



## HIGH-CALCIUM LIMESTONES IN OHIO

Limestone and dolomite have so many applications that they have been described as the “duct tape” of geologically derived materials. Deposits of high-calcium limestones in Ohio have been used since the mid-1800s to produce cement and lime, which continue to be essential items for a growing industrial economy. Cement has various uses in the construction industry. Lime, both magnesium-rich and high-calcium varieties, has a multitude of uses in the chemical, glass, paper, and steel industries, as well as in agriculture and water treatment.

A high-calcium limestone is a carbonate rock containing mostly calcium carbonate ( $\text{CaCO}_3$ ) and less than 5% of magnesium carbonate ( $\text{MgCO}_3$ ); however, the majority of available carbonate resources in Ohio are dolomitic limestone, which contains 20% or more of  $\text{MgCO}_3$ . In addition, many of the easily accessible, highly calcareous limestone deposits in Ohio have either been depleted or are currently being mined. It is important to understand the areal extent and chemical composition of potential high-calcium limestone resources remaining in Ohio, so that informed decisions can be made about their future development.

### GEOLOGY OF HIGH CALCIUM LIMESTONES IN OHIO

#### PUTNAM HILL LIMESTONE

The Putnam Hill Limestone is part of the lower portion of the Pennsylvanian-age Allegheny Group. The Putnam Hill is located in portions of Muskingum, Perry, Licking, Coshocton, Holmes, Wayne, Tuscarawas, and Stark Counties. The Putnam Hill is a medium-gray, massive, finely crystalline limestone that contains abundant fossils and has zones of chert and flint scattered throughout it. The Putnam Hill averages 3 feet thick but can range up to 10 feet thick.

The Diamond Portland Cement Company quarried 10 feet of high-calcium Putnam Hill Limestone for a cement plant at Middlebranch, Stark County that operated from 1892 to 1977. The Putnam Hill Limestone at Middlebranch has a carbonate content of 94.7%  $\text{CaCO}_3$  and 1.5%  $\text{MgCO}_3$ .

#### VANPORT LIMESTONE

The Pennsylvanian-age Vanport Limestone is located in portions of southern Ohio (Vinton, Jackson, Lawrence, and Scioto Counties) and northeastern Ohio (Tuscarawas, Stark, and Mahoning Counties). The Vanport Limestone is up to 20 feet thick in Mahoning County, where it is brown, dense, and fossiliferous. The ESSROC Cement Corporation quarried the Vanport Limestone in southeastern Mahoning County during 2006 to supply a Portland Cement plant in nearby Bessemer, Pennsylvania. The average chemical composition from 3 samples was 94%  $\text{CaCO}_3$  and 1.3%  $\text{MgCO}_3$ .

The Vanport Limestone was mined at several locations in Lawrence County. In the Hanging Rock Region, it was used as a flux in iron furnaces in the late 1800s; later, it was used to support a thriving cement industry. The Superior Portland Cement Company mined the Vanport underground at Pedro, Elizabeth Township from the turn of the century until 1954. The Vanport Limestone is 7 feet, 10 inches thick at Pedro. It was used to produce cement that was used extensively in the construction of locks and dams in the Ohio River.

#### MAXVILLE LIMESTONE

The Maxville Limestone is Upper Mississippian in age. The Maxville outcrops in areas of Perry, Muskingum, Hocking, Vinton, Jackson, and Scioto Counties. The Maxville is up to 40 feet thick along Jonathan Creek in Muskingum County. The lower zone

of the Maxville is a massive blue-gray limestone that weathers to light brown and is approximately 25 feet thick. A 3-foot-thick middle “nodular” zone consists of interbedded limestone and shale that is fossiliferous. The approximately 12-foot-thick upper zone is thin- to medium-bedded, dense, blue-gray limestone. The Maxville has a disconformable contact with the overlying Pennsylvanian-age sediments. The upper Maxville is often removed by erosion, which creates challenges with stratigraphic correlation.

The Pittsburgh Plate Glass Company, Columbia Chemical Division, operated a Portland cement plant at East Fultonham, Muskingum County beginning in the 1920s. Chemical analyses of Maxville Limestone samples from East Fultonham indicate an average of 94%  $\text{CaCO}_3$  and 1.4%  $\text{MgCO}_3$ . The East Fultonham underground mine was abandoned in 1984 and the entire operation closed in 1987. Maxville Limestone greater than 50 feet thick occurs in the subsurface over a wide area of southeastern Ohio. Depth to the top of the Maxville varies from 110 feet in Morgan County to greater than 1,900 feet in Monroe County.

Chemical analyses from the subsurface Maxville in southern Ohio vary from 81%–98%  $\text{CaCO}_3$  and 0.1%–5.6%  $\text{MgCO}_3$ . The Alpha Portland Cement Company mined the Maxville north of Ironton, Lawrence County from 1913 until it closed in 1970. Depth to the top of the Maxville Limestone is approximately 475 feet. The Maxville in the Alpha mine is 97 feet thick, of which 43 feet was mined. The Maxville at Alpha is gray to brown, regular-bedded, dense, sparsely fossiliferous limestone.

#### COLUMBUS LIMESTONE

The Devonian-age Columbus Limestone has a wide distribution in northern and central Ohio and a chemical composition that approaches or surpasses 90%  $\text{CaCO}_3$  in many places. The typical Columbus exposure consists of a lower portion of brown, massive, dolomitic limestone that contains chert and rare fossils. The average thickness of the lower portion of Columbus Limestone is 40 feet. The upper 65 feet of Columbus Limestone consists of gray, crystalline, highly fossiliferous limestone.

Active Columbus Limestone quarries produce stone used primarily as aggregate for the construction industry, but the Columbus has been utilized for more specialized purposes in the past. For example, the Pittsburgh Plate Glass Company began operating an underground Columbus Limestone mine in Barberton, Summit County during 1942, which operated until 1976. The upper 51 feet of the Columbus Limestone had been identified as suitable for the manufacture of heavy chemicals, so two 16 x 7-foot shafts were sunk to a depth of 2,300 feet. The coarse stone (greater than 7/8 of an inch in diameter) was used by the chemical plant and the smaller stone (less than 7/8 of an inch in diameter) was used to manufacture Portland cement.

#### DUNDEE LIMESTONE

The Devonian-age Dundee Limestone is exposed in several quarries in northwestern Ohio and is present in the subsurface at depths of less than 900 feet. The lower Dundee is light gray to light brown, sucrosic, sandy dolomite and limestone rock with abundant chert. The upper Dundee is a medium- to coarse-grained fossiliferous limestone. The basal portion of the upper Dundee is often sublithographic to lithographic and pelletal in part. Thickness of the lithographic limestone facies ranges from less than 20 feet to greater than 60 feet. The insoluble magnesium oxide content of the Dundee averages less than 0.5% in chemical analyses.

The Lafarge Corporation, Great Lakes Region, operates a Portland cement plant in Paulding County. In 2006, Lafarge

produced more than 800,000 tons of Dundee Limestone from the Paulding quarry to manufacture Portland cement. Lafarge also produced more than 140,000 tons of the overlying Silica Shale to be used in the cement manufacturing process.

### BRASSFIELD LIMESTONE

The lithology of the Silurian-age Brassfield Formation is heterogeneous, consisting of limestone, dolomite, and shale. The Brassfield outcrops in portions of eight counties in southwestern Ohio. Its total thickness in southwestern Ohio is 11–50 feet. In Greene, Montgomery, Miami, and Preble Counties, the lower portion of the Brassfield is composed of light-gray to white limestone with green clay or shale partings and interbedded dolomite. The upper portion is a pink to gray, medium- to coarse-grained, fossiliferous limestone. From central Highland County to the Ohio River, the Brassfield member of the Drowning Creek Formation is relatively less bioclastic and contains abundant chert.

Chemical analyses of more than 1,000 samples of the Brassfield in Ohio reveal several locations with limestone intervals that are greater than 10 feet thick and contain more than 95% CaCO<sub>3</sub>. Many areas containing the Brassfield in southern Preble County, western Montgomery County, southwestern Miami County, and western Greene County contain less than 3% MgCO<sub>3</sub>. CEMEX operates a Portland cement plant southeast of Fairborn in Greene County. In 2006, CEMEX produced approximately 1 million tons of Brassfield Limestone from quarries in Greene and Montgomery Counties to manufacture Portland cement, which is the most common type of cement used in concrete production.

### BLACK RIVER GROUP

The Ordovician-age Black River Group is found in Ohio's subsurface. Depths to the top of the Black River in southwestern Ohio range from approximately 700 feet (in counties adjacent to the Ohio, Little Miami, and Great Miami Rivers) to greater than 2,000 feet in Champaign County. The Black River consists of 400–500 feet of micritic and pelletal limestone with some dolomitic and argillaceous zones. There are several potential high-carbonate zones within the Black River, but the "Carntown" unit in the lower portion of the Black River is the most consistent high-calcium zone.

In 2006, the Carntown unit was mined along the Ohio River at a lime plant in Carntown, Kentucky. An analysis of a 34-foot section of the unit indicates a chemical composition of 95.1% CaCO<sub>3</sub> and 3.8% MgCO<sub>3</sub>. Chemical analyses of the Carntown unit in Ohio revealed several areas of mineable thickness with 97–98 % total carbonate and less than 2% insoluble oxides.

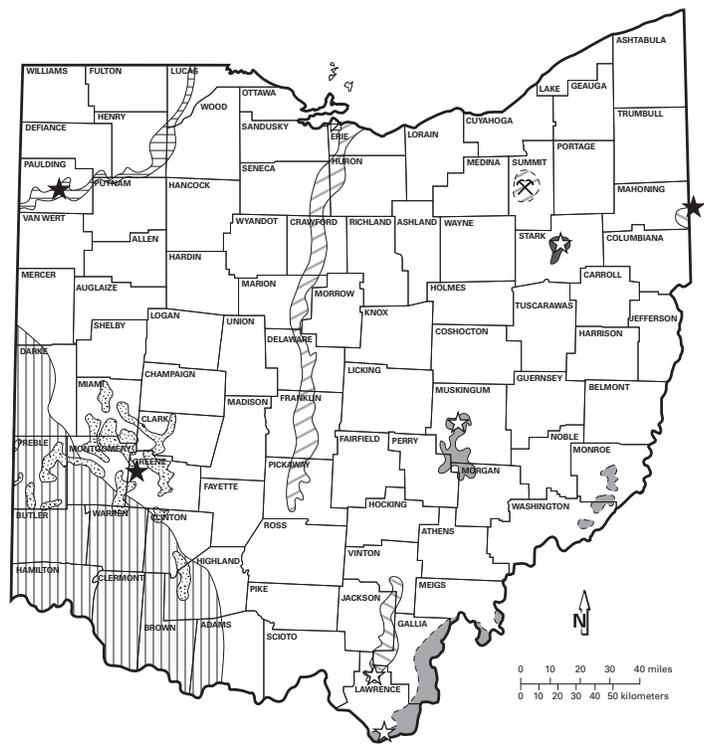
### FUTURE DEVELOPMENT OF HIGH-CALCIUM LIMESTONES IN OHIO

Annual cement production in Ohio is less than 25% of the state's cement consumption. The cost of transporting cement is significantly high for industries that use cement, which suggests there is a demand to increase cement production within the state. There is also a growing secondary market for high-calcium limestone used for flue-gas desulfurization at Ohio coal-burning power plants complying with federal Clean Air Act regulations.

Relatively inexpensive water transport may be key to the economic success of any new high-calcium limestone production facility. Near the Ohio River, in portions of Lawrence and Gallia Counties, Maxville Limestone is more than 100 feet thick at potentially mineable depths of less than 1,000 feet. The "Carntown" unit of the subsurface Black River Group found along the Ohio River near Cincinnati and the Dundee Limestone at shallow depths near Lake Erie also contain deposits of high-calcium limestone that warrant further geologic evaluation for their production suitability.

### FURTHER READING

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| Putnam Hill Limestone (Pennsylvanian)                 | Dundee Limestone (Devonian)               |
| Vanport Limestone (Pennsylvanian)                     | Brassfield Limestone (Silurian)           |
| Maxville Limestone (Mississippian)                    | Black River Group (Ordovician) SUBSURFACE |
| Columbus Limestone (Devonian) SUBSURFACE WHERE DASHED | Current cement plants (2008)              |
| Abandoned PPG Industries limestone mine               | Abandoned cement plants                   |

Surface or near-surface geologic units that contain potentially mineable high-calcium limestone.

