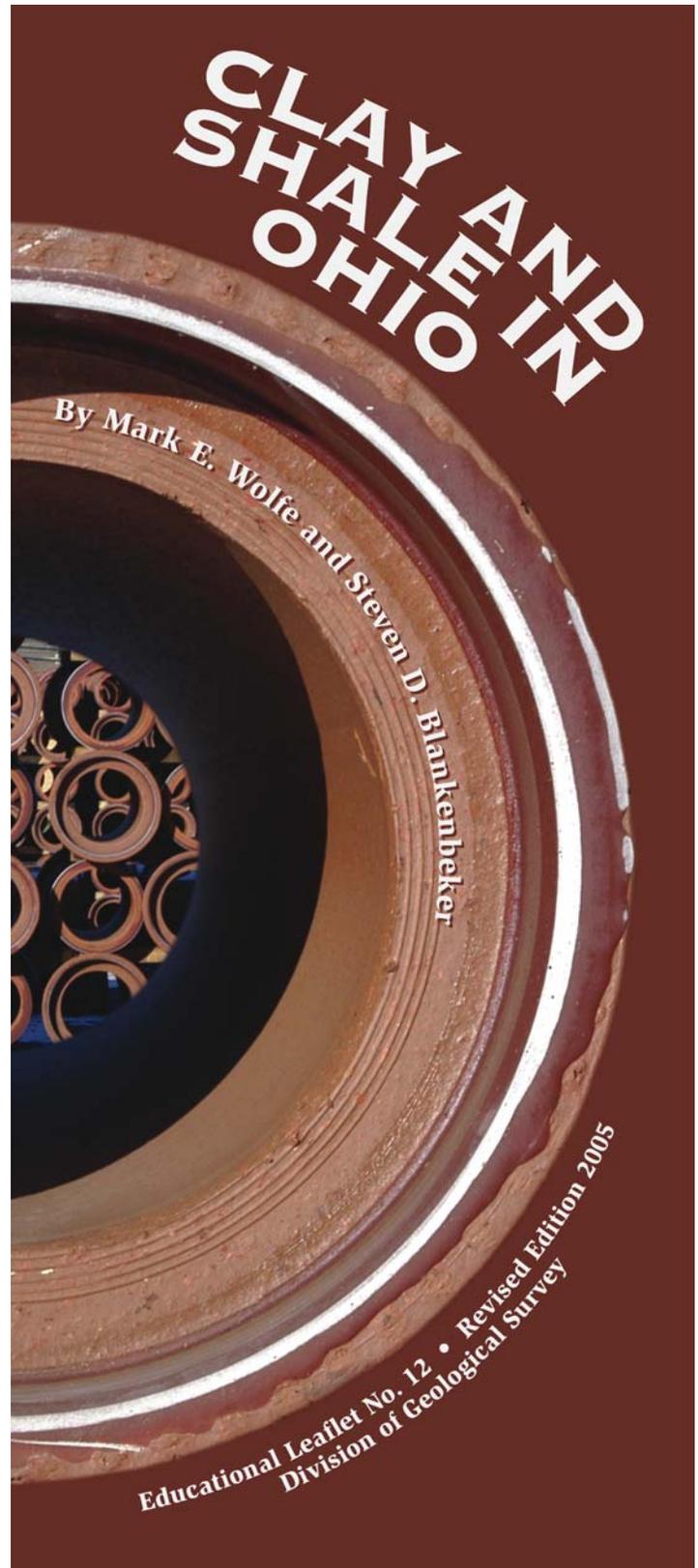


INTRODUCTION

Ohio has an abundant supply of shale and clay resources that are ideally suited as raw material for production of high-quality ceramic products. Pennsylvanian-age shales and clays of eastern Ohio are the primary sources of raw materials for the ceramic industry; Mississippian- and Devonian-age shales of northern and central Ohio, and Pleistocene-age glacial clays of western Ohio, are important secondary sources. Some of the finest pottery, brick, pipe, and tile in the world are made from these Ohio raw materials.

American Indians used Ohio clay to fashion pottery, platform and effigy smoking pipes, and other ceremonial objects. The first use of brick by the early European settlers in Ohio was in the construction of Campus Martius at Marietta from 1788 to 1791. The manufacture of pottery in Ohio is first mentioned in 1799 at Cincinnati. By 1840, nearly 100 factories in 32 counties were producing pottery. The first reported manufacture of other types of clay and shale products in Ohio include roofing tile—1814, pressed brick—1829, fire brick—1841, terra cotta—1859, drain tile—1859, sewer pipe—1868, sanitary and decorative (encaustic) tiling—1879, and paving brick—1885. Ohio continues to be among the national leaders in the mining and manufacturing of clay and shale products vital to the construction and retail industries. Although clay and shale have been mined in Ohio for more than 200 years, supplies should be more than adequate to meet growing demand in the 21st century.

Clay is an unindurated (not hardened) earthy material composed mostly of submicroscopic particles (0.004 mm or smaller in diameter). The key property of clay is its “plasticity.” When clay is wet, it is easily shaped. When fired at high temperatures in a kiln, however, formerly moldable clay becomes very hard. Clay minerals (kaolinite, illite, chlorite, vermiculite, and montmorillonite) are hydrous aluminum silicates formed primarily through chemical weathering of feldspars and micas found in metamorphic and igneous rocks. Kaolinite is the primary clay mineral in most underclays (clays immediately below a coal); illite is the dominant clay mineral in glacial clays. Silt-size (0.004-0.0625 mm) grains of quartz, mica, feldspar, and carbonates from the mechanical weathering of source rocks are common accessory minerals in clays.





Hawk effigy pipe carved from Ohio pipestone or “flint-clay.” Ohio Historical Society photo.

Ohio clay deposits formed in a variety of depositional environments. Underclay deposits commonly are present directly below coal beds and represent ancient soil (paleosol) in which Pennsylvanian-age plants were rooted. Other Ohio clay deposits formed when clay-and-silt-sized materials transported by streams accumulated on the bottoms of quiet water bodies such as lakes or lagoons. Glacial clay deposits were formed through the action of continental glaciers that ground up entrained shales and soils into silt- and clay-sized materials and redeposited them as till or glacial-lake (lacustrine) clays.

Shale is a fine-grained, thinly laminated sedimentary rock that consists primarily of clay with lesser amounts of organic material, and silt-sized particles of quartz, mica, and other common minerals. Most shale in Ohio was formed in shallow seas, lakes, lagoons, or swamps. Shales generally must be ground very fine before they develop plasticity and can be used to manufacture ceramic products.

PROPERTIES AND USES OF CLAY AND SHALE

Plasticity, maturing temperature, fired color, and relative amount of contaminants are critical properties of shale and clay that determine suitability for usage as a raw material in the manufacture of ceramic products. The property that most people associate with clayey materials is plasticity or stickiness. This property sets shales and clays apart from other mineral resources and is the result of the molecular structure of the clays.

Individual clay molecules have a flat or platy form and link together to form larger, sheet-like molecular structures. Clay and shale particles are each made up of millions of these molecular sheets stacked one upon another like cards in a deck of playing cards. Water is readily absorbed on the flat surfaces of clay particles and acts as a lubricant that allows particles to freely slide over and across one another. The result is a very slippery and sticky material that is readily molded. In ceramic manufacturing, whether the desired product is a piece of pottery or a brick, the ability of clay and shale to be easily molded is critical.

Clays and shales vary widely in their degree of plasticity. Glacial clays are generally the most plastic because they are extremely fine grained and have a very high surface to weight ratio that allows each particle to absorb a large amount of water relative to its own weight. Glacial “clays” generally are highly plastic despite the fact that the true clay-mineral content of some of these materials may be less than that of other clay resources. The underclays of the coal fields are next in plasticity, followed by shales. Clays or shales that are high in siliceous or sandy material have lower plasticities. Some products, like brick, require a material with low to medium plasticity. If the material is too plastic, it becomes very difficult to



The Adena human-effigy pipe, a prehistoric Indian artifact made from clay found in Scioto County. Ohio Historical Society photo.

form and dry the product, while maintaining its shape. Shales work well for brick for this reason. Stoneware potters prefer highly plastic clays that easily form strong vessels on a potter's wheel.

The maturing temperature of a clay or shale is the temperature at which the material begins to fuse or melt. After being heated to this temperature and allowed to cool, previously moldable clay is transformed into a solid product. Clays and shales vary greatly in this property. Some shales melt as low as 1700°F, while some clays are able to withstand temperatures in excess of 2500°F before they start to fuse. As a general rule, the more kaolinite present in a clay, the higher the temperature must be for the material to melt. The more fluxing minerals present (iron oxides, calcium carbonates, potassium oxides) the lower the maturing temperature. Glacial deposits have the lowest maturing temperatures in the state; the fireclays (hence the name) have the highest.

The resultant color of a fired ceramic product depends mostly on the mineral composition of the shale or clay being used to make the product. Shales generally fire to some shade of red or brown due to the significant amount of iron-oxide minerals that are present in them. Most shales contain between 6 and 10 percent iron oxide, and even though they may be red, brown, yellow, green, gray, or black in the ground, they will usually fire red. The high-quality fireclays of the coal fields typically have a low iron content and a high kaolinite content. This combination results in a material that will fire buff or off-white but seldom red.

Contaminants are present to some degree in nearly all clay and shale deposits. Glacial materials may include rocks and other debris that were transported along with the clays before deposition. Shales may include particles of limestone, dolomite, fossils, silica (sand), carbon, and other undesirable materials. Fireclays may contain iron contaminants such as pyrite (iron sulfide) and siderite (iron carbonate), high percentages of silica, as well as organic carbon and calcium carbonate; these contaminants make the material inferior in quality. Clays and shales most desired for the manufacture of ceramic products have minimal contaminants.

HISTORY AND PRODUCTION TRENDS OF CLAY AND SHALE IN OHIO

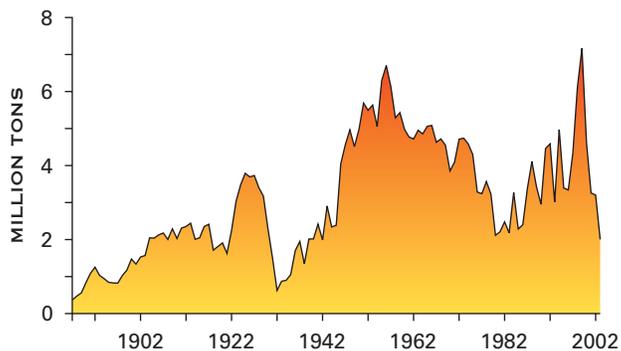
East Liverpool, located on the Ohio River in Columbiana County, was one of Ohio's early centers of pottery activity. By 1884, there were 21 companies (87 kilns) producing whiteware, creamware, and Rockingham or yellowware at East Liverpool. Semi-vitreous china (almost glass-like in appearance) was developed in the East Liverpool district in 1890 through the introduction of new raw-material blends, better clays, and harder firing processes. Knowles, Taylor & Knowles Company, The Hall China



Finishing room of a pottery in East Liverpool, Columbiana County, circa 1890. Ohio Historical Society photo.

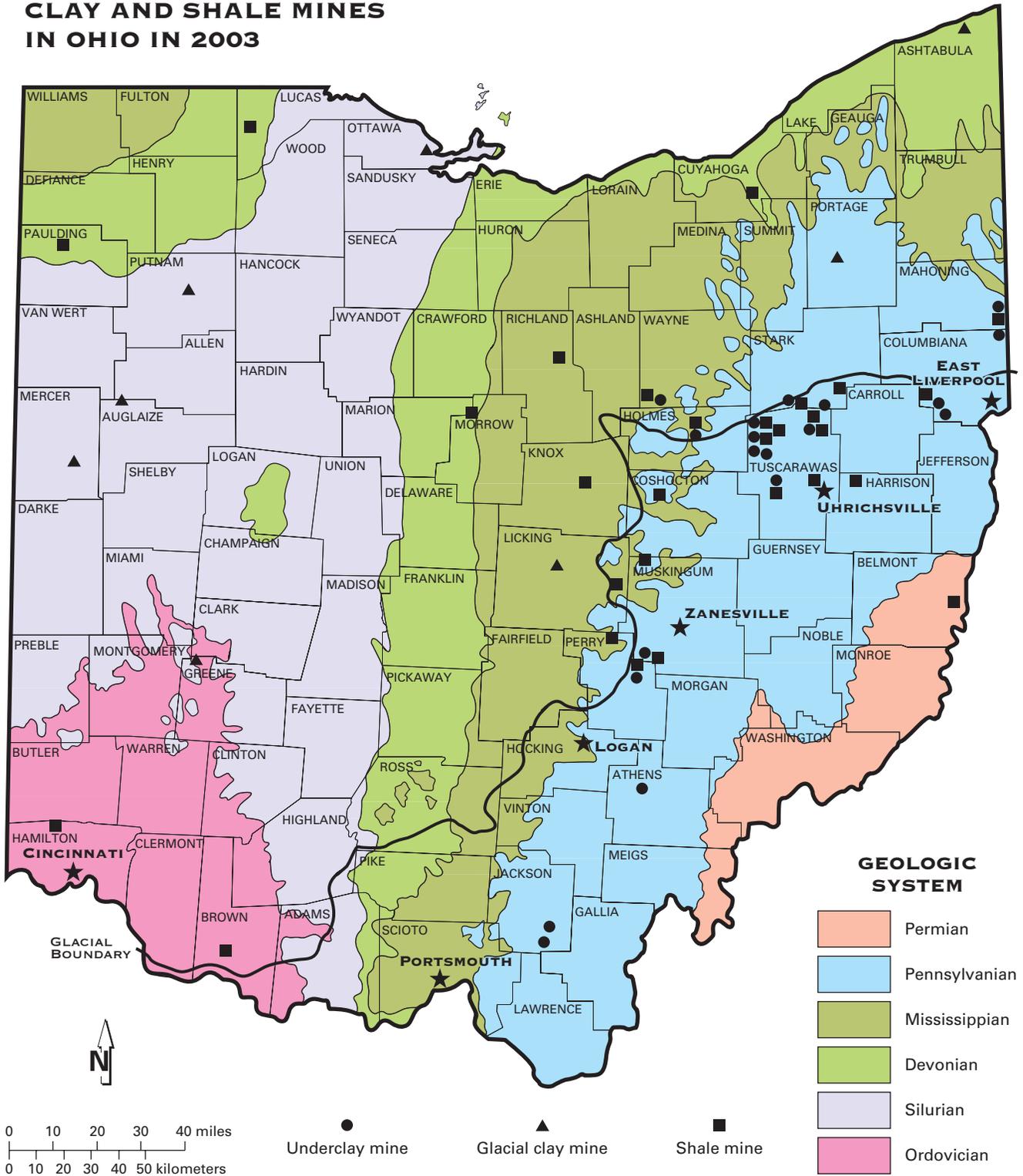


Peebles Block was manufactured in Portsmouth, Scioto County. The Portsmouth area supplied paving brick to many towns all along the Ohio and Mississippi Rivers.



Tonnage of clay and shale produced in Ohio, 1876-2003.

CLAY AND SHALE MINES IN OHIO IN 2003





A variety of bricks made by the Belden Brick Company, Tuscarawas County.



Pottery from current Ohio potters. Center: Buckeye Stoneware, Zanesville (Muskingum County); left: Beaumont Brothers Pottery, Crooksville (Perry County); right: Fioriware Art Pottery, Zanesville (Muskingum County).

Company, and The Homer Laughlin China Company were the early innovators in this type of china. The Pottery Museum in East Liverpool has many fine examples of early Ohio china.

Cincinnati ranked next to East Liverpool for many years in the production of whiteware, but was a leader in the production of decorative art pottery. Today, Cincinnati is widely recognized as a historic ceramic art center. The famous Rookwood pottery, found in art museums and private collections throughout the world, was first produced by Cincinnati's Maria Longworth Nichols in 1880 using clay resources primarily obtained from the Ohio Valley. Rookwood was a pioneer in the development of various crystalline glazes and employed master decorators from the Art Academy of Cincinnati to create its elegant designs.

The Zanesville area in Muskingum County was also an extremely important early center of the clay and shale industry in Ohio. Muskingum County supported 22 potteries as early as 1840. Clay products were easily shipped down the Muskingum River by flatboat to the Ohio River and from there onto numerous southern markets. Pressed brick manufacture began in Zanesville in 1875 and soon grew into a thriving industry. By 1886, the Zanesville area was regarded as producing some of the finest ornamental and enameled brick in the country. The Zanesville area was also a leader in sanitary and decorative (encaustic) tile as well as paving brick. The art pottery of Zanesville's S. A. Weller Pottery Company and other area manufacturers such as the Roseville Pottery Company in Perry County, are valuable collectibles today. A recent resurgence in the art pottery industry in the Zanesville area has resulted in sustained growth in existing companies and the successful start-up of many new operations. The Ohio Ceramic Center near Roseville, the Zanesville Art Center in Zanesville, and the National Road/Zane Grey Museum near Norwich have beautiful collections of Zanesville area ceramics.

Three other Ohio communities also were important centers for manufacture of clay products. Ceramic-product plants in the Logan area of Hocking County consumed several hundred tons of Pennsylvanian-age clay daily from the 1880's through the 1950's to manufacture building tile, sewer pipe, drain tile, paving bricks, and salt-glazed bricks. Portsmouth, on the Ohio River in Scioto County, was well known for the production of fire brick and paving brick from clays of the Pennsylvanian-age Pottsville Group. The Uhrichsville/Dennison area of Tuscarawas County also supported a thriving ceramic industry and was widely known for the quality and number of shale and clay units (from the Pennsylvanian-age Pottsville, Allegheny, and Conemaugh Groups) that could be produced locally. Tuscarawas County clays and shales were once used to produce huge amounts of sewer pipe and are still used to manufacture millions of building bricks annually.

Ohio mined 2.0 million tons of clay and shale in 2003, ranking 5th nationally. The greatest annual production



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was recorded in 1999 when 7.1 million tons of clay and shale were produced in Ohio. Estimated cumulative production of clay and shale in Ohio since 1800 is 365 million tons. Most clay and shale in Ohio is mined by the open-pit method. The only active underground clay mine in the United States, however, is located at Stone Creek in Tuscarawas County.

Underground mining of clay was once very common in Ohio; the ODNR, Division of Geological Survey has records of more than 200 abandoned underground mines in the state that once mined clay. Because clays are associated with coals, some mines recovered both clay and coal. The mining of multiple commodities from a single mine is still common today, but all are from surface operations.

The largest (52 percent) single use of Ohio clays and shales in 2003 was to produce common clay products such as building bricks. The Sugarcreek area in Tuscarawas County is a large building brick manufacturing area; other important brick-producing areas are in Licking, Marion, Columbiana, and Richland Counties. Additional uses of Ohio clay and shale in 2003 were as liners in landfills, cement manufacture, the production of lightweight aggregate (used in specialized structural building applications), and construction activities.

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Cover photo: Ceramic sewer pipe made by the Logan Clay Products Company in Logan, Hocking County.