranging from 98 to more than 99 percent CaCO_3 . Their porosity is low. White, gray, and green with veined and clouded markings are available. Large quantities of memorial marbles are quarried and fabricated in this area. Most of the production is from Rutland County. The largest quarry is at Danby, the largest mill at West Rutland, and the largest shop at Proctor.

QUALITIES, CHARACTERISTICS, AND DURABILITY

Questions frequently arise as to the merits of certain types of stone to which trade names are applied. Inquiries are common also concerning the durability of memorial stones, the relative endurance of stones from different localities, and the comparative merits of marble and granite.

Many trade names are applied to memorial stones such as Stony Creek, Oakland White, Rock of Ages, or Rainbow among the granites and Etowah, Madre Cream, Creole, Eureka, or Imperial marbles. Prospective users may raise questions as to whether these named varieties or types are superior to others in the same or nearby regions. The Bureau of Mines has no data indicating that any of them is more enduring than the others. Some of them are special types that have no counterparts in the same or other districts. In other instances the types to which trade names are applied may differ little from the general character of the stone in a given region. Differences that exist may be due to more rigid selection of stone or to superior workmanship in fabrication, but these are features on which the Bureau of Mines has little or no information. Customers are to be guided by appearance, color, texture, design, and the evidence that may appear in the finished product of the degree of skill and care that have been exercised in shaping, carving, and finishing.

Information concerning the relative durability of the different types of stone is frequently requested. Is a granite, for instance, more enduring than a marble? No positive answer can be given to this question because, owing to differences in composition and physical properties, certain granites may be more enduring than the average marble and certain marbles may last longer than the average granite.

The effects of weathering on granite differ considerably from those on marble. Granite consists of a mixture of several hard and insoluble minerals, which, with temperature changes, expand and contract at different rates, and thus slowly disintegrate. On the other hand, marble suffers little disintegration by expansion and contraction as it consists essentially of one mineral - calcite. Marble, however, is slowly soluble in water containing carbon dioxide, small quantities of which are always present in the air or in rainwater. It also dissolves slowly if exposed to acid fumes. Granite, therefore, deteriorates chiefly by disintegration and marble by processes of solution. In standard memorial stones, these processes, however, are so extremely slow that under average conditions visible changes will not appear for many decades.

Both granites and marbles are notably enduring. Cleopatra's Needle, a shaft of stone now standing in Central Park, New York City, was fashioned from Syene

granite in Egypt 3,500 years ago. Although its corners are rounded, the main structure shows only moderate evidence of thin surface weathering. An example of marble endurance is the temple of Athena Nike built of white Pentellic marble in Athens, Greece, in 450 B. C. In 1676 A. D., 2,126 years later, it was still in use, but was destroyed in that year by an invading army. A more modern example of enduring marble is the Taj Mahal already mentioned, the exterior of which is said to be in good repair after more than 300 years of exposure.

All of the standard monumental granites and marbles produced by reputable firms in well-known regions last so long with so little visible change that the factor of endurance should scarcely be given consideration in making a choice. Selection may therefore be made on the basis of color, texture, design, and workmanship that best suit individual taste.

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