Lead and Zinc Mining in Kansas

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Introduction

The 1870 discovery of zinc ore near Galena, Kansas, marked the beginning of a century of lead and zinc mining in the Kansas part of the Tri-State mining district (fig. 1). The Tri-State was one of the major lead and zinc mining areas in the world and included parts of southeastern Kansas, southwestern Missouri, and northeastern Oklahoma. Mining in the district has ceased, but for one hundred years (1850–1950), the Tri-State produced 50 percent of the zinc and 10 percent of the lead in the United States.

Lead and zinc deposits in Kansas occur within the region called the Ozark Plateau in extreme southeastern Cherokee County. This region is defined by outcrops of Mississippian rocks (the oldest surface rocks in the state), which formed about 345 million years ago. The Ozark Plateau covers about 55 square miles in Kansas and includes the towns of Baxter Springs and Galena.

Mining in the Tri-State area left the environment contaminated with heavy metals such as lead, zinc, and cadmium. Flooded underground mines produce acidic water that threatens local aquifers and municipal water supplies. Tailings piles and open mine shafts dot the landscape. Because the mining companies that once operated in the Tri-State mining district have long since disappeared, cleanup and reclamation of mined areas has become the responsibility of federal, state, and local entities.

This circular explains the history and geology of the Tri-State mining district in Kansas, the environmental consequences of lead and zinc mining, and efforts to solve some of these problems and reclaim the land.

History

The first commercial ore discovery in the Tri-State mining district was made in southwestern Missouri around 1838. By the start of the Civil War, these mines were producing so much lead that both the North and South fought to control the mining area to secure a source of lead for bullets. The fighting closed the mines for most of the war.

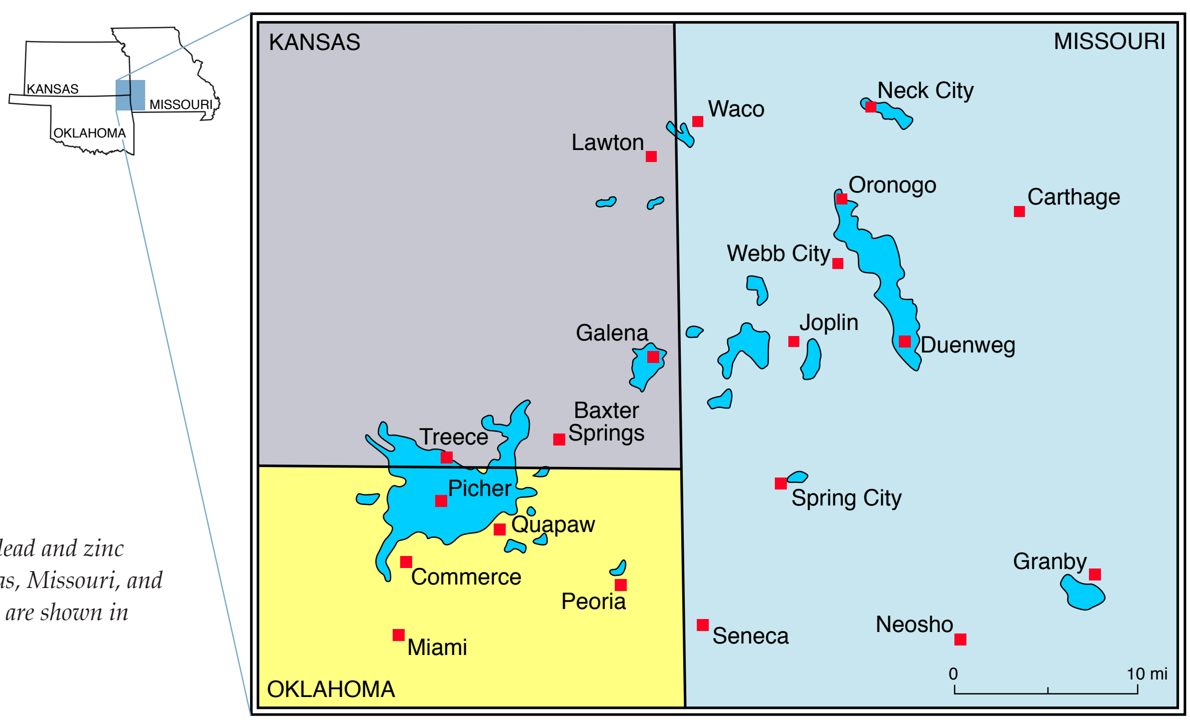

Figure 1. The Tri-State lead and zinc mining district of Kansas, Missouri, and Oklahoma. Mined areas are shown in dark blue.

Production from the Tri-State peaked between 1918 and 1941. During the 1920s, more than 11,000 miners worked in the area, and perhaps three times as many were involved in support work and industries.

Although zinc was much more common than lead throughout the Tri-State mining district, production up to 1869 was confined to lead, which could be easily smelted in homemade furnaces. Zinc production took off in the early 1870s, following the completion of railroad lines and the construction in 1873 of a coal-fired zinc smelter at Weir City, Kansas (fueled by coal from nearby mines). In 1878, another smelter was built at Pittsburg, Kansas. In the early 1900s, smelting costs were reduced by the discovery of a shallow gas field in southeastern Kansas. Using this cheap fuel source, new gas-fired smelters were built in southeastern Kansas, displacing the coal-fired smelters.

In much of the Tri-State, mining was done underground, using room-and-pillar methods, in which room-shaped areas are mined and similarly shaped areas are left for roof support, resulting in a checkboard-like arrangement of alternating rooms and pillars. Underground rooms had walls 25 to 100 feet high and pillars 20 to 50 feet thick. In the eastern part of the district, however, the ore was closer to the surface, and the shallow mining could be done using hand tools and a simple hoisting device that was either man- or animal-powered. Galena, Kansas, became known as a poor man's mining district because small claims could be worked by a few miners.

Many of the rock layers that were mined for ore also were aquifers — that is, water-bearing formations. Thus, water flowed into the mines through these rock layers. To keep the mines from filling with water, as many as 63 pumping plants operated 24 hours a day. In 1947, for example, more than 36 million gallons of water were pumped from the mines every day (enough to cover one acre of ground with water 110 feet deep).

After World War II, production in the Tri-State mining district gradually declined. In 1970, the last active mine, located 2 miles west of Baxter Springs, Kansas, shut down due to environmental and economic problems, bringing to an end a century of lead and zinc mining in the Tri-State.

During the life of the district, more than 4,000 mines produced 23 million tons of zinc concentrates and 4 million tons of lead concentrates. The Kansas part of the Tri-State district produced more than 2.9 million tons of zinc, with an estimated value of $436 million, and 650,000 tons of lead worth nearly $91 million.

Geology

Lead and zinc ores in the Tri-State area occur in Mississippian cherty limestones. After these cherty limestones were deposited at the bottom of an inland sea, they were exposed at the surface and subjected to erosion. Over time, the softer limestone was leached from the beds, while the more resistant chert remained. Caves developed in some places, but in many places the removal of the limestone caused the beds to collapse. These collapsed beds contained mostly broken pieces of chert and were very porous and permeable. Later these beds became sites of ore deposition.

Following this period of erosion, the seas returned during the Pennsylvanian Period (323 to 290 million years ago), and the shales of the Cherokee Group were deposited on top of the Mississippian rocks. This set the stage for the ores to be deposited, probably millions of years later.

The lead and zinc ores found in the Tri-State district are believed to have formed from hot, metal-bearing solutions that originated deep within the earth. These solutions probably rose along major faults and fractures until they came to the Mississippian beds (fig. 2). The Cherokee Group shales acted as an impermeable barrier, or cap, to the rising metal-bearing solutions and forced them

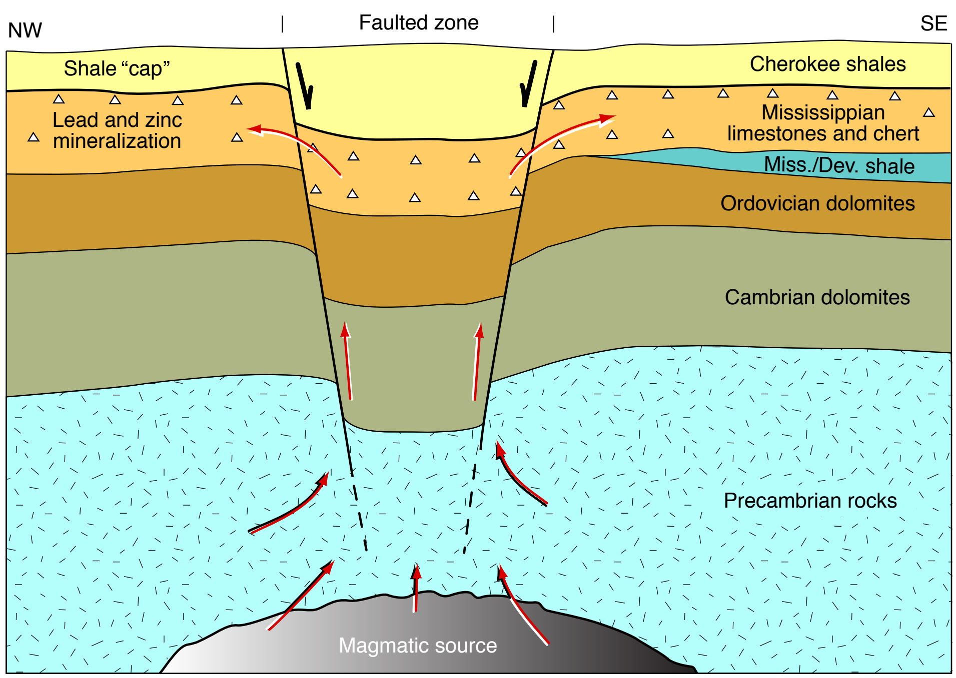

Figure 2. Red arrows show origin, movement, and deposition of ore-bearing solutions.

to migrate laterally. These solutions spread through the broken beds of chert and other porous and permeable layers in the Mississippian limestones, depositing the galena, sphalerite, and other associated materials.

Only two minerals, galena and sphalerite (figs. 3, 4), were commercially important in the Tri-State district. Sphalerite (zinc sulfide, ZnS) is five times more abundant than galena (lead sulfide, PbS). Sphalerite and galena can occur as crystals lining cavities, as cement that fills the spaces between broken chert fragments, or as finely disseminated grains.

Chalcopyrite, a copper mineral, also occurs in the region, but not in economic amounts. Other non-commercial minerals and rocks associated with galena and sphalerite include pyrite, marcasite, dolomite, calcite, quartz, and jasperoid.

Figure 3. Galena (lead sulfide) from Cherokee County, Kansas.

Figure 4. Sphalerite (zinc sulfide) from Cherokee County, Kansas.

Environmental Consequences

Lead and zinc mining left behind a number of physical hazards and environmental problems. Over the years, physical hazards such as open mine shafts, collapsed mine shafts, and subsidence areas have claimed lives, caused property damage, and created avenues for water to enter and leave the mines. Subsidence was often a result of the final phase of mining, known as "robbing the pillars," which involved mining the pillars that supported the mine roof. Without these supports, the mine collapsed, eventually causing subsidence at the surface.

In the early 1980s, the U.S. Bureau of Mines, in cooperation with state geological surveys, conducted detailed studies of the physical hazards associated with the old mining areas. The studies identified more than 1,500 open shafts and nearly 500 subsidence collapse features in the Tri-State. A total of 599 mine hazards were found in and around Galena, Kansas, many of which were concentrated in an area known as "Hell's Half Acre." In 1994 and 1995, the U.S. Environmental Protection Agency (EPA) and local citizens filled in all the mine collapses and shafts in the town of Galena (fig. 5). New top soil was hauled to cover the tailings and boulders in the area.

The hundred years of mining also left the region with serious environmental problems. When the mines closed, the pumping stopped, and the abandoned tunnels filled with water. The water in these tunnels became contaminated by iron sulfide (from pyrite and marcasite) and other metallic sulfides, which remained in the mine walls or were left behind by the miners. In addition to becoming very acidic, the water contained dissolved metals, some of which are very toxic. This water, in turn, contaminated local groundwater, springs, and surface water.

Lead and zinc production involved crushing and grinding the mined rock to standard sizes and separating the ore. This left behind piles of leftover rock called tailings that covered 4,000 acres in southeastern Cherokee County. These wastes were also a source of contamination. Lead, zinc, and cadmium from the tailings leached into the shallow groundwater, contaminating local wells; in addition, runoff moved contaminants into nearby streams and rivers (fig. 6). Wind also blew fine metal-bearing dust (from tailings piles and roads made of tailings) into the air, spreading the contamination to nearby non-mined areas. Radon gas from the mining operations was detected in the air around Galena. During the 1980s, this area was considered one of the most environmentally blighted in the nation.

Some of the cleanup efforts are funded by the U.S. Environmental Protection Agency's Superfund. The

EPA began working in the area in the early 1980s and work is ongoing. The EPA divided the Cherokee County site into six subsites that correspond to six general mining locations, including the areas around Galena, Baxter Springs, and Treece, Kansas.

Because the area in and around Galena had some of the worst contamination, early cleanup efforts were centered there. Chief among these was the provision of safe water supply for rural residents whose wells had been contaminated. Two new wells were constructed in the deep aquifer, and a new rural water district was formed that currently provides over 500 households with a long-term source of clean drinking water.

From 1997 to 1999, contaminated soil was removed from 602 residential properties in Galena and replaced with clean backfill and grass sod or seed; fifty additional properties were remediated in 2000 and 2001. Remediation of residential soils has been completed in Treece and is ongoing in Baxter Springs. Cleanup continues at other sites in southeastern Kansas. For more information, check the EPA Region 7's website: http://www.epa.gov/region07/index.htm.

Places to Visit

Galena Mining and Historical Museum. Check out the mineral and fossil specimens at this museum, located in the old train depot, 319 W. 7th, Galena, KS 66739 (620-783-2192).

Baxter Springs Historical Museum. Located on historic US-66 (now called US-69 Alternate), Baxter Springs is the oldest cowtown in Kansas. The Historical Museum at Eighth and East avenues contains a variety of historical exhibits including a full-scale replica of a lead and zinc mine. The museum is open on weekends year round and at various times during the week (620-856-2385).

Tri-State Mineral Museum. A good place to learn more about lead and zinc mining is the Everett J. Ritchie Tri-State Mineral Museum in Joplin, Missouri. It is located in Schifferdecker Park, 4 miles east of the state line on K-66. For more information, contact Tri-State Mineral Museum, 7th & Schifferdecker Ave, Joplin, MO 64801 (417-623-2341).

Schermerhorn Park. Probably the best place to see the Mississippian limestones of the Ozark Plateau is Schermerhorn Park, about 1 mile south of Galena on the east side of K-26. Shoal Creek, one of the major tributaries to the Spring River, flows through the park. This spring-fed, Ozarkian stream has been the major

Figure 5. Galena, Kansas, (top) before (1980) and (bottom) after (1999) reclamation.

force shaping the features so common to the Ozark region-rolling hills and steep river bluffs. The park sits at the west end of a tall limestone bluff on the north side of the river.

Among the numerous caves carved into the region's Mississippian limestone is Schermerhorn Cave, located within the park. A spring issues from the cave's entrance. The cave entrance can be reached by walking a short distance, but the interior of the cave is not accessible to the public.

Figure 6. Water contaminated by iron sulfide (orange color in photo) flows from tailing piles into Tar Creek near Picher, Oklahoma.

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The Kansas Geological Survey (KGS) is a research and service division of the University of Kansas that investigates and provides information about the state's natural resources. KGS scientists pursue research related to surface and subsurface geology, energy resources, groundwater, and environmental hazards. They develop innovative tools and techniques, monitor earthquakes and groundwater levels, investigate water-quality concerns, and map the state's surface geology.

The KGS has no regulatory authority and does not take positions on natural resource issues. The main headquarters of the KGS is in Lawrence in the West District of the University of Kansas, and the Kansas Geologic Sample Repository of the KGS is in Wichita.

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