OHIO GEOLOGY

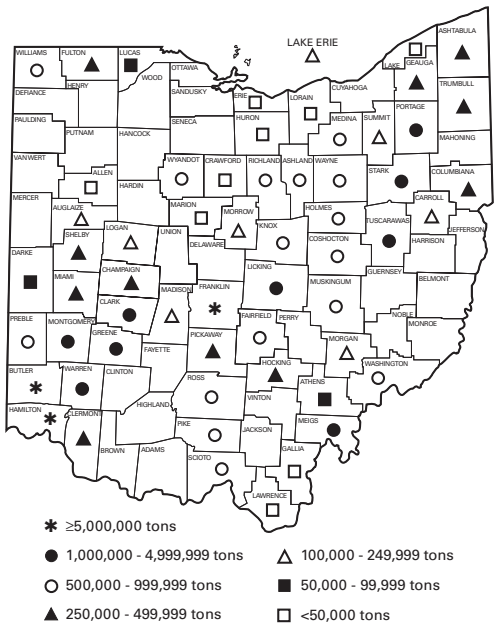
GEOFACTS No. 19

OHIO DEPARTMENT OF NATURAL RESOURCES • DIVISION OF GEOLOGICAL SURVEY

SAND AND GRAVEL

Sand and gravel mining is Ohio's second-largest (on a tonnage basis) mining industry. In 2000, 55.9 million tons of sand and gravel were produced in Ohio, making it the fifth-largest sand and gravel producing state after California, Texas, Michigan, and Arizona. Sand and gravel mining also is the second-largest nonfuel mining industry in the United States; national production of construction sand and gravel in 2000 was estimated to be 1.17 billion tons.

Sand and gravel are the only mineral resources to be produced in every state and are the most widely produced mineral resources in Ohio—84 of the state's 88 counties have reported commercial sand and gravel production during the past 50 years. In 2000, Ohio had 297 reporting sand and gravel mines operating in 58 counties plus Lake Erie. The top-10 sand and gravel producing counties, in decreasing order of production, in 2000 were: Butler, Hamilton, Franklin, Portage, Stark, Greene, Tuscarawas, Clark, Warren, and Meigs. Together, these counties accounted for more than 65 percent of Ohio's sand and gravel sales.



Sales of sand and gravel in Ohio in 2000, by county.

Sand and gravel were the last of Ohio's mineral resources to be commercially exploited. State records for sand gravel production begin with 1904, when 1.4 million tons were reported to have been produced. Sand and gravel were not produced to any significant extent before 1900 because the primary applications for construction sand and gravel did not exist before that time. Primary uses for sand and gravel in the early 1900's, as well as today, were aggregate for concrete and paving. At that time, wood-plank sidewalks were being replaced with concrete sidewalks, bridge and building foundations were being constructed of poured concrete rather than cut stone, and dirt roads began to be surfaced with aggregate to accommodate the newly invented automobile.

WHAT ARE SAND AND GRAVEL?

Sand and gravel are an unconsolidated natural accumulation of rounded rock and mineral fragments. Unlike other mineral resources such as gypsum, salt, limestone, dolomite, clay, shale, and coal, which are defined on the basis of composition, sand and gravel are defined on the basis of particle size. **Sand** consists of rock or mineral particles ranging in size from 0.002 to 0.08 inch in diameter, and **gravel** consists of particles ranging from 0.08 to 4 inches in diameter. Geologists commonly further define sand and gravel and larger rock particles as: **grains** (0.04 to 0.08 inch), **granules** (0.08 to 0.16 inch), **pebbles** (0.16 to 2.5 inches), **cobbles** (2.5 to 10 inches), and **boulders** (more than 10 inches). Sand and gravel particles are eroded fragments of rock formations (and shell material in coastal and former coastal areas); thus, their range in chemical and mineralogical composition is as variable as the rocks from which they are derived. Some of the more common rock and mineral compositions of sand and gravel particles in Ohio are: limestone, dolomite, quartzite (derived from Sharon conglomerate), shale, sandstone, siltstone, chert, flint, quartz, coal, and a large variety of igneous and metamorphic rock and mineral types transported to Ohio from central Canada by Ice Age glaciers.

High-quality sand and gravel deposits in Ohio are composed mostly of hard, durable rock and mineral types such as limestone, dolomite, quartzite, granite, diorite, greenstone, and quartz. Undesirable or deleterious constituents in sand and gravel deposits cause premature deterioration or disfiguration of the products (such as pavement, concrete blocks, and sidewalks) in which they are used. Some of the more common deleterious constituents in Ohio sand and gravel deposits include shale, friable sandstone, siltstone, coal, chert, claystone, and ironstone.

HOW ARE SAND AND GRAVEL USED?

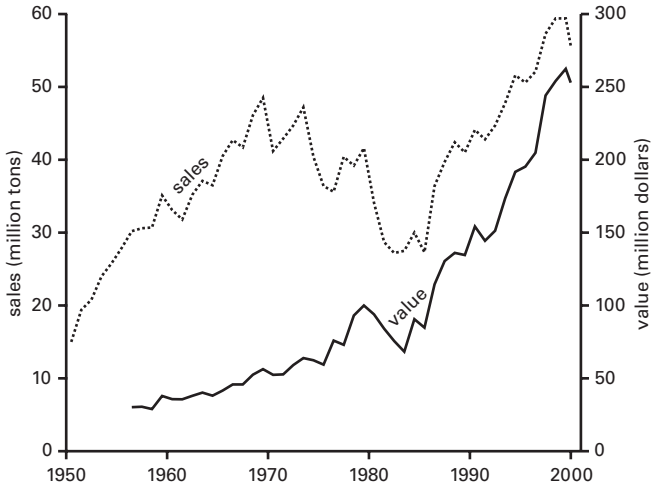
Sand and gravel are used primarily for **aggregate**—hard, nonreactive rock particles that can be characterized and marketed according to particle size, shape, hardness, soundness, and mineralogy. Aggregate is the most used mineral commodity in the United States and may be derived from natural deposits of sand and gravel or from crushing of quarry rock. The dominant use of sand and gravel is as construction aggregate in portland-cement concrete and asphaltic concrete. Most building and bridge foundations, many modern commercial buildings, most new interstate-class highways, and sidewalks are made of portland-cement concrete. Asphaltic or bituminous concrete (blacktop) is the preferred paving material for many primary and secondary highways, parking lots, bike trails, and driveways and for repaving of concrete highways. Gravel aggregate commonly is used alone or with a binder (such as tar) to pave rural roads and as ballast for railroad tracks. Other construction uses of sand and gravel include fill material, drainage media, and filtration beds for water-treatment facilities. Industrial and other uses of Ohio sand include molding sand for castings in foundry operations, sand-blasting abrasive, and traction enhancer for ice-covered highways and sidewalks.

Approximately 4 tons of sand and gravel must be mined each year for every person in the United States. About 90 tons of aggregate are required for a new six-room house, 15,000 tons are required for an average-size school, and 85,000 tons are required for each mile of new four-lane highway.

HOW ARE SAND AND GRAVEL DEPOSITS FORMED?

Most sand and gravel deposits in Ohio were formed directly or indirectly by continental glaciers, which occupied up to two-thirds of the state during the recent Ice Age, about 2 million years to 10,000 years before the present. Sand and gravel deposits formed directly by glaciers include kames and eskers. **Kames** are conical hills or short irregular ridges of stratified (layered) rock material transported by glaciers and deposited by glacial meltwater flowing along the margins of or within crevasses in melting glaciers. Kames are found throughout the glaciated portion of the state primarily in

continued



Sales and value of sand and gravel in Ohio. Figures from 1984 to 2000 include Lake Erie dredged material.

the Ohio River drainage system. The largest kame complex in Ohio occupies a 15-mile-wide by 50-mile-long corridor in portions of Geauga, Portage, Summit, and Stark Counties. **Eskers** are sinuous, linear ridges of stratified material deposited by meltwater streams flowing on, within, or below melting glaciers. Eskers are much less common than kames in Ohio. The state's best developed esker is probably the 10-mile-long Circleville Esker, which occupies the central portion of the Scioto River valley in Pickaway County. **Outwash** is stratified drift deposited indirectly by glaciers in valleys or on plains by meltwater issuing from the front of a melting glacier. Outwash deposits are present in most river valleys connecting the glaciated portion of the state with the Ohio River. Outwash also is present along the Ohio River. The largest inland outwash deposits in Ohio are present along a 100-mile-long stretch of the Great Miami-Mad River system between Bellefontaine and Cincinnati and a 90-mile-long stretch of the Scioto River valley between Columbus and Portsmouth.

Sand and gravel also have been deposited as beach ridges, offshore bars, deltas, and dunes along the former coastlines of Ice Age lakes which occupied the drainage basin of today's Lake Erie. These deposits can be found throughout the Lake Erie watershed and are used as a source of molding sand for production of heavy iron and steel castings (such as engine blocks) in addition to aggregate.

Sand and gravel are deposited as alluvium on the floodplains of postglacial streams throughout glaciated and unglaciated areas of Ohio. Alluvial sand and gravel deposits generally are finer grained than glacial-meltwater deposits, as present-day streams typically have less energy than meltwater streams and therefore less ability to transport large particles. Alluvial deposits also tend to contain a significant amount of organic matter eroded from fields by runoff and carried into adjacent streams. Extensive deposits of alluvial sand and gravel occur as sand bars, river bottoms, and floodplains along major streams such as the Ohio, Great Miami, Maumee, Whitewater, Scioto, Licking, Hocking, Muskingum, and Tuscarawas Rivers. Postglacial sand and gravel also have been deposited as lacustrine (lake) deposits on the bottom and along the shore of Lake Erie and as lens-shaped bodies within fine-grained glacial deposits (till). Commercial production of sand and gravel from lacustrine deposits and lenses within till is very limited in Ohio and accounts for far less than 1 percent of total production.

HOW ARE SAND AND GRAVEL DEPOSITS MINED?

The method of choice for mining sand and gravel is primarily a function of depth to the water table. Kame, esker, and outwash deposits lying above the elevation of adjacent streams generally are situated above the water table and thus can be mined using large earth-moving equipment such as front-end loaders and diesel-powered shovels. The portion of outwash and alluvial deposits lying below the water table is mined using floating vacuum dredges, floating clamshell dredges, floating bucket-ladder dredges, draglines, or diesel-powered shovels with long reaches. In some instances, a sand and gravel operation will use large earth-moving equipment to remove the portion of the sand and gravel deposit lying above the water table, then convert to a dredging operation to remove the remainder of the deposit lying below the water table. Mining below the water table creates an artificial lake.

After removal from the ground, sand and gravel are transported by front-end loaders, trucks, or conveyors to a processing plant, where the material is washed, sieved for desired size gradations, and stored in conical stockpiles. In some instances, gravel particles are crushed before sieving in order to increase the amount of a desired particle-size fraction. Material is then removed from stockpiles using front-end loaders and/or conveyors and typically loaded into large dump trucks, which deliver the product to the job site. Before leaving the mine, the dump trucks pass over a scale, which weighs the load of sand and gravel. The scale master tallies the amount of material being hauled away by each buyer and provides that information to the mine's business office, which generates invoices. While most sand and gravel mined in Ohio are transported by truck, some material also is moved by rail, river barges, and Great Lakes-class freighters.

Sand and gravel are sold by the ton (2,000 pounds). A ton of dry, loose sand or gravel has a volume of about 20 cubic feet. In 2000 in Ohio, a ton of sand and gravel sold for an average of $4.53 at the mine. As high-volume, low-value commodities, transportation is the dominant factor controlling the ultimate cost of sand and gravel delivered to a job site. The cost to transport sand and gravel by truck over open highways is variable but was about 15 to 20 cents per ton per mile (the rate is higher for distances less than about 10 miles) in 2000. Long-haul transportation costs by barge, freighter, or rail may be as little as one-eighth the cost of long-haul truck transport. Transportation costs in congested urban areas generally are three to four times the cost of open-highway transportation. As an example, the cost of a dump-truck load of sand and gravel mined on the south side of Columbus doubles by the time it is delivered to a job site 10 miles away on the north side of the city. In order to minimize aggregate-transportation costs, it is essential that aggregate be produced as close as possible to urban centers where most aggregate is consumed. For this reason, forward-looking land-use planners and zoning officials are using geologic maps to designate selected areas within their jurisdictions for future aggregate-mining development.

After mining, sand and gravel pits are among the least expensive mining sites to reclaim and commonly are converted into beautifully landscaped golf courses and attractive building sites for new houses. Postmining land values commonly exceed premining values because of terrain improvements and the creation of wetlands and lakes and ponds for boating, fishing, and swimming.

FURTHER READING

Bates, R. L., and Jackson, J. A., 1982, Our modern stone age: Los Altos, California, William Kaufmann, Inc., 132 p.
Dorr, Ann, 1987, Minerals—foundations of society: American Geological Institute, 2nd ed., 96 p.
Langer, W. H., and Glanzman, V. M., 1994, Natural aggregate—building America's future: U.S. Geological Survey Circular 1110, 39 p.
Wham Media, Inc., Wherever you are on Earth . . . you're on rock!: 20 p.
Wolfe, M. E., 2001, 2000 Report on Ohio mineral industries: Ohio Division of Geological Survey, 153 p., map.

• This GeoFacts compiled by Dennis N. Hull • Revised November 2001 •

The Division of Geological Survey GeoFacts Series is available on the World Wide Web: http://www.dnr.state.oh.us/geo_survey/