INDUSTRIAL MINERALS OF TEXAS

2018

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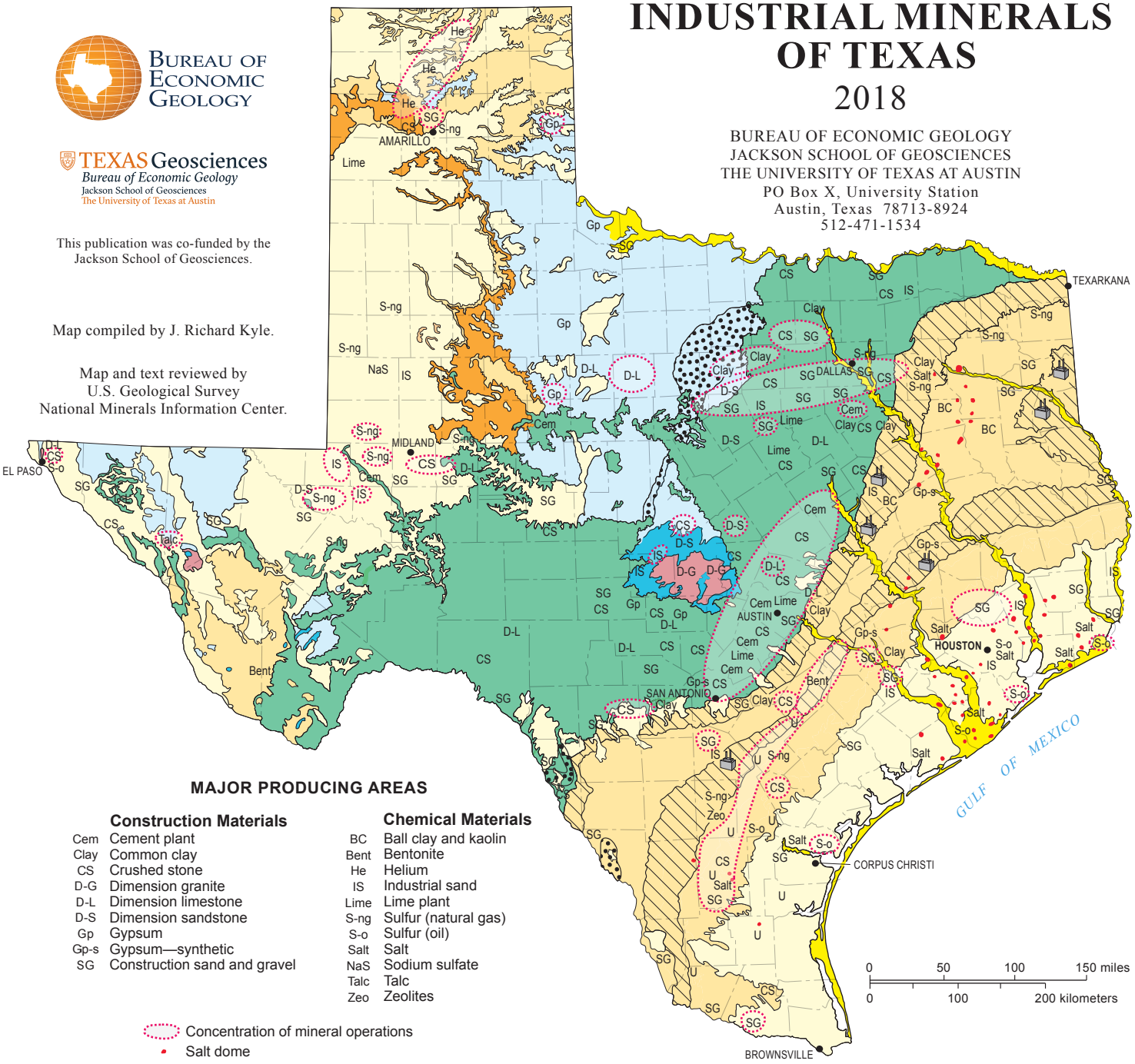
This publication was co-funded by the Jackson School of Geosciences.

Map compiled by J. Richard Kyle.

Map and text reviewed by
U.S. Geological Survey
National Minerals Information Center.



MAJOR PRODUCING AREAS

Construction Materials

Cem	Cement plant
Clay	Common clay
CS	Crushed stone
D-G	Dimension granite
D-L	Dimension limestone
D-S	Dimension sandstone
Gp	Gypsum
Gp-s	Gypsum—synthetic
SG	Construction sand and gravel

Chemical Materials

BC	Ball clay and kaolin
Bent	Bentonite
He	Helium
IS	Industrial sand
Lime	Lime plant
S-ng	Sulfur (natural gas)
S-o	Sulfur (oil)
Salt	Salt
NaS	Sodium sulfate
Talc	Talc
Zeo	Zeolites

Concentration of mineral operations

Salt dome

Energy Minerals

Bituminous coal

Lignite coal

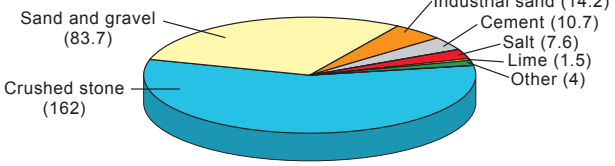
U Uranium

Mouth-of-mine electricity plant

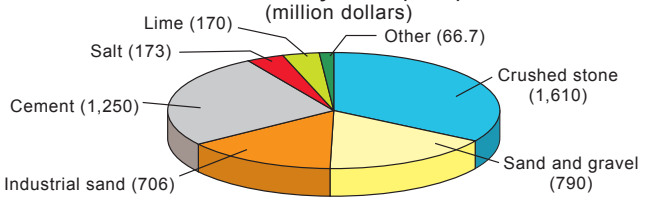
Million years ago			Dominant Rock Types
CENOZOIC	Quaternary	2.6	Unconsolidated sands and muds — Alluvium
	Neogene	23	Sandstones and mudstones (volcanics in Trans-Pecos Texas)
	Paleogene	65	
MESOZOIC	Upper	145	Limestones (sandstones and mudstones in Trans-Pecos Texas)
	Lower	245	Sandstones and mudstones
PALEOZOIC	Upper	320	Permian carbonates and evaporites Mississippian sandstones and mudstones
	Lower	540	Limestones, dolostones, chert, and sandstones
PRECAMBRIAN	Unconformity		Granite intrusions and metamorphic rocks

Unconformity: A boundary between two rock units that represents a gap in the geologic record due to erosion or nondeposition of rock.

Commodity Production (2015)
(million tonnes)



Commodity Value (2015)
(million dollars)



"Other" includes clays (ball, bentonite, common, fire, fuller's earth, kaolin), dimension stone, gypsum, helium, talc, and zeolites.

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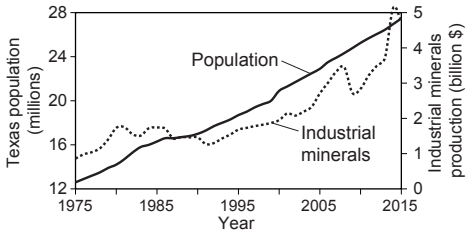
Industrial Minerals of Texas

Introduction

The varied Earth materials that form the diverse surface of Texas provide many valuable industrial rocks and minerals used by modern society. Use of Earth materials by Texas residents started in prehistory with clay for pottery, flint for projectile points and tools, grinding stones for food production, and many other uses of local rocks.

Today Texas is an important producer of the industrial mineral resources that are used widely by the state's ever-growing population. Texas typically ranks in the top three U.S. states for the value of non-fuel mineral production, accounting for 6.5% of the total U.S. minerals value in 2016. With Texas essentially lacking significant metals production, this value represents industrial minerals production totaling ~$5 billion. These industrial minerals are used extensively in the construction and chemical industries, and their production typically is a direct reflection of the state's economic vitality. Almost 90% of current Texas industrial mineral value comes from production of cement, crushed stone, construction sand and gravel, and industrial sand.

Industrial mineral consumption typically tracks regional population and is reflected in the doubling of Texas' population since 1980 to its current 28 million residents,



with comparable growth forecast for the years ahead. For the purposes here, this group of industrial minerals also includes some energy mineral resources—lignite and uranium—that are important producers of electricity for residential, commercial, and industrial consumers. The soils and water essential to Texas' agricultural and forest industries can also be considered industrial minerals.

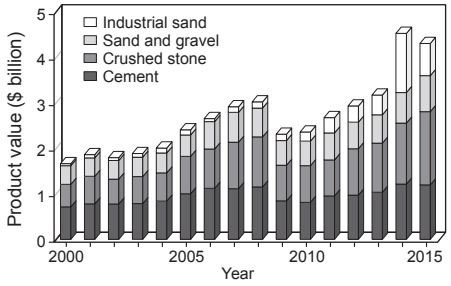
Texas Energy Minerals

Although coals of various geological ages and ranks are present in Texas, recent production has been dominated by extensive "brown coal" lignite deposits of early Cenozoic age in the Gulf of Mexico Coastal Plain. Local early Cenozoic bituminous coals occur in the Rio Grande Valley, as well as in Cretaceous and Pennsylvanian strata in other regions. Extensive mining of Gulf Coast lignites began in the 1970's for fuel at "mouth-of-mine" power plants to supply growing regional electricity needs. Texas' electricity demand increased more than 400% since 1970 and shows no signs of slowing. Texas lignite production has totaled more than 1.8 billion tons, peaking at 56.5 million tons in 1993, and continuing at an annual rate of more than 39 million tons (2016). The lignite beds extend into the subsurface toward the Texas coast, but current economics only allow surface extraction near the outcrop belt. A competitive electricity market with abundant supply from natural gas plants and alternative energy sources has resulted in the closure of several lignite-fueled power plants.

Cenozoic strata of the Coastal Plain host uranium deposits in South Texas. Uranium production started in the early 1960's and reached a peak of 3,900 tons of U_3O_8 in 1980. South Texas uranium production declined steadily through the 1990's and ceased during unfavorable market conditions. The past decade has seen minor uranium production from in situ leaching operations, but these plants are currently on standby.

Texas Construction Materials

Crushed stone, gravel, and sand that are consumed in large quantities as aggregate by the construction industry dominate annual state production in terms of tonnage. Texas produces more crushed stone than any other state from more than 200 quarries; a larger number of operations produce sand and gravel from unconsolidated surface deposits. Specialty industrial sand production for use as proppants in hydraulic fracturing for enhanced petroleum



production has increased markedly since 2000. Dimension stone, used mostly for monuments and building exteriors but with growing high-end residential use, is supplied by Texas' limestones, sandstones, and granites. Cement, another vital construction material manufactured principally from limestone and clay, is a valuable industrial mineral product, with 2015 production from 11 in-state cement plants estimated at more than $1.2 billion. Natural and synthetic gypsum is used in plaster, wallboard, and cement. Clays of various types, largely in the Coastal Plain, are used in many products, with common clay being consumed in large quantities in the manufacture of bricks and ceramic products.

Texas Chemical Minerals

Many industrial minerals are used in the chemical industries, from primary industrial applications to secondary applications in which they serve as sources of valuable elements. For example, salt (sodium chloride) has diverse uses, but most is produced as a chlorine source for the manufacture of hydrochloric acid, a widely used industrial chemical. Lime (calcium oxide produced by calcining limestone) has many uses as well, including water purification, paper manufacture, and sugar refining. Zeolites are valued for their ion-exchange capacity and are used in water- and other purification processes. Bentonitic clays have diverse applications in industrial processes, including drilling-fluid production and vegetable-oil refining. Ball and kaolin clays are used in ceramics and as fillers and coating agents in the rubber and paper industries. Limestone also has many chemical uses, including flue-gas desulfurization of SO_2 from coal-fired electricity-generation plants to produce synthetic gypsum. Sulfur, produced by more than 60 refineries of "sour" crude oil and natural gas from Texas and imported sources, is another widely used element, principally in the manufacture of sulfuric acid. The principal domestic source of helium is from natural gas in Texas Panhandle fields. Talc deposits in West Texas are mined for fillers in ceramic. paper, plastic. and rubber products.

Geology of Major Producing Regions

Most industrial minerals are relatively common Earth materials that can only be produced commercially by relatively low-cost near-surface extraction techniques. Thus, industrial-mineral production typically occurs in areas where favorable rock units occur at the surface, relatively near the population centers that will consume the products. These essential mineral resources are products of past geologic events that have affected this part of Earth's crust. Ancient plate tectonic processes created a vast mountain range, the roots of which are represented by the Precambrian metamorphic rocks and granites exposed in the Llano region of Central Texas and smaller exposures in West Texas. After a long period of erosion reduced this mountainous terrain, Texas was covered by shallow seas during the early Paleozoic (Cambrian–Ordovician), late Paleozoic (Permian), and late Mesozoic (Cretaceous). These environments produced the extensive carbonate strata that form the Edwards Plateau and other surface belts of limestone that are essential to Texas' crushed stone, cement, and lime production. Evaporation of these shallow seas in the Permian and Cretaceous also produced local gypsum deposits. Even more extensive early Mesozoic evaporites, present under the Coastal Plain and Gulf of Mexico, have been deformed into "salt domes" that supply salt via underground mines and brine operations.

Surface deposits of Cenozoic age blanketing older rocks in much of Texas provide many valuable industrial mineral resources. Cenozoic strata were formed by river and coastal processes that distributed the gravels, sands, and muds eroded from the Rocky Mountains and the continental interior. Deposition of these thick sedimentary layers built the Coastal Plain and extended the Texas shoreline to its current position (and farther during the glacial period that resulted in lower sea level 18,000 years ago). Swamps related to deltaic environments provided environments for extensive plant growth and are preserved as lignite deposits. Ash from volcanoes in western Texas and elsewhere in southwestern North America provided unusual Coastal Plain sediments that were altered to valuable industrial zeolites, bentonites, and other clay deposits. Cenozoic volcanic ash also was the source of uranium that was concentrated by groundwater to form Texas' uranium deposits. Most construction sand and gravel are produced from the unconsolidated alluvial deposits of Texas' major river systems. Recent and ancient desert winds have produced ideal sand grains for proppant use.

Economic Importance

The total value of Texas' industrial mineral production for 2016 was ~$5 billion, with additional value supplied by lignite production. Further, industrial rocks and minerals are produced in virtually every Texas county, often related to local transportation, construction, and other industrial activities. Industrial-mineral production provides local employment, and unusual mineral concentrations provide specialty products for regional distribution. As Texas' population continues to grow, production of energy and industrial minerals will continue to satisfy the demands of residential, commercial, and industrial customers.

Major Sources

- Bureau of Economic Geology, interactive Texas Mineral Resources Map (B. A. Elliott) https://coastal.beg.utexas.edu/txmineralresources/
- Railroad Commission of Texas, Mining and Exploration http://www.rrc.state.tx.us/mining-exploration/
- Texas Commission on Environmental Quality, Mining and Mineral Extraction https://www.tceq.texas.gov/permitting/mining.html
- U.S. Geological Survey, Texas State Minerals Information http://minerals.usgs.gov/minerals/pubs/state/tx.html
- U.S. Department of Energy, Energy Information Administration, Texas state profile and energy estimates http://www.eia.gov/state/?sid=TX
- U.S. Department of Labor, Mine Safety and Health Administration—MSHA, Mines Data Set https://arlweb.msha.gov/OpenGovernmentData/OGIMSHA.asp#msha-datasets

—J. Richard Kyle

Bureau of Economic Geology

The **Bureau of Economic Geology,** established in 1909, is the oldest research unit at The University of Texas at Austin. The Bureau functions as the state geological survey of Texas, and the Director is the State Geologist. The Bureau conducts basic and applied research programs in energy resources and economics, coastal and environmental studies, land resources and use, geologic and mineral mapping, hydrogeology, geochemistry, and subsurface nanotechnology.

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