

Mines in the Illinois Portion of the Illinois-Kentucky Fluorspar District

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Front cover: *Fairview Fluorspar and Lead Company Good Hope Shaft and Fairview Mill, Rosiclare, Illinois.*
(ISGS file photograph by H.E. Culver, circa 1920.)

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ABSTRACT

This report compiles into a cohesive document details of the individual mines within the Illinois portion of the Illinois-Kentucky Fluorspar District (IKFD). This document also contains brief sections concerning the mining methods, geology, historical production figures, and theories of the origin of the ore deposits. In 2012, the Kentucky Geological Survey produced a map of the IKFD that covers only the Kentucky portion. The mine location map that accompanies this document was designed to augment the Kentucky fluorspar mine map. During research activities for this project, we gained access to confidential unpublished files from several mining companies. Maps, exploration reports, drill logs, and production figures were scanned and are available upon request at the Prairie Research Institute. Although the last mines in Illinois ceased operations in 1995, there is potential for future mining activities in deeper, relatively unexplored strata. The authors hope this report and the scanned documents will be helpful for future exploration activities and to other interested parties.

INTRODUCTION

The Illinois-Kentucky Fluorspar District (IKFD) was, for most of the 20th century, the primary source of fluorspar for the United States. The strategic importance of fluorspar was heightened during World War II because of the use of fluorspar in steel manufacturing. Production of fluorspar ore in this region peaked shortly after World War II and was sustained until the 1970s, when competition from foreign suppliers began to erode the dominance of this mineral district. The early mines were originally operated by dozens of local entrepreneurs producing small tonnages of fluorspar, but in the 1930s, corporate ventures such as Ozark-Mahoning and the Aluminum Ore Company (a precursor of ALCOA) entered the picture. The larger companies erected modern processing mills that allowed a lower grade ore to be enriched into a commercial product. Historical photographs of mines and mining activities in this district provide a nice pictorial archive of these mines and are compiled in the book *Fluorspar Mining: Photos from Illinois and Kentucky, 1905–1995* (Russell 2019).

“Fluorspar” is an industrial synonym for the mineral fluorite. The chemical formula for the mineral is calcium difluoride (CaF_2). The fluorspar ore found in the IKFD is usually not 100% CaF_2 and contains minor impurities, mainly calcite and quartz. The ore may also contain galena, barite, and sphalerite, which can be separated and sold. For much of the 19th century, mining concentrated on galena, and fluorite was considered a waste product (Goldstein and Williams 2008). By the late 1800s, fluorspar was being utilized as a fluxing agent in the smelting of steel, which made fluorspar a valuable commodity. From 1914 to 1915, the ores of the IKFD accounted for more than 99% of fluorspar production in the United States (Weller et al. 1920). In about 1953 to 1954, the major use of fluorspar shifted from predominantly steel manufacturing to the manufacturing of hydrofluoric acid for the chemical and aluminum industries (Voskuil and Bush 1955). The primary uses of fluorspar today include the production of hydrofluoric acid and various other chemicals, steel manufacturing, aluminum smelting, hydrofluorocarbon, and fluoropolymer production (McRae 2016).

PRODUCTION HISTORY

Statistics on fluorspar and metal mining in Illinois from 1925 through 1985 are available in the Illinois Department of Natural Resources *Illinois Coal Reports*. Published annually, the *Illinois Coal Reports* document the short tons of raw or crude ore mined in Illinois by company. The crude ore mined is milled or refined before being sold; therefore, the crude ore figures are larger than the finished or refined tonnage of fluorspar shipped. The refined or finished tonnage of fluorspar is reported in the U.S. Geological Survey (USGS) *Minerals Yearbooks*.

Available supply, demand, and economic conditions controlled the volume and sale price of fluorspar. The need for fluorspar increased during World Wars I and II and lessened during economic downturns, such as the Great Depression of the 1930s (Figure 1a). From 1925 to 1985, more than 125 individual companies produced fluorspar in Illinois, but the top 24 companies accounted for 97% of the total crude ore production in Illinois (Table 1). Changing ownership of mines

and properties makes tracking fluorspar production by company difficult; thus, Table 1 provides only an estimate of raw fluorspar production. An asterisk in Table 1 indicates a discrepancy or error in the data related to that company. This could be due to typographical errors, erroneous data submitted by the mining company, or other human errors. Although the data have a few problems, the *Illinois Coal Reports* as a whole are an excellent source of raw production figures for the Illinois portion of the district.

The *Illinois Coal Reports* indicate that in 1925, seven companies were mining fluorspar in Illinois. In 1936, eleven companies reported production, and in 1941, twenty-nine companies were producing fluorspar ore. In 1946, twenty-three companies reported production. The number of companies producing ore in Illinois in 1955 decreased to ten, and by 1965, only five companies were producing ore. During the late 1970s, IKFD reserves and production continued to decline. The decline was also partly affected by competition from imported fluorspar from Mexico, China, and South Africa. In 1981, the Hastie Mining Company produced 2,404 tons of crude ore, the Inverness Mining Company produced 128,085 tons of crude ore at its Minerva Mine and 46,105 tons of crude ore at its Spivey Mine, and Ozark-Mahoning produced a combined total of 199,506 tons from several mines.

The single largest producer in the IKFD was Ozark-Mahoning and related companies. Ozark Mining began an exploration program in southern Illinois in 1937 and erected a mill in Rosiclare in 1939. In 1946, the Mahoning Mining Company and Ozark Chemical Company merged to form the Ozark-Mahoning Company (Evans and Hellier 1986). Ozark-Mahoning was acquired by Pennwalt in 1974 and operated as a subsidiary. Elf Atochem acquired Pennwalt in 1990, and Elf Atochem merged with Total Fina in 1999. This company was referred to as Ozark-Mahoning or simply Mahoning, even after the purchases and mergers. Ozark-Mahoning company files indicate the company produced more than 10 million tons of raw crude ore. The raw production estimate for Ozark-Mahoning in Table 1 has been supplemented by information contained in Ozark-Mahoning company scanned documents.

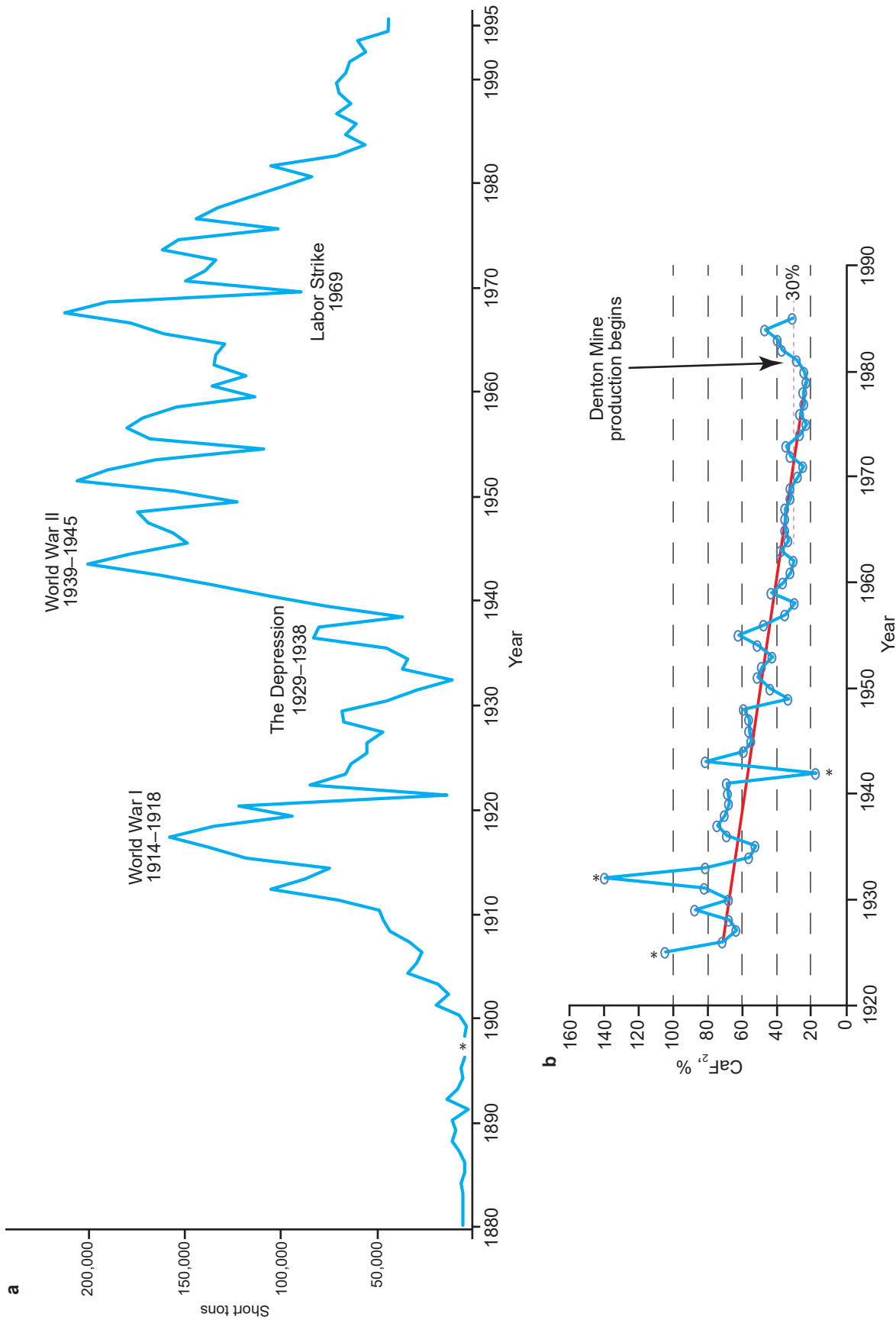


Figure 1 (a) Short tons of finished fluorspar produced by year from 1880 through 1995 in the Illinois portion of the Illinois-Kentucky Fluorspar District. No significant production has occurred in Illinois since 1995. Data were extracted mainly from *Illinois Coal Reports* (used courtesy of Illinois Department of Natural Resources) and U.S. Geological Survey (USGS) *Minerals Yearbooks* (used courtesy of the USGS). (b) Average grade of ore (% CaF_2) processed in the Illinois-Kentucky Fluorspar District from 1925 to 1985. Average grade was calculated by dividing the tons of finished spar reported in the USGS *Minerals Yearbooks* (a) by the raw tons mined, which is reported in the *Illinois Coal Reports*. The grade is for CaF_2 only and does not take into account any credits for Pb or Zn, which would make a lower grade ore profitable, or stockpiling of ore. According to Ross Lillie, in the late 1970s, the average cutoff grade for Ozark Mahoning was typically 30% (CaF_2), but if percentages of Zn, Pb, and sometimes Ba were high enough, the cutoff grade could be lowered. The red line shows that lower grade ore was being mined through time and indicates that 20% was about the lowest grade ore mined. An asterisk (*) indicates a reporting error in one of the data sets for that year.

Table 1 Production of “raw” crude ore in Illinois by company from 1925 to 1995¹

Company	Raw (short tons)	Years of production
Ozark-Mahoning and related*	10,239,405	1938–1995
Minerva Oil Company, Inverness Mining Company, and Allied Chemical Company*	5,021,463	1944–1982
Aluminum Ore Company (ALCOA) and related	1,994,109	1936–1965
Rosiclare Lead and Fluorspar Company*	1,990,745	1925–1952
Crystal Fluorspar Company	411,799	1930–1951
Hillside Mines	310,231	1925–1954
Illinois Minerals*	190,704	1977–1979
Benzon	163,989	1925–1937
Goose Creek Mining Company	149,839	1952–1958
Victory Fluorspar Mining Company	138,281	1929–1945, 1952–1955
Hoeb Mining Company	87,610	1956–1963
G.B. Mining*	70,298	1948–1949
Patton and Sons	60,356	1956–1967
Fluorspar Products	60,078	1934–1947
A.H. Stacey	53,213	1946–1951
P.M.T. Mining	43,444	1949–1956
Hastie Mining*	41,650	1969; 1973–present
Mackey-Humm	40,088	1953–1956
Inland Steel	34,363	1945–1948
Knight, Knight, and Clark	23,650	1926–1938
Crown Fluorspar Company	23,021	1942
Yingling Oil Company*	21,557	1942–1948, 1951
Total top producers	21,169,893	
Other producers	652,471	
Estimated total raw short tons	21,822,364	

¹Data extracted from *Illinois Coal Reports* and other sources. An asterisk (*) denotes a probable discrepancy in the data (see text for details).

By comparing the raw tons in the *Illinois Coal Reports* with the refined and shipped tons in the USGS *Minerals Yearbooks*, we can estimate the average grade of the ore by year (Figure 1b). When compiling this publication, we noticed a few obvious errors in the statistics provided in the *Illinois Coal Reports* or USGS *Minerals Yearbooks*. In 1925 and 1932, the USGS *Minerals Yearbooks* reported more finished tons shipped than the *Illinois Coal Reports* reported raw tons being mined, which skews the ore grade above 100%. The *Illinois Coal Reports* cite no production for the S.C. Yingling Company in 1941, 809,857 raw tons in 1942, and 2,190 raw tons in 1943. The 1942 Yingling production of 800,000 tons far exceeds maximum annual output of the Rosiclare

Mine, which Weller (1943f) identified as the largest fluorspar mine in the United States. We suggest Yingling produced significantly less than 800,000 tons. Except for 1942, Yingling never produced more than 8,000 raw tons. Subtraction of the anomalous production of Yingling in 1942 allows an average ore grade to fall more in line with the historical fluorspar grade during that time (Figure 1b). In 1976, the *Illinois Coal Reports* state that 189,975 tons was mined by Hastie Mining Company. In 1975, Hastie reported 4,591 raw tons, whereas in 1977, Hastie reported 1,751 raw tons. A conversation with Don Hastie, owner of Hastie Mining, indicated that Hastie Mining probably produced about 5,000 tons of spar during 1976 (Don Hastie, personal communica-

tion with Brett Denny, February 28, 2020). Illinois Minerals is listed as having produced fluorspar from 1977 to 1979. However, no corroborating information could be obtained concerning these mines. Eric Livingston, geologist with Ozark-Mahoning from the 1970s through the 1990s, could not remember any Illinois Minerals mining operations in southeastern Illinois (Eric Livingston, personal communication with Ross Lillie, March 2020). Illinois Minerals occupied an office in Alexander County, and amorphous silica (tripoli) production may be what was inaccurately reported as fluorspar production. The G.B. Mining Company also reported 69,745 tons of raw ore in 1949 but only 553 tons in 1948. These are the only 2 years of production from this

company, and although the large tonnage produced in 1949 seems speculative, this tonnage is possible and is reported in Table 1.

In the late 1800s to early 1900s, only high-grade ore was mined, with little milling or processing being applied. The ore grade gradually decreased through time, partially because of the higher grade deposits being mined first. However, through time, as milling equipment and processing techniques improved, a lower grade ore could be mined profitably. Improved milling techniques allowed the concentration and enrichment of fluor spar as well as the concentration of secondary minerals such as lead, barite, and sphalerite, which could make a lower grade ore economic. Obviously, some mines contained higher grade material, and some lower grade ore was economic mainly because of secondary minerals. The USGS *Minerals Yearbooks* from 1925 to 1927 indicate an average ore grade of 50% to 60% CaF_2 during that time period.

Ozark-Mahoning records indicate that by the end of 1969, the total raw production from the Hill-Ledford Mine was 792,848 raw tons at 23% CaF_2 and 1.6% Zn, whereas the East and North Green Mines produced 355,243 tons of 31% CaF_2 and 5% Zn. These data corroborate and align with the district average grade estimates contained in Figure 1b. Around 1981, Ozark-Mahoning opened the Denton Mine, which increased the ore grade for several years. The last two fluor spar mines operating in Illinois, Annabel Lee and Minerva No. 1, ceased production on November 29, 1995. Ozark-Mahoning records indicate that more than 900,000 tons was mined at both the Denton and Annabel Lee Mines. As of this report, the Hastie Mining and Trucking Company is producing a small amount of fluor spar at its limestone quarry operation at Cave-in-Rock, but no other production is ongoing in Illinois. However, mineral exploration programs have been active in this region during the last few years, and future fluor spar mining ventures in the IKFD are likely.

Several authors have previously reported the total tons of refined fluor spar sourced from the entire IKFD. In 1956, the USGS (1956) estimated the total fluor spar

reserves of the IKFD as 8.1 million short tons of measured ore and 4 million tons of inferred ore. Grogan and Bradbury (1968) also estimated that 9.5 million tons of fluor spar had been mined since 1880. Trace (1976) determined that 7,402,334 tons had been mined in the Illinois portion of the IKFD and that 3,180,913 had been mined in the Kentucky portion of the IKFD through 1970. Anderson and Sparks (2012) estimated that 3.5 million tons of fluorite had been produced in the Kentucky portion of the IKFD. To provide an updated production figure for the entire IKFD, we extracted information from the USGS *Minerals Yearbooks*. Before 1910, fluor spar production figures were not extremely accurate, but we were able to obtain finished or refined tonnage estimates from Bastin (1931), Hamrick and Voskuil (1949), and Weller et al. (1952). From the sources listed, we estimated that approximately 9.4 million tons of refined fluor spar has been shipped from the Illinois portion of the IKFD. However, during the last few years of production, a few Illinois producers imported foreign fluor spar to mill and sell, which supplemented their Illinois production. Inverness Mining Company imported fluorite from Mexico from 1982 to 1985, and Ozark-Mahoning reported importing Mexican fluor spar from 1986 to 1995. In addition, some Illinois producers purchased stocks from the U.S. government strategic minerals stockpile to process and ship. The authors of the USGS *Minerals Yearbooks* stipulated that they had accounted for these complications in their domestic production figures. However, it is likely that after 1985, the importing and processing of foreign material and material from the U.S. strategic minerals stockpile somewhat skewed the tonnage reported from Illinois. The finished fluor spar production in Illinois from 1982 to 1995 was about 859,000 short tons, and the majority of the finished fluor spar was certainly domestic and sourced from Illinois. Reducing the estimated Illinois production attributable to imported foreign material by 400,000 tons yields a very conservative estimate of 9 million short tons of fluor spar sourced, refined, and shipped from Illinois. Combining the 9 million tons from Illinois with the 3.5 million tons of fluorite produced in the Kentucky portion (Anderson and Sparks 2012) yields 12.5 million tons.

Historically, the price of fluor spar has fluctuated with market conditions and in response to supply and demand. Below, we provide some historical figures for the price fluctuations over the years, with no attempt to equalize the dollars for inflation. From 1880 to 1916, the price of fluor spar ranged between \$4.00 and \$8.21 per ton (Hatmaker and Davis 1938). The price from 1926 to 1930 averaged \$18.49 per ton (Hatmaker and Davis 1938). In 1931, the price of metallurgical-grade fluor spar (known as “met spar”) sold at mines in the IKFD was \$15.00 per ton, but the price fell in 1932 to \$9.00 per ton (Davis 1933). Acid grade is more valuable, and in 1931 it was worth \$28.00 per ton but fell to \$20.00 per ton in 1932 (Davis 1933). The use of fluor spar to facilitate steel production during World War II drove the price of met spar to \$23.83 per ton and that of acid grade used in the manufacture of hydrofluoric acid and other fluor chemicals to \$28.86 (Davis 1943). In 1964, the average price of fluor spar in the IKFD had increased to \$50.62 per ton (Biggs 1966). By 1985, the price of met spar had risen to \$125.00 per ton and acid grade to \$165.00 to \$175.00 per ton (Pelham 1987). After 1985, producers considered the price of Illinois fluor spar proprietary, and their production and sales figures were not published in the *Illinois Coal Reports*. However, the USGS *Minerals Yearbooks* indicate that in 1995 the price range for Mexican acid-grade fluor spar decreased to \$115.00–\$135.00 per ton and to \$80.00–\$105.00 per ton for metallurgical grade (Miller 1996). Recently, broad price fluctuations have not been uncommon coming from Chinese sources. The USGS *Minerals Yearbooks* indicated that acid-grade Mexican filter cake fluctuated between \$400.00 and \$550.00 in 2012 (Miller 2015). However, because of lessened global demand in 2013, prices of Chinese acid spar dropped by 21% (Miller 2015). In 2017, almost all the fluor spar consumed in the United States was imported. Mexico supplied about 72% of 2017 U.S. imports, whereas China and South Africa each supplied 9% (McRae 2017). Supply and quantities, source of the product, demand, purity or percentage of CaF_2 , quality of and trace elements in the fluor spar, along with geopolitical decisions have affected the recent marketable price (Table 2).

Table 2 Price range in U.S. dollars per metric ton of acid-grade fluor spar by year from 2010 to 2018¹

Country	2010 ^a	2011 ^a	2012 ^b	2013 ^b	2014 ^c	2015 ^c	2016 ^d	2017 ^e	2018 ^f
Mexico	260–290	400–450	400–550	350–550	290–420	260–310	260–310	260–310	260–320
China	360–380	550–650	400–600	310–530	290–370	260–300	250–270	260–420	400–530

¹Data from ^aMiller (2013), table 3; ^bMiller (2015), table 3; ^cMcRae (2017), table 3; ^dMcRae (2020), table 3; ^eSingerling and Wooten (2018), table 5; and ^fMcRae and Wooten (2019), table 4.

GEOLOGY OF THE ILLINOIS-KENTUCKY FLUORSPAR DISTRICT

The geology of the IKFD has been discussed in many previous reports, with those of Bain (1905), S. Weller et al. (1920), Bastin (1931), J.M. Weller et al. (1952), Trace (1974, 1976), and Trace and Amos (1984) being the most notable. Two rounds of geologic mapping of the district in Illinois at 1:24,000 scale have been conducted, the first by Baxter and Desborough (1965) and Baxter et al. (1963, 1967) and the second by Denny and Counts (2009) and Denny et al. (2008a, 2008b, 2010, 2011, 2013, 2016). Both have been summarized at a county-wide scale by Denny and Seid (2014) and Devera et al. (2016). The discussion below covers selected aspects of the geology of the district as it relates to the genesis of ore deposits.

Ore Deposits

Economic minerals within the IKFD occur in four types of deposits: (1) horizontal bedding replacement or strata bound, (2) veins along vertical faults and fractures, (3) residual gravel (referred to as “gravel spar”) derived from the weathering of either veins or beds, and (4) fluorite breccia. The primary ore mineral was fluorite, but several mines contained significant quantities of sphalerite and galena. Geologists noted that barite was quite abundant along the periphery of the ore shoots (Perry 1973), but calcite was by far the most abundant gangue mineral. At some of the mines, a considerable quantity of barite was not mined because of the price, as well as because of the deleterious effect of finely ground witherite associated with barite in the milling and gravity separation–flotation processes (Bradbury 1959). Sphalerite was abundant in some bedding replacement ore, as documented in both the Minerva and Davis-Deardorff Mines

in the Cave-in-Rock Subdistrict. Some deposits contained a small amount of silver in the galena, along with recoverable cadmium and germanium in the fluor spar. Sikich (1959) reported that 6,400 tons of zinc was mined in southern Illinois in 1958. Gustavson and Sikich (1958) also reported that 3,075 ounces of silver was recovered during refining or smelting of the galena. In total, 1,775 tons of lead and 9,225 tons of zinc were produced in southern Illinois as a by-product of fluor spar mining in 1960 (Sikich 1961). Other minerals associated with the fluorite ore in this district included pyrite, chalcopyrite, quartz, celestite, cerussite, greenockite, malachite, smithsonite, witherite, strontianite, benstonite, and alstonite (Goldstein 1997). Paralstonite was identified as a new mineral, with type locality at the Minerva No. 1 Mine (Roberts 1979). Pyromorphite and anglesite were noted in oxidized zones at the Patrick Mine (Weller et al. 1952). Azurite was identified from specimens collected in the Lead Hill area as coatings on quartz and cherty limestone matrix (personal communication reported to R.C. Lillie, X-ray diffraction by Dr. John Rakovan, Miami of Ohio, 2019). The paragenetic sequence of mineralization has been studied by Hall and Friedman (1963), Richardson and Pinckney (1984), and Spry and Fuhrmann (1994).

Marketing the ore required separating the host rock and other gangue minerals from the ore minerals. This was accomplished through milling or refining by both mechanical and chemical processes. In the early years, fluorite or galena was handpicked from the ore, and the host rock and gangue minerals were discarded. Modern milling operations use a variety of techniques to separate the valuable minerals from the waste, including crushing, grinding or milling, and separating minerals by gravity and flotation. The raw ore sent to the mill is normally greater than 30% fluorite, 1% to

14% sphalerite, and 1% to 5% galena. The completed, refined, or finished fluor spar is classified, according to the percentage of fluorite, as acid grade (>97% CaF₂), ceramic grade (97% to 85% CaF₂), or metallurgical grade (met spar; 85% to 65% CaF₂).

Stratigraphy of the Host Rock

Mineralization in the IKFD occurs in sedimentary rocks of Paleozoic age. Stratigraphic nomenclature in this region has been updated several times, but the older stratigraphic nomenclature persists in geologic literature from this mining district. Strata-bound or horizontal bedding replacement deposits are primarily hosted in Mississippian carbonates, but they also occur in Ordovician to Devonian carbonates at Hicks Dome. Fluor spar veins throughout the region are associated with Mississippian to Lower Pennsylvanian System rocks. The current stratigraphic nomenclature of the lower part of the Chesterian (Upper Mississippian) rock in Illinois is given in Figure 2.

In vein-type mines, the mining companies usually name the mining or working levels as depths below the ground surface. Hence, the 300-foot level would be located 300 feet below the ground surface at the main hoisting shaft. In strata-bound deposits, the mining levels were more commonly named for the stratigraphic formation that formed the roof above the mineralized beds. For example, the “Bethel Level” would be found in the limestone bed below the Bethel Sandstone, which, when using current stratigraphic nomenclature, would be the Downeys Bluff Limestone Member of the Paoli Limestone (Figure 2). Lower Chesterian Series stratigraphic nomenclature in Illinois is complex and has undergone several revisions. Early geologic classifications combined all strata from the top of the Ste. Genevieve Limestone to the base of the Bethel Sandstone into the Renault Formation (Weller et al.

AGE	SERIES	FORMATION	THICKNESS (ft)	GRAPHIC COLUMN	RANGE OF FLUORITE MINERALIZATION	
					Vein	Strata-bound
Pennsylvanian	Atokan — Morrowan	Tradewater	+200			
		Caseyville	250–350			
	Kinkaid	0–200				
	Degonia	0–40				
	Clore	30–120				
	Palestine	40–80				
	Menard	80–140				
	Waltersburg	20–60				
	Vienna	10–20				
	Tar Springs	90–150				
	Glen Dean	40–90				
	Hardinsburg	20–140				
Mississippian	Chesterian —<					

Group	Formation	Member or Bed	Graphic Column
West Baden	Bethel		
Cedar Bluff	Downeys Bluff		
	Yankeetown		
	Renault	Shelterville Levias	
	Aux Vases	Rosiclare	
	Ste. Genevieve	Spar Mountain Ss.	
	St. Louis		

Figure 2 Stratigraphic column with primary bedding replacement deposit levels (purple polygons) for the Illinois-Kentucky Fluorspar District. Nomenclature from Denny et al. (2008a) and Grogan and Bradbury (1968). Formation thicknesses from Trace (1954a, 1954b), Thurston and Hardin (1954), Hardin (1955), Williams and Duncan (1955), Baxter et al. (1963), and Baxter and Desborough (1965).

1920). Swann and Atherton (1948) correlated the Rosiclare Sandstone with the Aux Vases. Swann and Atherton (1948) also classified a lower sandy zone in the Ste. Genevieve as the Spar Mountain Sandstone. Both Baxter et al. (1967) and Swann (1963) correlated the Rosiclare with the Aux Vases. They also used the name Spar Mountain for a sandy bed in the Ste. Genevieve Limestone, conforming with the Swann and Atherton (1948) classification. Because the “Renault” of southeastern Illinois includes rocks younger than the type section in Monroe County, Nelson et al. (2002) combined units and reduced several formations to member status (Figure 2). Nelson et al. (2002) discontinued usage of Renault Formation in southeastern Illinois and substituted the Indiana name Paoli Limestone. They also divided the Paoli Formation into the Downeys Bluff Limestone Member (youngest), Yankeetown Member, Shetlerville Limestone Member, and Levias Limestone Member (Figure 2). In addition, previous authors, such as Baxter and Desborough (1965) and Willman et al. (1975), had used the term West Baden Group to encompass the Bethel Sandstone (oldest), Ridenhower Formation, and Cypress Formation. Under current usage (Nelson et al. 2002; Denny and Nelson 2005), the West Baden is a formation (not a group) composed predominantly of sandstone and is restricted to areas where the Bethel, Ridenhower, and Cypress cannot easily be differentiated. Although Nelson et al. (2002) recommended abandoning the Rosiclare Sandstone for the Aux Vases, the term Rosiclare is so entrenched in the historical literature that removing this term would undoubtedly create more confusion. However, it should be noted that the Aux Vases is currently the preferred stratigraphic nomenclature. For additional information on the stratigraphy, we recommend the Illinois State Geological Survey (ISGS) ILSTRAT web interface (https://isgs.illinois.edu/ilstrat/index.php/Main_Page).

A thin, sandy limestone was mineralized near the base of the Ste. Genevieve Limestone in the Annabel Lee Mine in the Harris Creek Subdistrict. This silty to sandy limestone unit was never more than 1 foot thick and was often challenging to identify in cores. The working level was described by miners as the St. Louis Level. The interval was below the Spar

Mountain Member but still within the Ste. Genevieve Limestone. To prevent a confusing name being applied to this level, the name “Cadiz Level” was proposed by Ross Lillie, who worked as a mine geologist for the Ozark-Mahoning Mining Company. Cadiz is a very small, unincorporated community and former site of a Civilian Conservation Corps work camp located near the Annabel Lee Mine. The Cadiz Level was recognized, but not uniquely identified, in a stratigraphic section drawn by Minerva Oil Company geologists (Montgomery et al. 1960, p. 8, fig. 3).

Ore Models

Depositional models or theories concerning emplacement of the strata-bound fluorspar involve low-temperature hydrothermal replacement of carbonate host rock. Acidic fluorine-rich ore fluids are theorized to have ascended along small faults and fractures, and sometimes through cylindrical-shaped breccia pipes, until reaching an upper impermeable boundary or roof rock. The upward flow of the fluids is suggested by the mushroom-type structures observed at some of the mines at Lead Hill (Currier 1944) and the breccia pipes observed in several mines in the Cave-in-Rock Subdistrict (Brecke 1962). The mineralizing fluids ascended until they encountered an impermeable or less permeable roof rock, at which time the fluids flowed laterally along the fault zone or the bedding of the host strata. In bedding replacement deposits, the fluorite replaced the carbonate host, which was usually limestone. It is unclear whether the carbonate host rock supplied calcium to form the fluorite, buffered the pH of the very acidic ore fluid (Kenderes and Appold 2017), or possibly both. Conceptually, a limestone (CaCO_3)-to-fluorite (CaF_2) reaction would proceed as follows: CaCO_3 (solid) + 2HF (ore fluid) $\rightarrow$ CaF_2 (solid) + H_2O (liquid) + CO_2 (gas). Some ore models proposed the ore fluid ascended in response to an increasing geothermal gradient, which was initiated by Permian igneous activity that underlies the entire IKFD. The age of the mineralization is not certain, given that age determinations from Permian to Early Cretaceous have been suggested by previous authors (Harder 1986; Ruiz et al. 1988; Chesley et al. 1994; Symons 1994; Brannon et al. 1996a).

The vein-type ore along fault planes most likely formed in an analogous manner, but the fluorspar crystallized in open spaces or voids along faults. The vein deposits are also usually in contact with or adjacent to a carbonate host rock, and in places have replaced an earlier phase of vein calcite. The amount of displacement along mineralized faults normally ranges between 50 and 500 feet (Weller et al. 1952). Faults with smaller displacement typically did not create enough open space to accommodate the ascending ore fluid, whereas faults with large displacement commonly produced gouge zones or incorporated shale layers that impeded the flow of the ore fluid. However, exceptions to these rules are known. The fluorite breccia beneath Hicks Dome, although somewhat different in form, is most likely genetically and temporally related to the other fluorspar deposits in the region. The Hicks Dome mineralized breccia is described in the Hicks Dome section of this document.

Mississippi Valley-Type Relationship

Geochemical investigations indicate that the chemistry and temperature of the ore-forming fluids in the IKFD have much in common with other Mississippi Valley-type (MVT) deposits, and this district has been considered an MVT district (Ohle 1959). The issue with an MVT classification for the IKFD relates to the fact that MVTs are generally not associated with igneous rocks, whereas numerous ultramafic intrusive rocks, breccias, and diatremes occur within the IKFD. However, much evidence exists that the ore deposits were formed in a similar manner as other MVT deposits.

Hall and Friedman (1963) proposed that ores in the Cave-in-Rock Subdistrict were sourced from several different fluids. Their work with oxygen and carbon isotopes suggested that the ore probably formed through a combination of connate, hydrothermal, and magmatic fluids. The mixing of several types of fluids is also supported by geochemical analyses of the ore (Richardson et al. 1988; Spry et al. 1990; Spry and Fuhrmann 1994). Fluid inclusion microthermometry results from Spry and Fuhrmann (1994) also suggested the mixing of three fluids, with two being relatively saline and relatively hot and the third being cooler and less saline. Pelch (2011) likewise proposed the

mixing of at least three fluids in the Cave-in-Rock Subdistrict, based on an analysis of the elemental concentrations and microthermometry of fluid inclusions.

Although consensus is lacking on the proper classification of these deposits, as a whole, the ore-forming solutions were acidic, with pH as low as 0 to 1.4 (Kendres and Appold 2017), saline (typically >20% NaCl equivalent), and epithermal or low-temperature hydrothermal (80 to 150 °C). A few workers have proposed a relationship between the underlying ultramafic igneous activity and mineral deposition (Plumlee et al. 1995; Kendrick et al. 2002). Although mineralized breccia-type deposits have not been well studied, rare earth minerals, niobium, and possibly thorium are associated with the fluorite mineralization within breccia beneath Hicks Dome (Pinckney 1976). The identification of microcrystalline aggregates of xenotime in fluorite (Wall and Mariano 1996) is very suggestive of carbonatite intrusion beneath Hicks Dome (Mariano 1989). Morehead (2013) concluded that magmatic carbon is most likely present at Hicks Dome and that more than one igneous phase may be present in the region. Long et al. (2010) also discussed the presence of rare earth elements at Hicks Dome in their compilation of U.S. rare earth element deposits.

Illinois-Kentucky Fluorspar District Ore Model

Considering the available data, we suggest that IKFD mineralization formed through the mixing of several fluids, including possibly NaCl-rich “MVT brines,” hydrothermal fluids, and magmatic fluids associated with the ultramafic intrusions (Denny et al. 2017). The ultramafic igneous rock was most likely a key factor in supplying a higher geothermal gradient, uplifting and fracturing the host rock, and providing at least a portion of the fluorine to the ore-forming solutions. The pH of the acidic mineralizing fluids was buffered in contact with the limestone host rock, which led to the disequilibrium and crystallization of the ore minerals.

Faulting and Tectonic History

Mineralized veins are mostly aligned along northeasterly striking high-angle normal faults, which are assumed to be

the primary conduits for the ascending ore fluid. Although most faulting occurred before the deposition of the minerals, some postmineralization movement has been documented along faults in the Rosiclare Subdistrict. In particular, postmineralization movement along the Daisy Vein is very well documented. The overprinting of multiple tectonic events along with the Permian igneous uplift and subsequent subsidence have created a very complex geologic fabric.

The region has undergone tectonic activity spanning more than 500 million years of Earth's history. Three major episodes of tectonism took place in response to plate movements during the assembly and disassembly of supercontinents:

1. Failed rifting produced normal faults during the breakup of the supercontinent Rodinia in the latest Proterozoic Era and early Cambrian Period.
2. Northwest-directed compression induced reverse faulting and ultramafic igneous activity during the Alleghenian orogeny, related to the assembly of the supercontinent Pangea during the late Paleozoic Era.
3. Crustal extension induced a second episode of normal faulting (with a probable left-lateral component) during the breakup of Pangea, culminating during the Jurassic Period.

Cambrian Failed Rifting

Setting the stage for the IKFD was the failed rifting that took place during the breakup of the supercontinent Rodinia during the latest Proterozoic to the middle Cambrian Period. The term “failed rifting” defines the partial breakup of a tectonic plate without complete separation and the development of an ocean basin. The failed rift segments relevant to the IKFD are the northeast-trending Reelfoot Rift (Ervin and McGinnis 1975) and the east-trending Rough Creek Graben (Soderberg and Keller 1981), which join in southern Illinois and adjacent Kentucky (Figure 3). Regional seismic reflection profiles (Bertagne and Leising 1991; Potter et al. 1995, 1997) image some of the large normal faults that compose the Reelfoot Rift and Rough Creek Graben. Penetrating the Precambrian crystalline basement, these faults outline grabens that contain thick Cambrian sedimentary rocks absent elsewhere in the region. Late

Paleozoic reverse faulting originating within the Precambrian is interpreted on the flank of the Rock Creek Graben, and Permian or younger extensional faulting is suggested as overlying the fluorspar-area faults (Potter et al. 1997). Deep oil and gas test holes have partially penetrated these rift-filling strata, yielding clues to the tectonic succession.

The failed rifting is significant in that it created zones of crustal weakness that were reactivated during later tectonic episodes. As is evident in the New Madrid Seismic Zone, portions are still undergoing movement today. These same crustal fracture zones also provided pathways for subsequent hydrothermal mineralization.

Late Paleozoic Compression

As Rodinia broke apart, the Reelfoot Rift and Rough Creek Graben became a narrow, elbow-shaped arm of the sea. By late Cambrian time, crustal subsidence became more general, producing an elongate trough that became the Illinois Basin (Kolata and Nelson 1991, 2010). The sedimentary rocks that would later host IKFD orebodies accumulated in the basin. During the Pennsylvanian Period, tectonic plates that had rifted away earlier began to collide with the eastern and southern margins of the North American plate. The Appalachian and Ouachita Mountains rose in response to collisions that were part of the process of assembling all the major landmasses of the globe into the supercontinent of Pangea. Collisions related to the Appalachian and Ouachita Mountain-building events transferred compressional stresses toward the northwest into the present area of the IKFD.

This crustal compression had two main consequences. First, some of the normal faults that had formed during Cambrian rifting became reverse faults, hanging walls moving upward. This action chiefly affected the Lusk Creek, Shawneetown, and Rough Creek Fault Systems, which today generally delimit the western and northern boundaries of the IKFD. Second, a series of northwest-trending fractures served as pathways for ultramafic magma derived from the Earth's mantle. Chaotic reflectors near Hicks Dome were modeled as “a combination of intrusive brecciation, intense faulting, and alteration of carbonate strata by

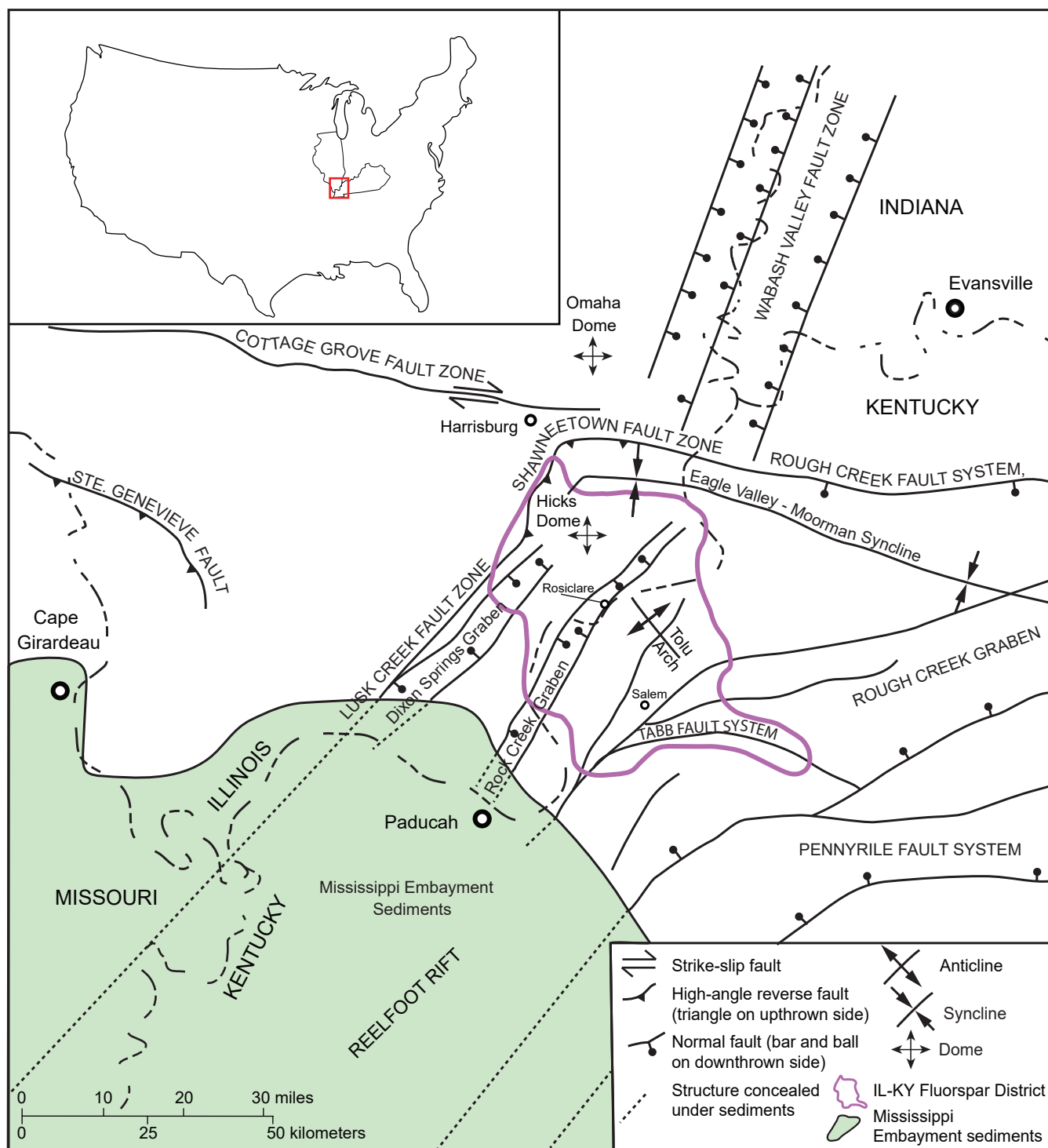


Figure 3 Map showing major fault zones in the Midwest. Modified from Denny et al. (2008a).

acidic mineralizing fluids, all of which occurred in the Permian" (Potter et al. 1997, p. 537). Evidence of and theories regarding whether Hicks Dome also formed during the compressional episode remain in conflict.

Mesozoic Extension

The third great tectonic episode shaping the IKFD commenced with the breakup of Pangea, which began late in the Triassic Period and is continuing to the present. New ocean basins, including the Atlantic Ocean and Gulf of Mexico, are products of the breakup, which also reactivated many older zones of weakness within the North American continent. Many older faults within the IKFD underwent normal movement, and many new normal faults developed (Potter et al. 1995). These faults displaced the Permian-age dikes of the district (Hook 1974; Trace 1974) and overprinted reverse faults of the Lusk Creek, Shawneetown, and Rough Creek Fault Systems (Nelson 1991, 1995).

The age of mineralization in the district is controversial, but most authors agree it is Permian or younger. Chesley et al. (1994) reported an early Permian date based on the $^{147}\text{Sm}/^{144}\text{Nd}$ isochron for fluorite. Symons (1994) settled on a Late Jurassic age based on paleomagnetism. Using strontium isotope data, Ruiz et al. (1988) reported an Early Jurassic date. Brannon et al. (1996b) also reported an Early Jurassic age based on ore-stage calcite U-Pb and Th-Pb isotopes. Assuredly, a Jurassic age is attractive from the tectonic viewpoint, although Permian mineralization of northeast-trending normal faults is less compatible with the northeast-southwest compressional stress regime that prevailed at that time.

The age of Hicks Dome is also controversial. Its association with Permian-dated intrusions has led many authors to assign Hicks Dome to the Permian Period. However, Ruiz et al. (1988) suggested a Mesozoic age based on strontium isotope data. Shallow intrusions on the dome are conceivably Permian age, whereas deeper breccias that formed the dome are younger. As Potter et al. (1995) showed via seismic reflection data, the major breccias and intrusions that raised the dome reside within the Precambrian

basement, not the Paleozoic sedimentary succession.

Role of Strike-Slip Faulting

Geologists dating back at least to Bastin (1931) have reported evidence for an element of strike-slip faulting in the IKFD. Hook (1974) stated, "The northwest-trending [dike] faults seem to have predominantly strike-slip movement" (p. 81). Many authors, ourselves included, have observed striations and mullion indicative of a strike-slip component on the northeast-trending faults that bear vein deposits. However, those who have studied the structure closely concur with Trace (1974) and Hook (1974) that the horizontal component cannot be large because Permian dikes display little or no lateral offset where they intersect the younger northeast-striking faults.

That said, a modest strike-slip element may have been sufficient to play a large but unappreciated role in orebody genesis. In the Rosiclare Subdistrict, host to the richest fluorspar mines in the United States, the complex fracture zone that bounds the southeast side of the Rock Creek Graben bends from its typical northeast trend to nearly due north. Bounding the east side of the zone is the widest vein in the IKFD, the Rosiclare Vein, which follows a nearly vertical fault that is sinuous in dip direction. Bastin (1931), who spent more time underground in these mines than any other publishing geologist, reported multiple examples of wide-open caverns and fissures along the veins of the Rosiclare Subdistrict. These included "a channel large enough for a man to crawl into" (p. 42) in the Daisy Mine and a cavern lined with crystals that was 60 feet long, 30 feet high, and as wide as 15 feet in the Argo Vein. The veins themselves contained jumbled, angular, and corroded clasts of wall rocks as large as about 3 feet across. Such conditions led to speculation of pull-apart or transtensional structures. Bastin (1931) also noted striations and mullion indicative of strike-slip. At the Hillside Mine, slickensides and grooves are pitched 20° to 30° S on a fault having the west side downthrown, a configuration consistent with left-lateral slip. In the Daisy Mine, the plunge of striations varied from 10° S to 80° N, again consistent (for the most part) with a sinistral component.

Elsewhere, Hook (1974) observed, "The Gaskins Mine in the Empire District on the west side of Hicks Dome has predominantly horizontal slickensides and tension fractures indicating left-lateral movement" (p. 83). However, right-lateral indicators also have been reported. Citing a personal communication with Don Saxby, Hook (1974) noted, "Both left-lateral and right-lateral movement have been observed in the Cave-in-Rock area of the district" (p. 83). In 1982, John Nelson observed prominent striations and mullion plunging northwest on the West Vein in Ozark-Mahoning's Barnett Mine. Being on a normal fault with the northwest side down, these features indicate right-lateral slip. Structural movement may currently be occurring, as evidenced at the Knight Mine, where residual "stress relief" deformed circular diamond drill holes into ellipses (personal communication from R.L. Perry to Ross Lillie, 2015; R.L. Perry was the Chief Geologist with the Ozark-Mahoning Company at the time of this observation). Just southwest of the IKFD in southern Pope and Massac Counties in Illinois, segments of the Fluorspar Area Fault Complex displace sediments as young as Pleistocene. The faults that offset Cenozoic units strike N20°–40° E, more northerly than the trend of the fault complex as a whole. They outline narrow, linear grabens into which sediments have dropped. As in the Rosiclare area, the fault pattern fits left-lateral transtension (Nelson et al. 1997, 1999). However, such a pattern is not consistent with the contemporary stress field, in which the principal compressive stress axis is oriented N60°–90° E and should induce right-lateral transpression (Zoback and Zoback 1980, 1991; Nelson and Bauer 1987). Although several explanations are possible, the most appealing is that the stress regime has changed through time (Nelson et al. 1999). Such changes in the stress field orientation would account for observations of right-lateral slip in the IKFD.

In summary, the IKFD has undergone three major episodes of deformation and probably several lesser episodes during the last 500 million years of Earth's history. Failed rifting during the breakup of Rodinia in the latest Proterozoic and early Cambrian Period set the stage for deep structural control of the faults. Compression associated with continental collision

during the assembly of Pangea in the late Paleozoic Era induced reverse faulting and ultramafic intrusions. Renewed extension as Pangea broke apart during the Jurassic Period created the northeast-trending faults and fractures that served as pathways for mineralizing fluids. Indicators are strong that the phenomenally rich Rosiclare Vein System formed at a releasing bend under left-lateral transpression. However, the stress regime has changed through time since the Jurassic and continues to evolve to the present day.

MINING METHODS

Underground Mining

Fluorspar veins extend hundreds to thousands of feet along strike, with widths that range from a few inches to about 40 feet, separated by lateral and vertical “barren pinches” that usually contain no mineralization. Most underground mining along vein deposits in the IKFD used a stoping method of mining. Shrinkage stoping, overhead stoping with support timbers, or “stulls,” modified sublevel mining, and square set systems have all been used (Hatmaker and Davis 1938; Saxby 1973). Some mines at Spar Mountain in the Cave-in-Rock Subdistrict drove a horizontal entry, or “adit,” into the side of the hill. However, most underground mines started with a vertical shaft, usually sunk over the vein or, more commonly, in competent ground to the side of the vein. Concrete was applied to the shaft collar and in the uppermost portions of the shaft to prevent the unconsolidated ground from caving, but concrete lining was generally not necessary after solid rock was encountered. Timbering of the sidewalls was common in the upper levels of the veins and where shale sidewalls were encountered. Upon reaching ore, horizontal openings, or “drifts,” commonly 12 feet wide × 7 feet high, were driven through barren rock to intersect the ore. The drifts connected with the ore-producing levels, along which the ore was transported to the hoisting shaft (Hurst 1927). The vertical space between working levels varied but commonly was about 100 feet. In stope mining, open excavations formed by ore extraction, or “stopes,” were created by caving the rock from above downward. This method is called “overhead stoping.” The stulls were

wedged diagonally between competent rock walls. Poles were then layered on top of the stulls to support the ore as it was blasted from above. The slope of the poles allowed the broken ore to gravity feed or funnel down to the ore cars below. Gates and chutes were constructed to allow the ore to be metered into the ore cars (Figure 4). Good explanations of mining practices were given by Bailie et al. (1960) and Reeder (1930).

In some mines, arches were left on the bottom just above the haulage level to support the broken ore between the stopes. Upward lifts, or “raises,” on about 25-foot centers were driven upward to about 20 feet, leaving arches to support the broken ore as it caved downward (Figure 5). This arch method was a much more stable and safer method of mining. Because the broken ore took up to a 50% larger volume than ore in place, some of the blasted material had to be removed to supply headroom for the advancing raises. The broken ore was drawn off as necessary to allow the proper headroom and floor for the raises (Figure 5). Once the ore had been loaded through the stopes into the rail cars, it was transported to the shaft, where it was hoisted to the surface in skips and dumped into storage bins. In the earlier mines, the headframe was constructed of wood, but mine operators later erected steel headframes to support the hoisting of the raw crude ore. The steel headframes at the Annabel Lee Mine in the Harris Creek Subdistrict and the Rosiclare Mine in the Rosiclare Subdistrict are still standing, but most other headframes have been demolished. Steam, electric, and gasoline engines were used to power the hoists that lifted the ore and miners to the ore levels.

Mining in the horizontal bedding replacement deposits commonly utilized a modified room-and-pillar method of mining similar to that used in mining horizontal layers of coal and salt. This method removed ore from rooms and left blocks or pillars to support the overlying roof, inevitably leaving ore in the ground. The ore was generally competent enough to require blasting with explosives. Once the material was fragmented, it was loaded into small railcars pulled by mules during the early years, and later into rubber-tired mobile haulage equipment. High-grade

ore was handpicked and sorted, but lower grade material was sent to a mill to be refined.

Surface Mining

Some of the ore within the veins cropped out at the surface, and some of the bedding deposits occurred close enough to the surface to enable mining in open pits. Because fluorspar is resistant to weathering, the ore formed what are termed “gravel spar” ore deposits as it was weathered or eroded. The ore was mainly angular to subrounded pieces of fluorite surrounded by clay. These gravel spar deposits were located over both bedding replacement deposits and veins. They were mined mainly through open pits and trenches and were dug by hand and with equipment of various sizes. The Hamp Subdistrict was reported to contain considerable gravel ore, as were some of the early mines in the Cave-in-Rock Subdistrict. Some of the deposits were large enough that both steam shovels and small draglines were used. The presently active Hastie Quarry extracts fluorspar and associated minerals in conjunction with limestone from an open pit.

MINERAL SUBDISTRICTS AND INDIVIDUAL MINES

Individual mines within the IKFD are grouped into subdistricts and discussed below. The individual mines were sometimes named after the mining company, but other mines were given various monikers, such as Black Jack, Interstate, Good Hope, Empire, and Eureka. Some veins extended across several property lines and had several shafts. For example, when a new shaft was sunk along the southwest extension of the Empire Vein (Empire Mine) on the Redd property, the new shaft and the mine became known as Redd. Portions of the following information were extracted directly from ISGS publications and maps (Denny et al. 2008a, 2010, 2011, 2013; Denny and Counts 2009; Seid et al. 2013a, 2013b; Denny and Seid 2014; Devera et al. 2016). Additional information may be found in 7.5-minute quadrangle geologic maps and reports available at the ISGS (<http://www.isgs.illinois.edu/maps/isgs-quads>).

During the summer of 2018, the authors gained access to the files left in the field

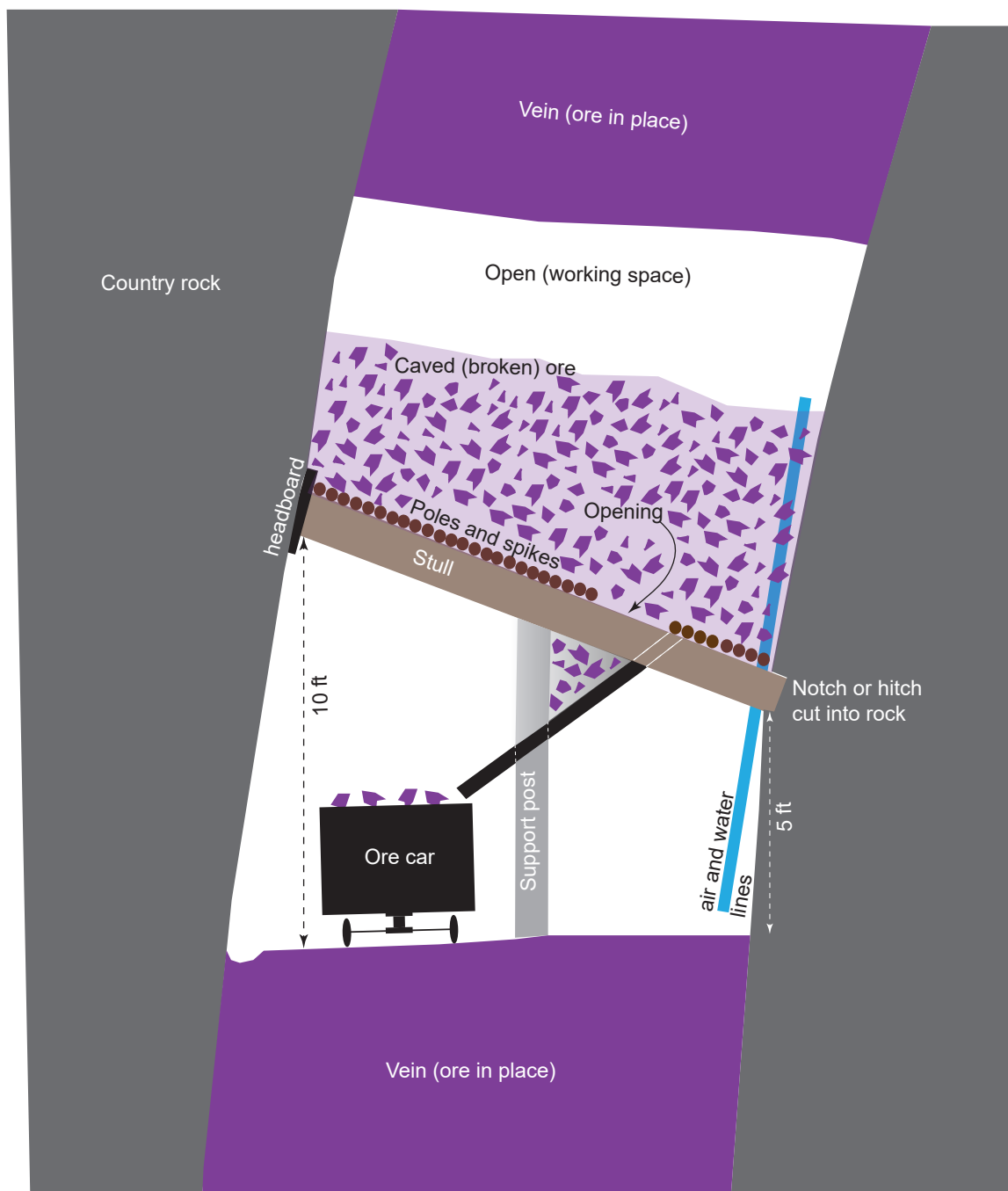


Figure 4 Cross section of a stope along a vein of fluor spar. The stull was wood timber driven to support the broken ore before it was loaded into ore cars. This view is looking along strike of the vein. Modified from Hurst (1927).

office of Ozark-Mahoning in Rosiclare. Ozark-Mahoning ceased mining operations in the district in about 1996. The Hastie Mining and Trucking Company purchased the Ozark-Mahoning property and records several years ago, and Hastie Mining allowed the ISGS to scan the

geologic records. The records contained more than 1,000 drill logs, hundreds of mine maps, and hundreds of geologic cross sections, drill profiles, and reserve calculations. The paper maps and cross sections were scanned at 400 dpi (.tif images) to retain the proper map scale,

whereas the drill logs and text documents were scanned at various resolutions. Several of these maps are depicted herein, but dozens of other maps and logs are archived at and available from the ISGS. These data will be made available to researchers on request. Because of the

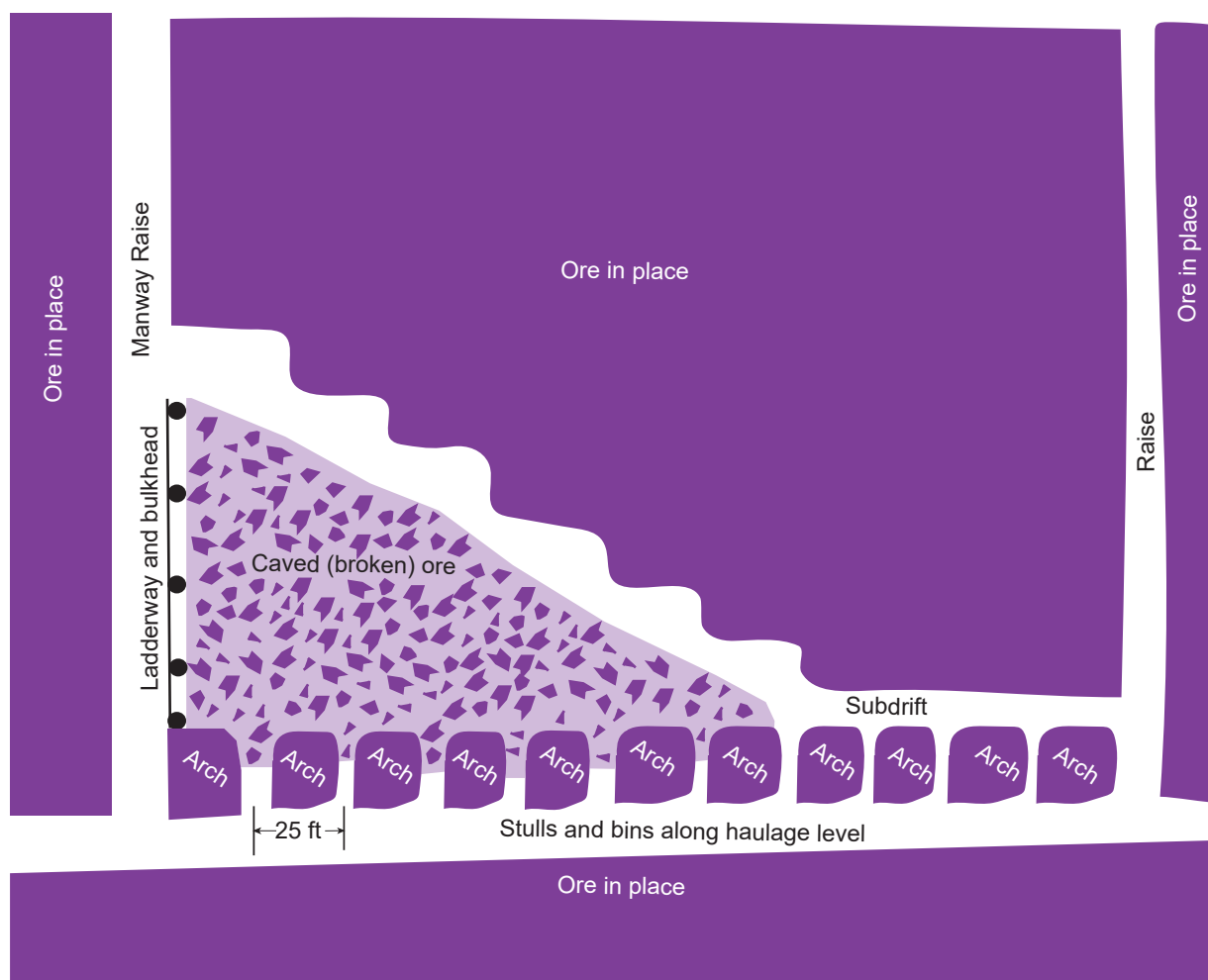


Figure 5 Cross section through a shrinkage stope. Arches were left to support the weight of the ore being drawn down from above. The stopes shown in Figure 4 are located between the individual arches. This view is looking perpendicular to strike of the vein. Modified from Reeder (1930).

sheer volume of material scanned, the data are still being organized. We hope that it will be made available online, but at present, the size of the digital data set is more than 500 gigabytes. Although the data have been collected, additional money is being sought to properly organize it and make it widely available.

Rosiclare Subdistrict

By far, the richest vein subdistrict in the IKFD is the Rosiclare Subdistrict. The Rosiclare Subdistrict is located in Hardin County, in southeastern Illinois, and extends from the Ohio River northward through the village of Rosiclare to just north of Illinois Route 146. The Rosiclare Mine, which operated for more than a century, was at one time the largest fluor-

spar mine in the United States and possibly the world. Several adjacent mines, notably the Argo, Blue Diggings, Daisy, Eureka, and Hillside, were also major producers. The veins are aligned along a set of north-trending normal faults of slight to moderate displacement (Figure 6). Mineralization is predominantly fluorite, along with calcite and lesser amounts of quartz, galena, and sphalerite. Barite in the Rosiclare Subdistrict is not common, in contrast to some other parts of the IKFD. The widest veins in the Rosiclare Subdistrict typically lay where one or both walls of the fault were composed of limestone or highly calcareous units. Fluorspar also replaced an earlier-phase calcite already present within the faults and fractures (Ladoo 1927). Both the fault and vein were usually named the same; thus,

the Rosiclare Vein lay along the Rosiclare Fault. From east to west, the major veins are named the Hillside, Rosiclare, Daisy, Blue Diggings, Argo, and Knight. The biggest problem in the Rosiclare Subdistrict was flooding, which forced a number of mines (including the Rosiclare) to shut down temporarily or permanently. In mines at the southern end of this subdistrict, fissures may have channeled water directly from the Ohio River into underground workings.

The veins in the Rosiclare Subdistrict were developed along an intricate system of faults that bound the southeast side of the Rock Creek Graben. Specifically, veins of unusual width and richness coincide with an approximately 3-mile segment of the fault zone where the strike changes

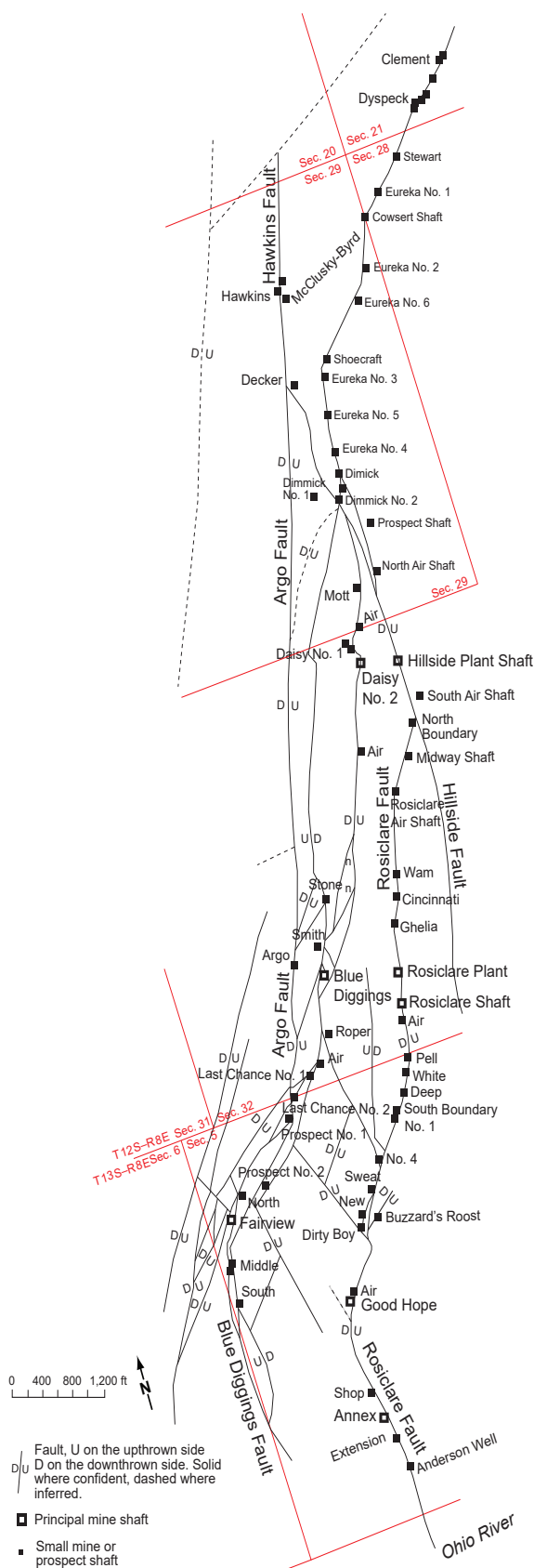


Figure 6 Mine shafts and faults within the Rosiclare Subdistrict. Modified from Weller et al. (1952). See Rosiclare Vein on accompanying map sheet.

from its usual N40°–50° E to N0°–20° E. We are not aware of any authors who have addressed the structural implications of this bend in the fault system, but correlation of the rich mineralization with the bend is inescapable. We speculate that the Rosiclare Subdistrict represents a discrete area of transtensional or pull-apart action along a system that probably had a small strike-slip component. The nearly vertical attitude of the richest vein, the Rosiclare Vein, is suggestive of strike-slip. Transtensional, pull-apart grabens have been documented along elements of the Fluorspar Area Fault Complex in far southern Illinois (Nelson et al. 1997, 1999). This style of deformation creates large, open fissures that facilitate the movement of ore-bearing fluids. The propensity for flooding and the occurrence of mud pockets at considerable depth also imply wide-open fissures along the veins.

Some faults bifurcate, split, or merge with other faults; thus, tracing the individual faults becomes difficult. The mining companies generally chose the names of the faults and mines, sometimes after property owners or mine operators. Changing ownership and different companies mining extensions of the same vein further complicated the names applied to the veins and faults. Near the southern end of the Hillside Mine, the Hillside Fault splits into two main segments. The easternmost extension is named the Hillside, but the western segment is called the Rosiclare Fault. The Rosiclare Lead and Fluorspar Company controlled production on the northern end of the Rosiclare Vein, whereas the Fairview Fluorspar and Lead Company, Franklin Fluorspar Company, and Aluminum Ore Company controlled the southern portion of the Rosiclare Vein (Bastin 1931). Some historical documents refer to the southern portion of the Rosiclare Vein as the Rosiclare-Fairview Vein (Weller et al. 1952). This is confusing because a Fairview Shaft is located west of the Rosiclare Vein, along the southern extension of the Blue Diggings Vein. The Hillside Fluorspar Mines were sold to the Inland Steel Company in June of 1945. The Mahoning Mining Company was renamed the Ozark-Mahoning Company, Mahoning Mining Division in December of 1946, and the Aluminum Ore Company was renamed the ALCOA Mining Company in 1948 (Weller et al. 1952). The extension of

the Rosiclare Vein to the south in places has been called the Rosiclare, Fairview, Good Hope, Extension, and Annex Vein. The extension of the Daisy Vein southward has been called the Blue Diggings. The ore bodies along the Rosiclare Vein were more persistent in width and length, whereas the widths of the Daisy and Blue Diggings Veins were erratic (Cronk 1930). The average width of the economic veins varied considerably, but mined thicknesses ranged from a few feet to 40 feet wide (Currier 1920).

A few mines operating in the Rosiclare District were described in pre-1900 newspapers and journals, but the precise locations of most of these mines were not certain (Parker 1891). William Pell was reported to have mined fluorspar along a vein near the Rosiclare Mine in 1842 (Bain 1905). The Pell operations seem to have been followed by Mullins and Argyle. The Pell Fluorspar and Lead Company was actively operating along a vein 10 to 30 feet wide in 1889 (General Mining News—Illinois 1889a). In 1889 and 1890, the Mullins Fluorspar and Lead Company was installing a concentrating plant for the recovery of lead and fluorspar, reorganizing mining, and constructing a mile-long tramway to connect the mines and mill (General Mining News—Illinois 1889b). Other pre-1900 documents indicate that the Illinois Lead and Fluorspar Company may have succeeded the Mullins Fluorspar and Lead Company. In 1894, the Argyle Mine was reported to be operating and installing new equipment (*Hardin County Independent* 1894). The individual mines within the Rosiclare District are discussed below in a general north-to-south order.

Clement Mine (Clement-Dyspeck Prospects) and Stewart Mine

The Clement Mine, also called the Clement-Dyspeck Prospects, was operated by the Rosiclare Lead and Fluorspar Company. The prospects were located northeast of Illinois Route 34 about 2 miles north of Rosiclare (Bastin 1931). A.H. Worthen described a prospect called the McAllen Diggings, present around 1860, in the general vicinity of the Clement Mine (Weller et al. 1952). These pits constitute the northern prospects along the Rosiclare-Hillside Fault Zone (Bastin 1931). Several small pits were developed and at least one shaft was sunk to 40 feet

deep (Bastin 1931). By 1928, this mine had produced 1,600 tons of finished spar from a vein 4 feet wide (Bastin 1931). The vein trended N45°–50°E and the dip was nearly vertical (Bastin 1931). Gravel spar was also reported as being mined in this area. Bain (1905) indicated that other prospects were located farther to the northeast, but little documentation of these prospects could be obtained.

The locations of these prospects are also depicted on a geologic map produced by Weller et al. (1952). Weller et al. mapped two shafts labeled Stewart, which were located between the Dyspeck property and the Eureka No. 1 Mine. Very little information is available concerning this prospect, and the Stewart Mine present in the Rosiclare Subdistrict should not be confused with the Stewart Subdistrict several miles to the west.

Eureka Mines, Shoecraft Mine, and Cowsert Shaft

As mapped and described by Weller (1943g), the Eureka Mines were developed near the northern end of the Rosiclare Subdistrict and were considerably less productive than mines farther south. In places, the vein was well developed, with 4 to 6 feet of nearly pure purple fluorspar, but in one place, a 2- to 3-inch band of galena paralleled a 6-inch vein of fluorspar (Bastin 1931). The Eureka Mines exploited a vein or narrow zone of veins that gradually changed strike from N10°E to N40°E. Although the vein locally attained a width of 12 feet, Weller (1943g) estimated an average width of 3 feet, and many segments of the vein were barren. The vein(s) followed west-dipping high-angle normal faults having throws in the range of 50 to 100 feet. The productive interval extended from lower Paoli Limestone near the surface to lower Ste. Genevieve Limestone at a depth of about 300 feet.

The first Eureka shaft was sunk in 1916, but mining did not begin in earnest until 1925. During the late 1920s and 1930s, five more production shafts were developed. Underground drifts and stopes partially connect, but wide areas barren of ore partition the workings along about 4,000 linear feet. In several cases, workings had to be abandoned because of flooding, cave-ins, and the occurrence of mud pockets as deep as 250 feet below

the surface. The Eureka No. 2 Shaft, also called the Cowsert Shaft, lies about 850 feet west of Illinois Route 34 (Bastin 1931). In 1928, the No. 2 Shaft was about 310 feet deep, with working levels of 80, 200, and 300 feet (Bastin 1931). Several additional Eureka shafts were sunk, and Davis (1943) reported that the Rosiclare Lead and Fluorspar Company was still producing ore from the Eureka No. 4 and Eureka No. 5 Shafts in 1942. By 1943, only the Eureka No. 4 Shaft was producing ore. With wartime and early postwar fluorite prices high, the Rosiclare Lead and Fluorspar Company continued operations intermittently through 1950 (Davis 1949, 1953). Weller (1943g) estimated total production of all the Eureka shafts at 35,000 tons of finished fluorspar, about the same as annual production from the Rosiclare Mine during its heyday.

Dimmick (Dimick) Mine

The Dimmick property was situated in the northern part of the Rosiclare Subdistrict, north of the Daisy Mine and southwest of the Eureka Mine (Baxter and Desborough 1965). Dimmick is also spelled “Dimick” (Weller et al. 1952). Prospecting commenced circa 1918 via open pits, shallow exploration shafts, and diamond core drilling. The property passed through several hands before W.E. Dimmick sank a shaft 200 feet deep and began drift development sometime in the 1930s. Veins more than 5 feet wide were encountered in Dimmick’s mine, but little stoping was conducted. After Dimmick’s death circa 1938, the mine passed to the Hillside Fluorspar Mines Company, which cleaned out old workings, sank a second shaft, and resumed production in 1942 (Davis 1943). The Dimmick No. 2 Shaft was sunk to 65 feet deep and a drift was driven 80 feet along a fault, but no mineralization was encountered (Bastin 1931). The workings encompassed two subparallel veins striking slightly east of north, dipping almost vertically, and merging toward the south (Weller 1942b). *Illinois Coal Reports* indicate that approximately 5,000 tons of ore was produced by Dimmick during the 1920s to 1930s.

Hawkins Mine

The Hawkins Mine was located about one mile north of Rosiclare and was in operation from 1943 through 1950. The mine was owned and operated by the

Rosiclare Lead and Fluorspar Company (Davis 1943, 1953). In 1943, good ore was mined at the 100-foot level (Davis 1945). The mine was still producing ore in 1945. Weller et al. (1952) stated that the Hawkins Fault was an extension of the Dimick Fault.

McClusky-Byrd Prospect

This prospect is located near the Hawkins Mine and was identified by Weller et al. (1952) on a geologic map. It is near the northernmost portion and is probably a northward extension of the Argo Fault.

Decker Prospect

This prospect is located south of the Hawkins Mine, near the junction of the West Dimmick and Argo Faults. Very little information is available concerning this prospect.

Hillside Mine

The Rosiclare Lead and Fluorspar Mining Company conducted diamond drilling in 1917–1919 from its Daisy Mine property. In 1919, the landowners of the Hillside property sold their property to G.H. Jones, who then organized the Hillside Fluorspar Mines Company (Muir 1947, p. 3). This company sunk a shaft in 1921, erected a mill, and commenced mining in 1922 (Muir 1947, p. 3). The Hillside Fluorspar Mines Company was later absorbed by Inland Steel Company (Muir 1947, p. 3). In 1948, Inland Steel discontinued all mining and milling operations in Rosiclare and sold the Hillside properties to the Rosiclare Lead and Fluorspar Company (Davis 1950). Inland Steel suspended its fluorspar operation in June 1954 (McDougal and Roberts 1958a).

A lead circuit in the mill produced a lead concentrate that was shipped to the National Lead Company in Collinsville, Illinois. The lead concentrate yielded 65% lead and 5 ounces of silver per ton (Bastin 1931). The Hillside Mine worked a north-trending vein contiguous with that of the adjoining Rosiclare Mine on the south. The vein was reported to be nearly vertical, 5 to 34 feet wide, and trending generally north–south (Bastin 1931). Considerable gravel spar was mined in the upper 200 feet of the vein (Muir 1947). The ore was primarily from fluorite and calcite veins, but a considerable amount of galena was recovered (Muir 1947). The

Hillside Vein contained a greater amount of calcite than was usual in the subdistrict. In places, the vein was largely calcite, crosscut by sheets of fluorite (Weller 1943h).

The richest segment of the Hillside Vein was about 1,300 feet long and averaged more than 10 feet wide, locally exceeding 30 feet. The vein follows a narrow fault zone that strikes slightly east of north and dips very steeply to the west, having a throw of 200 to 250 feet down to the west. Bastin (1931) reported that postmineralization normal faulting was present and that the west side of the fault was downthrown. The fault is noticeably sinuous in the dip direction and bifurcates in several places. Grooves or slickensides along the fault pitching 20° to 30° to the south from horizontal indicate that a lateral component was also involved in the movement of the fault (Bastin 1931).

The mine complex consisted of the main plant shaft to the 450-foot level (extended to 600 feet), a south air shaft sunk to the 250-foot level, and a north air shaft, approximately 900 feet north of the main shaft, sunk to the 450-foot level. Working levels were 170, 250, 350, and 450 feet (Bastin 1931). Later, this mine worked deeper levels at the 550- and 650-foot levels (Muir 1947). The vein was mined continuously for more than 1,600 feet at the 350-foot level. Ore was produced from 1922 through 1937 until the 550- and 650-foot levels were worked out (Weller et al. 1952). The ore was a few feet thick to more than 34 feet wide at the 350-foot level (Muir 1947). Deep drilling by the USGS cut this vein at depths of 790 to 1,360 feet, where it was barren except for a few traces of fluorspar (Weller et al. 1952). Discovery of a parallel vein in 1937 extended production for a few more years, but by 1942, the company was reduced to removing the arches below the stopes and backfilling the mined area with waste from the mill. Cumulative production through the end of 1941 was approximately 310,000 tons of finished fluorspar, as well as several thousand tons of lead concentrate (Weller 1943h).

Daisy Mine

The Daisy Vein was located about 600 feet west of the Rosiclare and Hillside Veins along the northern end of the Blue Diggings Vein System (Figure 7). An early

shaft about 40 feet deep was developed on this vein around 1891 (Emmons 1893). A shaft was dug along the Daisy Vein by the Rosiclare Lead and Fluorspar Mining Company in 1915 (Muir 1947, p. 3). Production from this mine was extensive from 1917 through 1943 (Muir 1947). As of 1942, the Daisy Mine may have been the largest producer in the entire IKFD, second only to the Rosiclare Mine. Production from the Daisy Mine was primarily along the Daisy Vein, but Muir (1947) stipulated that ore from the Blue Diggings Vein was also transported through the Daisy Mine workings. Muir (1947, p. 4) stated that through 1945, approximately 335,000 tons of fluorspar was produced at the Daisy Mine, with 218,000 tons coming from the Daisy Vein and 117,000 tons from the Blue Diggings Vein.

The Daisy Vein was approximately 8 feet wide but in places swelled to more than 25 feet wide. The vein was mined for more than 2,800 feet along strike to depths below 700 feet (Muir 1947, p. 7). The mine worked the 150-, 180-, 300-, 412-, 528-, 600-, 700-, and 800-foot levels (Figures 7 and 8). The 412-foot level was the main haulage level, and it extended for 2,000 feet southerly from the main shaft, where a crosscut was driven westerly to the Blue Diggings Vein (Cronk 1930). The vein showed postmineralization movement, with the west side being downthrown (Bastin 1931). The pitch on slickensides showed bidirectional movement, with one set pitching 10°S and a second set 80°N. In 1934, a “winze,” which is a sloped entry or passageway between working levels, was driven along the Daisy Vein to connect the 600- to 700-foot working levels (Davis 1935). In 1936, drifting on the 600-foot level followed ore for 1,300 feet in length (Davis 1938). In 1938, a drift was driven from the 800-foot level of the Daisy Vein to intersect with the Blue Diggings Vein (Davis and Trought 1941). Development work to the 800-foot level began in 1939 in both the Daisy and Blue Diggings Veins. Considerable tonnage of acid-grade fluorspar was mined in 1936 and 1937; it was brought directly from the stopes to the surface, dumped into trucks, and hauled to the mine yard (Davis 1938). This vein was mainly worked out by 1941, with small production only in the northern portions of the vein (Weller et al. 1952). As of 1942, the lower two levels of the Daisy were flooded

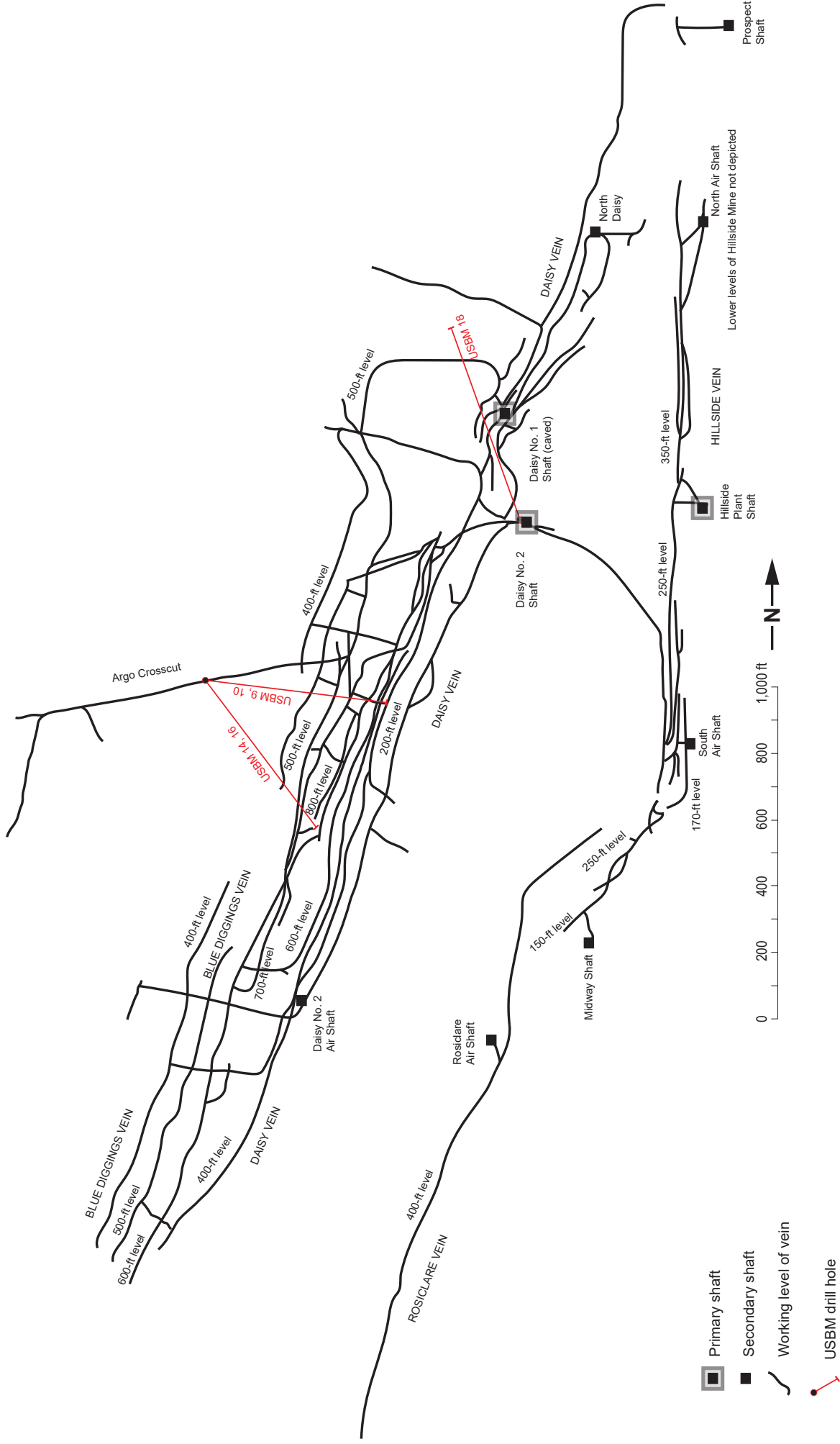


Figure 7 Plan view of the working levels in the Daisy and Blue Diggings Veins, circa 1946. Because the vein is dipping, the deeper levels appear as offset traces. U.S. Bureau of Mines (USBM) boring 14 and 16 intersects are shown on the cross section in Figure 8. Modified from Muir (1947) and unpublished Ozark-Mahoning scanned documents.

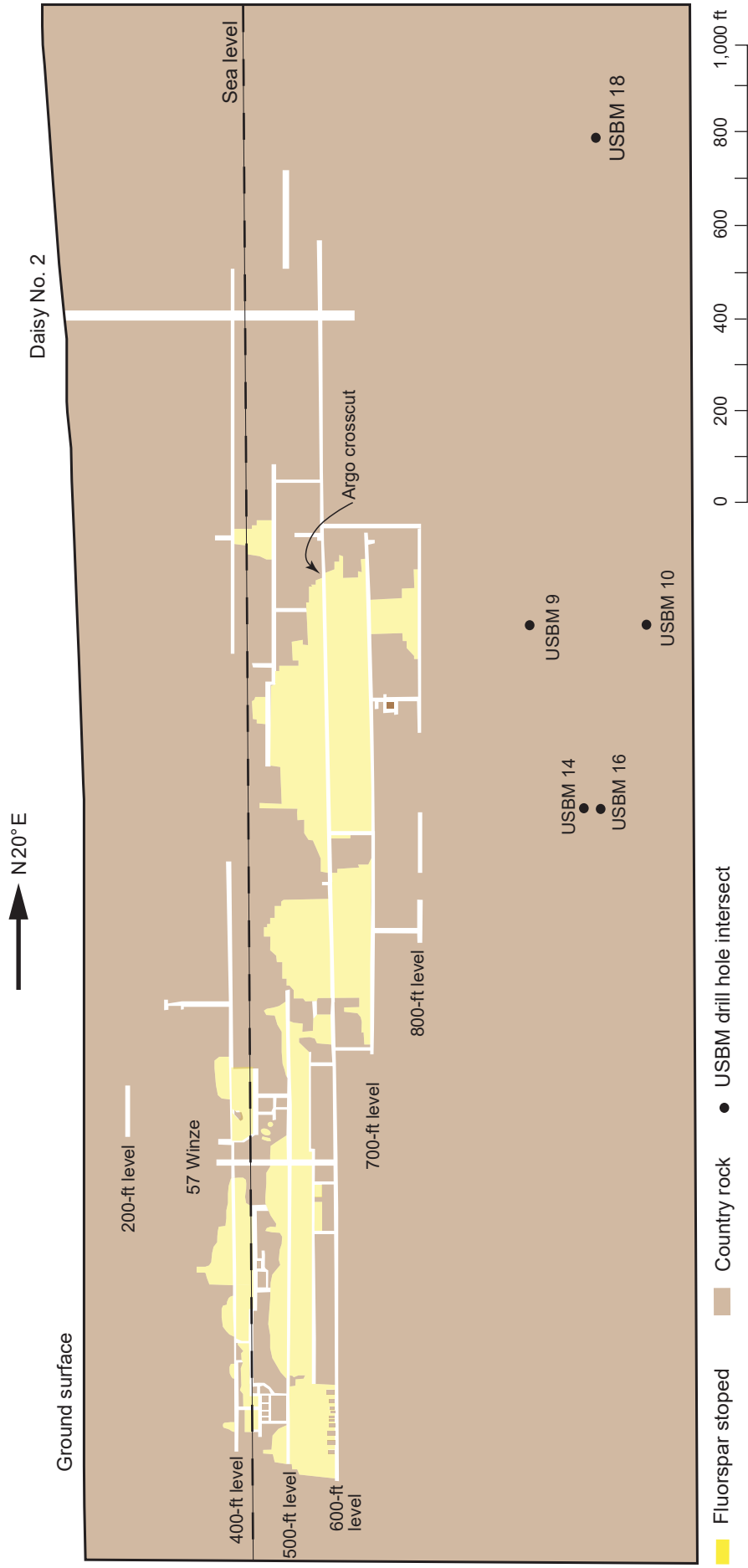


Figure 8 Cross section of the underground working levels along the Blue Diggings-Daisy Vein, circa 1946 (modified from Muir 1947). Strike of the U.S. Bureau of Mines (USBM) borings 9, 10, 14, 16, and 18 are shown by the red lines in Figure 7. The cross section is aligned N20°E (looking northwesterly). For additional information concerning the USBM drilling projects, see Muir (1947).

and many other passageways were blocked by rockfalls (Weller 1942a). In 1945 and 1946, the U.S. Bureau of Mines conducted a drilling program to depths of 1,010 to 1,260 feet, which was below the lowest workings in the Daisy Mine. No fluor spar mineralization was found at these levels, but the fault zone was 5 to 45 feet wide (Muir 1947; Weller et al. 1952). Additional borings by the U.S. Bureau of Mines detected abundant calcite but no fluor spar at deeper levels (Figure 8).

Argo Vein

This vein was about 450 feet west of the Blue Diggings Vein, trending N25° E and dipping steeply to the west (Bastin 1931). The vein in the north drift averaged 3 feet wide but pinched out a short distance into the south drift (Davis and Trought 1939). The vein followed a normal fault, with the west hanging wall being downthrown more than 100 feet (Figure 9). The displacement along the fault decreased to the north, and it merged with the Blue Diggings Fault to the south (Weller et al. 1952).

The Franklin Fluorspar Company commenced operations on the Argo Vein, sinking a shaft in 1922. In 1923, a crosscut from the 500-foot level of the Blue Diggings Mine was driven into the Argo Vein. In 1938, the 500-foot level of the Argo Vein was driven 380 feet north and 400 feet south. In 1940, the Aluminum Ore Company operated the mine and drove crosscuts at the 500-foot level (Davis and Trought 1941). Igneous dikes 6 inches to 2 feet wide were encountered on the 500- and 240-foot levels (Weller et al. 1952). Drifting and raising were conducted in 1942 to extend working levels to 700 feet (Davis and Trought 1941). A new 700-foot shaft was completed in 1943 (Davis 1943). More development was conducted on the 600- and 700-foot levels in 1945 and 1946 (Davis and Greenspoon 1948). In 1953, the Argo Vein was still producing ore for ALCOA (Holtzinger and Roberts 1956). In later years, some of the mines were interconnected, and ore from the Argo Vein was transported through crosscuts into the Blue Diggings workings and from there hoisted to the surface.

Blue Diggings Mine

This mine was located along a vein about 900 feet west and parallel to the Rosiclare Vein (Figures 6–9). The mine was named for the pure white to light blue color of the fluorite extracted from this vein (Weller et al. 1920). The Blue Diggings Vein was narrow, between 3 and 8 feet wide, but was reported to have large, cavernous openings sometimes lined with pyrite (Bastin 1931). The Fairview Fluorspar and Lead Company operated the Blue Diggings Mine from 1910 to 1920 (Bastin 1931). The main shaft was driven on the hanging wall and passed through the vein on the 200-foot level. Weller et al. (1920) reported that this mine contained zones of intense fracturing and that the strike and dip of the vein varied considerably. The mine was worked extensively until 1924, when it was considered worked out (Weller et al. 1952). The Aluminum Ore Company, later known as ALCOA, discovered significant orebodies mainly south of the original workings (Weller et al. 1952). In 1937, the shaft was deepened to 720 feet. Development work began in 1939 to the 800-foot level in both the Daisy and Blue Diggings Veins. The two veins were reported to be only 30 to 40 feet apart at this level. In 1943, the Aluminum Ore Company was producing ore at this mine (Davis 1945), and through 1953, the mine was producing ore for ALCOA (Holtzinger and Roberts 1956).

The Blue Diggings Fault is inclined less than the rest of the faults in the Rosiclare area and has been studied by several geologists (Weller et al. 1952). The fault is normal and generally strikes N30°–50° E and dips to the east between 55° and 65° (Bastin 1931). Muir (1947) stated that the fault in this area dips 45°–83° E and that the vertical displacement varies between 75 and 150 feet. Core drilling by the U.S. Bureau of Mines indicated that the Blue Diggings and Daisy Veins merged about 50 feet below the 800-foot level. Igneous dikes were encountered in a crosscut west of the Middle Shaft on the 300-foot level and on the 600- and 700-foot levels (Weller et al. 1952).

Fairview Mine

In September of 1941, drilling successfully located additional ore reserves along the southern part of the Blue Diggings Vein, where the Fairview Shaft and three smaller shafts were sunk (Weller et al. 1952). A crosscut was driven from the vein at the 800-foot level to the bottom of the Fairview Shaft, and a 7,500-gallon-per-minute sump and pumping station was installed in 1949 (Davis 1951). Work began in 1951 to drive a crosscut from the Fairview Shaft to the Good Hope Vein, which had not been mined for 30 years (Davis 1953). In 1953, the mine was producing ore for ALCOA (Holtzinger and Roberts 1956). In later years, small locomotives were used to move the ore cars through the drifts, and in 1947, signal lights to control traffic flow were installed in the Fairview-Blue Diggings workings (Davis 1950).

Rosiclare Mine

Initial mining along this property began around 1842–1843 (Holtzinger and Roberts 1956). Weller (1943f) wrote of the Rosiclare Mine,

This mine has been the most important fluor spar producer in the United States, if not in the entire world. The Pell Mine, now part of the Rosiclare Mine, was opened in 1842. It and several other small mines nearby were subsequently worked principally for lead until about 1870, when the first shipments of fluor spar appear to have been made. Fluor spar mining, however, did not become important until about 1900, and until 1909, production from the Rosiclare property was small and probably never exceeded 25 tons per day. Thereafter, the development of the mine was rapid, and from 1909 to 1915, an average of about 40,000 tons of finished fluor spar was produced each year. Maximum yearly production of about 100,000 tons was attained in 1917.

The Rosiclare Lead and Fluorspar Company operated the mine (Bastin 1931). Mineralization at the Rosiclare Mine continued deeper than any of the mines in the Rosiclare area (Weller et al. 1952).

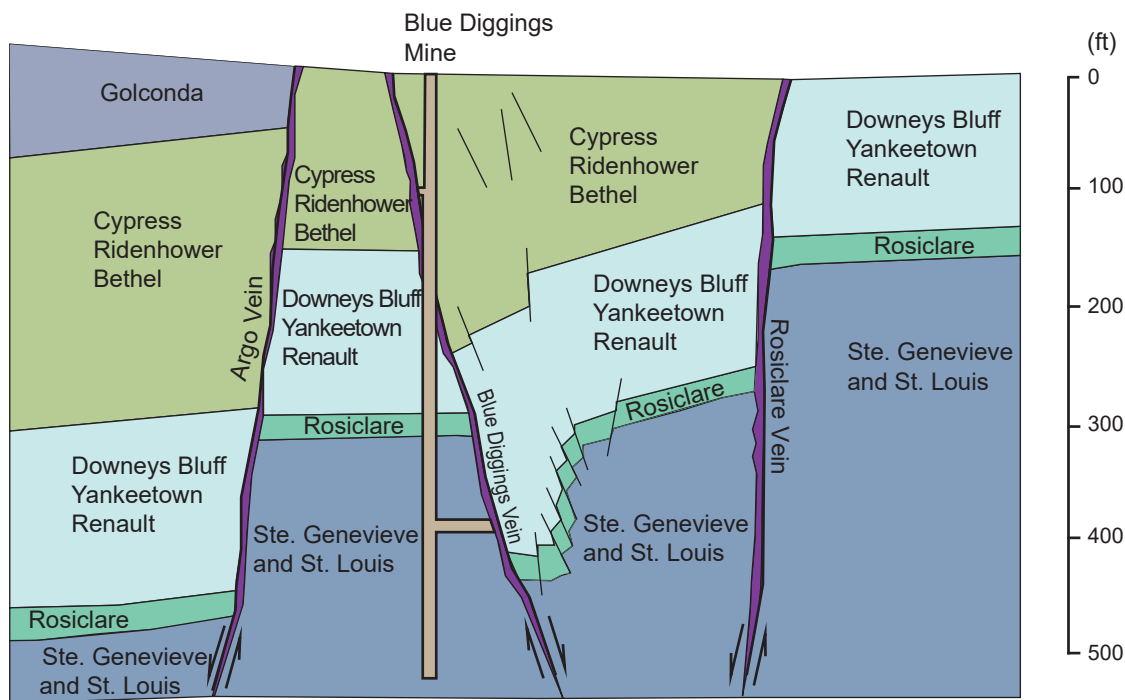


Figure 9 Idealized cross section across the Argo, Blue Diggings, and Rosiclare Veins. The view is looking northerly. Modified from Weller et al. (1920).

The vein consisted of fluor spar and calcite, with minor amounts of lead and zinc (Bain 1905). This vein was 30 to 35 feet wide near the Rosiclare Main and Plant Shafts, but Bain (1905) reported that the vein averaged about 10 to 12 feet wide. Developed within an intricate fault zone, the Rosiclare Vein trends slightly east of north and is slightly sinuous along strike. Faults and veins are nearly vertical, and throw varies from about 200 to 300 feet down to the west (Weller 1943f). Ste. Genevieve Limestone and older units on the east side are faulted against the Cypress Formation and older units on the west side of the fault.

The main shaft was sunk to a depth of 720 feet (Bastin 1931). During the period of greatest productivity, the Rosiclare Mine had working levels at 235, 320, 420, 520, 620, and 720 feet (Weller et al. 1920). As the deeper levels were advanced to the north, water became a significant problem (Weller et al. 1952). In January of 1924, water was being pumped from this mine at a rate of 3,500 gallons per minute, which was too much water and the mine closed (Weller et al. 1952). In 1938, additional pumps were installed in the Rosi-

clare Shaft. By 1940, the mine had been dewatered down to the 600-foot level and underground cleanup operations were ongoing (Davis and Trought 1941). Development work was undertaken on the 600- and 700-foot levels in 1941, and new ore production began in 1942. In 1943, a new 1,800 gallon per minute pump was installed, which raised the total pumping capacity of the mine to 8,800 gallons per minute (Davis 1945). High water from the Ohio River idled the mine in the spring of 1945, but production resumed by May. In 1948, water was coming into this mine at a rate of 7,000 gallons per minute. Because of the water influx, pressure grouting was planned to reduce the flow rate (Davis 1951). Production of ore was ongoing through the North and South Boundary Shafts in 1953 (Holtzinger and Roberts 1956). Production continued until 1954, when the Rosiclare Lead and Fluorspar Company pulled the pumps and allowed the water to flood the mine to the 220-foot level (Holtzinger and Roberts 1956). In 1958, exploration activities were conducted, but no further mine development is on record (McDougal and Foley 1959). The American Fluorite Museum now occupies the office at this

mine site. The headframe is still standing over a shaft on this property.

Good Hope Shaft

The Good Hope Vein was discovered in 1842 (Bain 1905) and is considered a southern extension of the Rosiclare Vein (Weller et al. 1952). Weller et al. (1952) stated that mining began on the Good Hope Vein in 1844 and continued until 1851 through a series of shallow shafts. Galena was present along with the fluor spar, which became more abundant at depth (Weller et al. 1952). Emmons (1893) suggested that the Good Hope Shaft was sunk by Mullins in 1847 on the Anderson property. In the early years, lead was smelted on the property, and later a milling plant was built at this location (Weller et al. 1952). Weed (1922, p. 821) stated that the mill could process 50 tons per hour. The vein was 25 feet wide (Weller et al. 1920), striking N21°E and dipping 80°NW (Bain 1905). By 1851, several shafts from 40 to 80 feet deep and one shaft to 130 feet deep were dug on the Good Hope Vein (Weller et al. 1952). The early shaft extended to a depth of 213 feet below the surface, and drifts were

run in both directions (north and south) at depths of 30, 60, 135, 160, and 210 feet (Bain 1905). An additional shaft was sunk on this vein in 1862, which allowed the mine to run until 1874. From 1891 to 1895, the owners of the Rosiclare Mine (Bain 1905) leased this mine. Production from the Good Hope Shaft continued from 1905 to 1913 until the original Good Hope Shaft began to cave. In 1909, the Fairview Fluorspar and Lead Company reopened an old shaft 1,700 feet north of the Good Hope Shaft (Weller et al. 1952). Weed (1922, p. 821) reported that this mine produced 47,604 tons in 1919 and 47,334 tons in 1920. Mining ceased in this area around 1924, when drifts apparently encountered water from the Ohio River. More than 3,400 gallons per minute was being pumped from these mines before the pumps were shut down (Bastin 1931). In 1943, the Aluminum Ore Company was producing ore at this location (Davis 1945).

Buzzard's Roost Shaft

The Buzzard's Roost Shaft, owned by ALCOA, was located east of the main fault on a smaller, northeast-trending subsidiary fault. Little information is available concerning this shaft.

Annex Mine

The Annex and Extension Shafts were sunk in 1911 (Weller et al. 1920). The Franklin Fluorspar Company controlled the Annex property (Bastin 1931), and in November of 1923, the Annex workings were flooded (Bastin 1931). The Annex Vein was 7 to 8 feet wide, but near the surface, it widened to about 20 feet (Bastin 1931). The vein narrowed to the south but widened northward to form the Good Hope orebody (Bastin 1931).

Extension Mine

This vein was operated by the Franklin Fluorspar Company and was extended for about 800 feet under the Ohio River (Bastin 1931; Weller et al. 1952). The vein was productive to about 300 feet, but below 300 feet, calcite was dominant (Bastin 1931). The vein was narrow near the Ohio River, but it widened to the north at the Extension and Annex Shafts to form good ore (Bastin 1931). On the 200-foot level of this mine and about

1,900 feet south of the Extension Shaft, the vein was about 3.5 feet wide (Bastin 1931). Water was encountered in this mine while driving a raise from the 200-foot level in November of 1923 (Bastin 1931). The water flooded the Good Hope, Extension, and Annex Mines, and 3,000 gallons per minute was being pumped when the workings were abandoned (Bastin 1931). In 1956, additional reserves were discovered along the Extension Vein (McDougal and Roberts 1958a).

Knight Mine

Ozark-Mahoning operated this mine around 1973 (Wood 1975; Malhotra and Smith 1976; Lamar and Bradbury 1979). The Knight Mine was located at the western edge of the Rosiclare District. Ozark-Mahoning files from 1982 indicate that 426,641 tons of refined ore was extracted from this mine. The Knight Vein widened considerably in rich areas. In 1980, Ozark-Mahoning geologists Ross Lillie and Eric Livingston examined active workings in a stope where the vein measured 42 feet across and consisted of virtually pure acid-grade spar. Massive, white, lightly translucent spar filled the vein from wall to wall. The Knight Vein persisted and widened at depth, with a coincidental disappearance of spar. Core drill records proved that vein widths exceeded 60 feet at depths below working levels, where the vein was composed mainly of massive calcite.

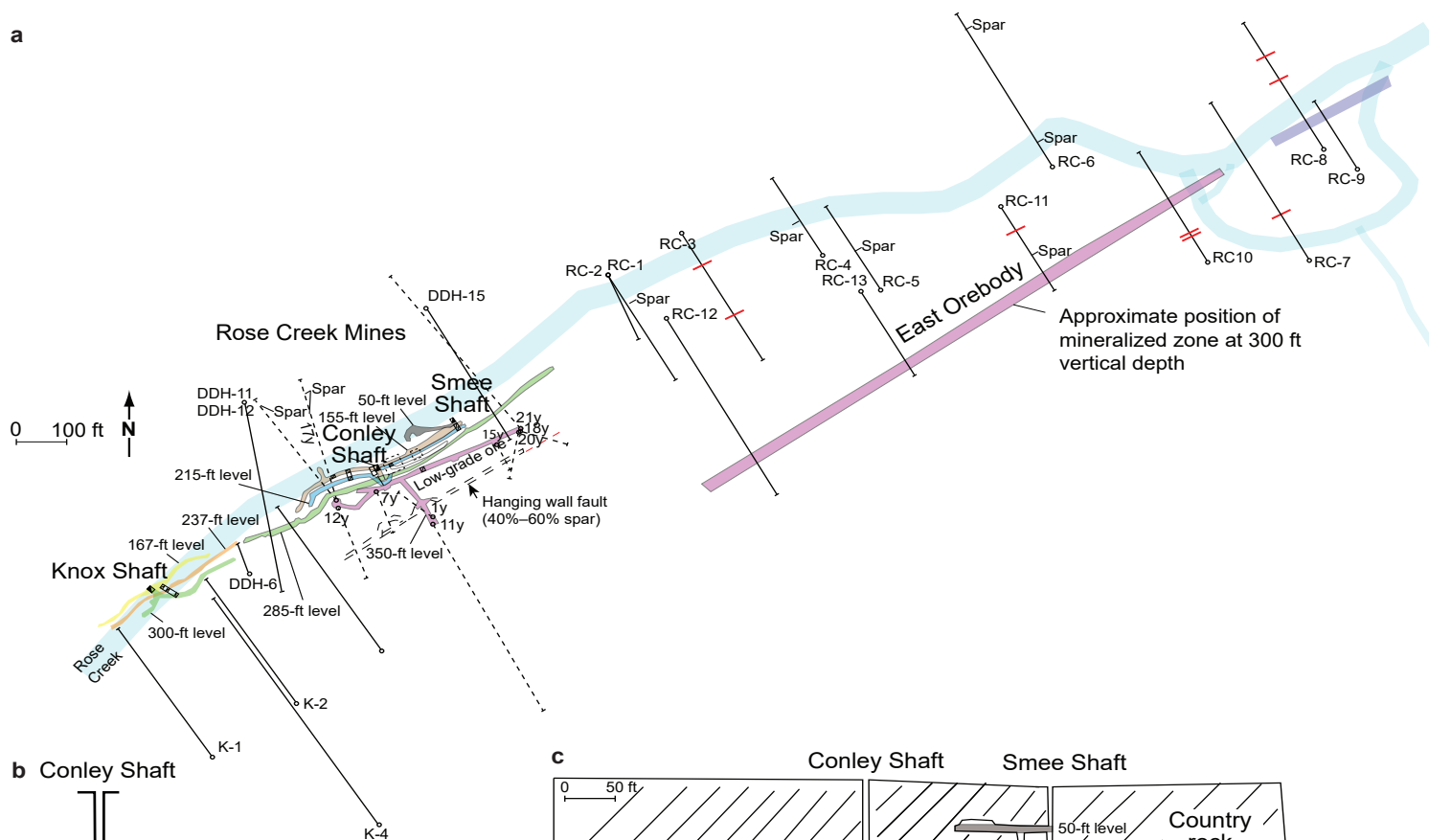
Rose Creek Subdistrict

The Rose Creek Subdistrict lies along the Rose Creek Fault, which underlies and aligns parallel with Rose Creek (Figure 10). This area is complex, with several faults apparently coming together (Baxter et al. 1967). Denny and Seid (2014) mapped the area slightly differently, but because this particular area is very complex, more data are needed to map the area properly. Burmeister (1952) indicated that several boreholes were drilled through the main fault, which intersected a mineralized fault striking N50°E and dipping 80°SE. Burmeister (1952) also stated that the Waltersburg Sandstone was present at the collar of the Knox Mine and that the fault was normal, with a displacement of 380 feet. Weller et al. (1952) traced the Rose Creek Fault in both directions for a distance of several miles.

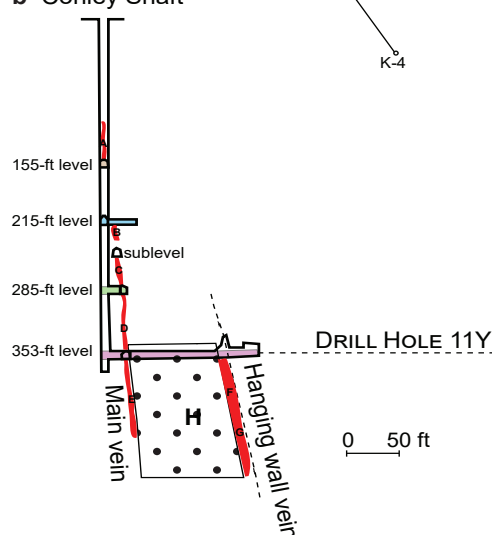
Rose Creek Mines—Conley and Smee Shafts

The Rose Creek Mines were operated by the Yingling Mining Company from 1942 to 1948 (Davis 1943, 1950). These mines were also called the Yingling Mines (Burmeister 1952). In 1942, Harve Smee sunk the Smee Shaft to 100 feet and drove drifts at the 50- and 100-foot levels (Burmeister 1952). The Conley Shaft was originally sunk to 90 feet (Burmeister 1952) but was later deepened to more than 300 feet. The vein lies along a fault trending N55°E and dipping 80°SE (Weller et al. 1952). Ozark-Mahoning mine maps indicated that the Conley Shaft was located in the middle of the mine workings. Working levels at 155, 215, 285, and 350 feet extended to the northeast and southwest along the fault away from the Conley Shaft. The Smee Shaft was at the northeast end of the mine and was also worked at the 50-foot level. The Minerva Oil Company commenced underground drilling in 1952, and the company reported low-grade ore below the 350-foot level between the main fault and the hanging wall fault. Most all of the exploration borings were drilled in a northwesterly or southeasterly direction to intersect a northeasterly striking fault or vein. Ozark-Mahoning maps suggest that a parallel fault, hosting 40% to 60% CaF₂ ore, was present to the southeast and that between the two faults, lower grade mineralization attaining 15% to 20% CaF₂ was present (Figure 10). Production at this mine from 1942 to 1949 was 8,500 tons of 60% CaF₂ ore and 3,450 tons of 35% to 50% CaF₂ ore (Burmeister 1952). In 1951, the Yingling Mining Company sold the Rose Creek property to the Minerva Oil Company (Holtzinger and Arundale 1955). Ozark-Mahoning mine maps indicate that additional ore was present along the master fault and in an east orebody. Minerva Oil Company reserve calculations from 1953 detailed that an additional 324,000 tons was possible along the master fault and that 97,000 tons was possible along the east orebody. Although the east orebody was 160 feet thick, with the top at 230 feet below the surface, the ore was low grade in sandstone and averaged about 19.6% CaF₂. A hanging wall orebody was also present southeast of the Conley Mine workings. More information is needed to determine whether the low-grade ore was ever mined.

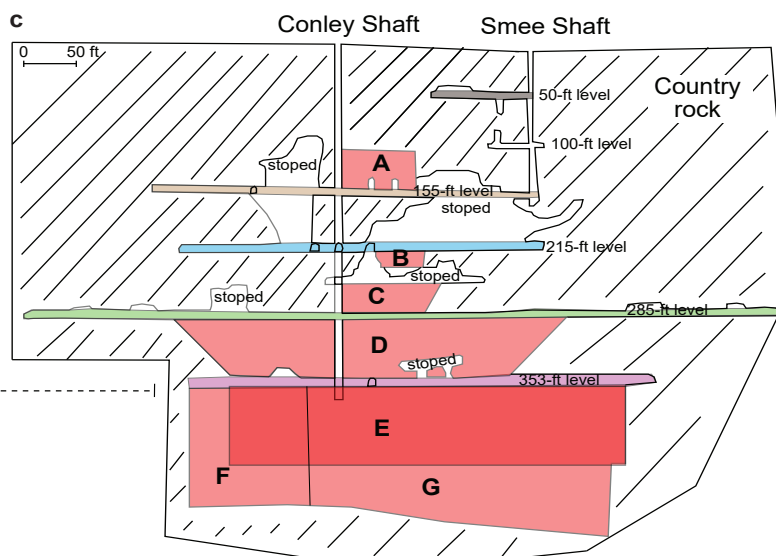
a



b Conley Shaft



c



Average ore grade

Location	Spar, %
Blocks A, B, C, F, and G	50
Block E	40
Block H	15–20
East orebody	19.6

Reserve calculations (in tons)

Block	Amount	Proven	Probable	Possible
A	600	600		
B	150	150		
C	600	600		
D	6,525	6,525		
E	7,500		2,500	5,000
F	3,272	3,272		
G	7,262	7,262		
H	324,333			324,333

Figure 10 Plan and cross section views of the Rose Creek Subdistrict near Herod, Illinois, circa 1953. Data from unpublished Ozark-Mahoning scanned documents. (a) Plan view of the Rose Creek Mine underground workings and drill data. Red lines along drill holes indicate fault encountered. All holes were drilled on an angle. Holes within or from underground workings are dashed lines. All data from Minerva Oil Company files, circa 1953, contained in Ozark-Mahoning scanned files. (b) Relationship of the hanging wall vein orebody to the main vein and the low-grade (15%–20% CaF_2) orebody lying between the two veins, looking northeast along veins. High-grade ore is red; low-grade is stippled. (c) Section showing ore reserves and underground mine workings along with ore reserve block as of 1953, looking northwest.

Knox Mine

The Knox Mine was located about 775 feet southwest of the Conley Shaft. It was probably along the same fault present at the Rose Creek Mine that trends N50°–60° E and dips steeply to the southeast (Weller et al. 1952). Near the Knox Mine, the fault is normal, with displacement down to the southeast approximately 400 feet. The Golconda Limestone is present on the northwest side of the fault, and the Waltersburg Sandstone is present on the southeast side. The mine was operated by the Knox Spar Company and produced siliceous fluorspar from a vein about 4 feet wide. Burmeister (1952) indicated that the shaft had been extended to the 300-foot level (Figure 10). Ozark-Mahoning mine maps indicate that working levels were at 121, 167, 237, and 300 feet. Drilling by the U.S. Bureau of Mines (K-4 and K-2) southeast of the mine indicated that disseminated spar was present in the Bethel Sandstone. The disseminated ore, if projected southwesterly, is in line with the east orebody present at the Rose Creek Mine.

Tanner Prospect

A prospect shaft exposed thin veins of spar. The pit was dug to 70 feet deep along a fault striking N55° W and dipping 80° SE (Weller et al. 1952). Unfortunately, Weller et al. (1952) did not plot this prospect on the geologic map that accompanies their report. We suspect that this prospect is close to the northeast-trending fault at the Knox and Rose Creek Mines, which intersects a northwest-striking fault mapped by Baxter et al. (1967).

Hamp Subdistrict

The Hamp Mines are aligned along the Hamp Fault, which lies along the north flank of Hicks Dome. The fault is very poorly exposed and was primarily mapped through mine notes and previous reports by Baxter and Desborough (1965), Weller et al. (1952), and Bastin (1931). The fault strikes almost due east–west circumferential to the dome and dips to the south at 60° to 75° (Bastin 1931). Because the Hamp Fault trends circumferential to Hicks Dome, Denny et al. (2010) suggested the fault was related to the domal or circular uplift at Hicks

Dome. The numerous small exploration pits in the area and the relocation of the roads made it difficult to accurately locate the early shafts and pits cited by various sources.

J.W. Waggoner began mining in this area in 1897. The shallow residual ore (gravel spar) that resulted from surficial weathering of veins was mined from open pits (Bastin 1931). As the upper shallow resource became depleted, shafts were sunk to lower levels along the east–west-trending vein. Mineralization was reported in veins from 6 inches to 9 feet wide for a distance of 700 feet. The ore was mainly fluorite and barite along clay-lined fractures and open spaces along the fault, with small quantities of galena and sphalerite. Replacement ore was also present, and Bastin (1931) noted that blastoid fossils replaced by fluorite and quartz were found in banded ore at this mine. During the early years, this mine produced 7,000 to 8,000 tons of ore (Bastin 1931) and yielded approximately 300,000 tons over a productive period of almost 100 years (Brecke 1965). Bastin (1931) reported that about 1,200 feet north of the Wormach Shaft, a “blanket or horizontal deposit” was worked.

A large east–west pit south of the gravel road at this location may be the source of the ore ALCOA mined in 1940. Weller et al. (1952) reported that ALCOA worked the east–west fault for 3,400 feet and drove one shaft to 300 feet deep. In 1941, the Yingling Mining Company developed the Nicholas Hamp property (Davis 1943). The Nick Hamp Mine was aligned along a 3-foot-wide vein that trends N40° W. The shaft at this mine extended to 150 feet below the surface (Weller et al. 1952). The precise location of the Nick Hamp is unknown, but it may be along a northwest extension of the Blue Vein near the Wallace Shaft (Figure 11). Dozens of shafts were present, most of which were aligned east–west, but several mines apparently followed veins trending approximately N30°–40° W. One of the northwest-trending veins is called the Blue Vein, and this vein projects to the intersection of secs. 12, 7, 13, and 18 (Figure 11). Ozark-Mahoning maps show that the westernmost mine, called the Hummingbird, lay along another N30° W vein called Cross Vein No. 1. Several

shallow shafts and prospects were also located along a north–northwest-trending fault near Hamp No. 2. These north–northwesterly faults intersected the main east–west-trending Hamp Fault. Individual mines of the Hamp Subdistrict are discussed below.

Local folklore reported sightings of several Sasquatch-like monsters around the Hamp Mines, and one was called the Hamp Mine Monster (Cline 2012). A statue of Sassy the Bigfoot has been erected as a tourist attraction at the intersection of Karbers Ridge Road and Garden of the Gods Road about a mile north of the Hamp Mines (<http://www.shawneeforest.com/bigfoot>).

Hummingbird Mine

This mine is located at the western end of the Hamp Subdistrict (Figure 11). Several shafts and shallow workings are aligned along a N30° W direction. Ozark-Mahoning mine maps indicate that this vein was referred to as Cross Vein No. 1.

LaRue Shafts

The LaRue Shafts were located along the western portion of the Hamp Subdistrict west of the Carnett No. 3 Shaft and east of the Hummingbird Mine (Figure 11). The LaRue No. 1 and No. 2 were located just east of the Hummingbird Mine (Figure 11).

Carnett Shafts

This prospect was owned by George Carnett and followed the east–west-striking Hamp Fault that dipped 70° S (Weller et al. 1952). A shaft that was dug to approximately 40 feet deep encountered an 8-inch vein of fluorite (Weller et al. 1952). Mine maps from the Ozark-Mahoning data identified nine Carnett shafts, most aligned in a general east–west trend. However, the Carnett No. 1 open cut, near the intersection of secs. 12, 7, 13, and 18, was aligned along a N30° W vein called the Blue Vein. The southeast extension of the Blue Vein at the Wallace No. 1 was called the Cross Vein No. 2. The Wallace Shaft was located near the southern end of the Blue Vein. Carnett No. 2 and No. 3 were located west of the Blue Vein along the main east–west-trending Hamp Vein.

Hamp Mine

The Hamp Mine worked open pits at the surface and underground on several working levels. In 1938, a new shaft was sunk to 100 feet, where a winze was driven 60 feet into good spar, and there a level was driven west for 100 feet (Davis and Trought 1939). The Aluminum Ore Company began digging a three-compartment shaft on the Hamp property in 1940 (Davis and Trought 1941). According to Davis and Trought (1941) a three-compartment shaft, probably the Central Shaft, was being dug in 1940. The fault was reported to dip steeply to the south and was worked on underground levels at 100, 200, and 300 feet. Two air shafts were present, but the Central Shaft was the main production shaft. An igneous dike was encountered in underground drilling on the 200-foot level. In 1951, Trammel and Guard (Davis 1953) were operating the Hamp Mine, and by 1953, ALCOA was producing ore from this region (Holtzinger and Roberts 1956). Ozark-Mahoning maps indicate that underground workings were present at levels of 100, 200, and 300 feet between the Carnett No. 1 and Hamp No. 1 Shafts. The apparent main shaft for this complex was called the Central Shaft (Figure 11).

Frohock Prospect

The Frohock Prospect, operated by Williams and LaRue, was located along the Hamp Fault (Weller et al. 1952). This prospect followed traces of gravel spar at the surface (Weller et al. 1952).

Weidman Prospect

Several prospect shafts are located here, ranging from 10 to 25 feet deep (Weller et al. 1952). Ozark-Mahoning mine maps identify, from south to north, the Big Tom Shaft, Ashford Shaft, WMS 5 Shaft, and Humm Shaft, which are aligned about N35°W. These shafts were located north of the Carnett Shafts near the eastern end of the Hamp Subdistrict.

Gintert Mines

Weller et al. (1952) listed three Gintert Mines near Karbers Ridge but did not plot these shafts on the accompanying map. Beecher Williams operated two Gintert shafts. The location of the first is T11S-R8E-8 (SW¼ SW¼ SE¼). This shaft was dug 30 to 60 feet deep along a 2.5-foot-

thick vein striking N45°W and dipping to the northeast. Gravel spar was also reported at this mine. The second Gintert shaft operated by Williams was east of the first and was a 70-foot-deep exploratory shaft that uncovered only traces of spar. The third location was given as T11S-R8E-17 (NE¼ NE¼ NE¼). This mine was operated by the Crystal Fluorspar Company, and a small amount of gravel spar trending N60°E was recovered (Weller et al. 1952).

Diamond Mine

The Diamond Mine was operated by George Carnett (Weller et al. 1952). A small amount of gravel spar was obtained in open cuts dug to depths of 40 to 125 feet (Weller et al. 1952). Ozark-Mahoning files indicate a Carnett shaft and the Arza Grace test pit in this general area, which is along the eastern edge of the Hamp Subdistrict (Figure 11).

Other Mines

Other shafts mapped in this area were the Cloverleaf, Hagan, and Wagner, which were all located near the eastern edge of the subdistrict. The Redd Shaft was located between the Carnett No. 2 and No. 3 Shafts (Figure 11).

Stewart Subdistrict

The Stewart Subdistrict comprises mines that were developed along the Stewart and Barnett Fault Zones (Figure 12). The Stewart Fault Zone is a series of parallel high-angle normal faults that strike N25°–30°E. The fault zone is about three-fourths of a mile wide along its northern limits and widens to nearly 1.5 miles to the south, where the eastern segment aligns with a bend in the Ohio River. The northern extent of this fault zone cannot be accurately traced north of the community of Eichorn, but it may merge into the Hobbs Creek Fault Zone to the north. The Stewart Fault is the eastern fault, and most of the mines have been dug along this fault. However, to the south at the Barnett and Parkinson Mines, the mineralization seems to be better developed along the western Barnett Fault Zone. As mapped by Baxter et al. (1967), the Stewart Fault Zone is a series of northeast-southwest-trending normal faults with about 100 feet of displacement generally downthrown on the west side (Baxter et

al. 1967). The projection of the strike of this fault zone many miles to the southwest lines up with the Compton Mine Fault Zone. Dozens of shafts have been sunk along the Stewart Fault Zone. Some of the information concerning individual mines discussed below was derived from Bastin (1931), S. Weller et al. (1920), J.M. Weller et al. (1952), and Ozark-Mahoning files.

D.C. Baker Mine

The D.C. Baker Mine was located near the small community of Eichorn along a vein that trends N55°E (Weller et al. 1952). The shaft was 30 to 100 feet deep (Weller et al. 1952). Baxter et al. (1967) plotted the Baker Mine in this area. The Sheldon, Hobbs, and Cowser Prospects are also in this general area.

Baker Mine No. 1 and Eichorn Mine

The Eichorn Fluorspar Mining Company worked the property before 1923 (Bastin 1931). The vein lies along a fault that trends N20°–30°E and dips to the southeast. Most ore fills open voids and fractures, with little evidence of replacement-style ore. Bastin (1931) reported the vein as being 2 feet wide. The older shaft here was sunk to 330 feet, with some drifting into the 100- and 200-foot levels (Bastin 1931). In 1926, the Knight Brothers and E.C. Clark pumped water from the shaft to examine the 100-foot level, but they recorded no production (Bastin 1931). In 1949, the Golconda Mining Company may have operated this mine (Davis 1951).

Balfour Prospect

The Balfour Prospect was located southwest of Eichorn. Weller et al. (1952) noted traces of fluorspar next to a 15-foot-deep prospect pit. This mine appears to be located along the northward extension of the faults present at the Parkinson Mine. The Barnett Fault in this location has a slight amount of displacement, and the Bethel Sandstone is present on both sides of the fault.

Stewart Mine Group (No. 1, No. 2, No. 3, No. 4, and No. 5)

The namesake for both the Stewart Subgroup and Stewart Fault Zone, these mines first operated in 1917 as open

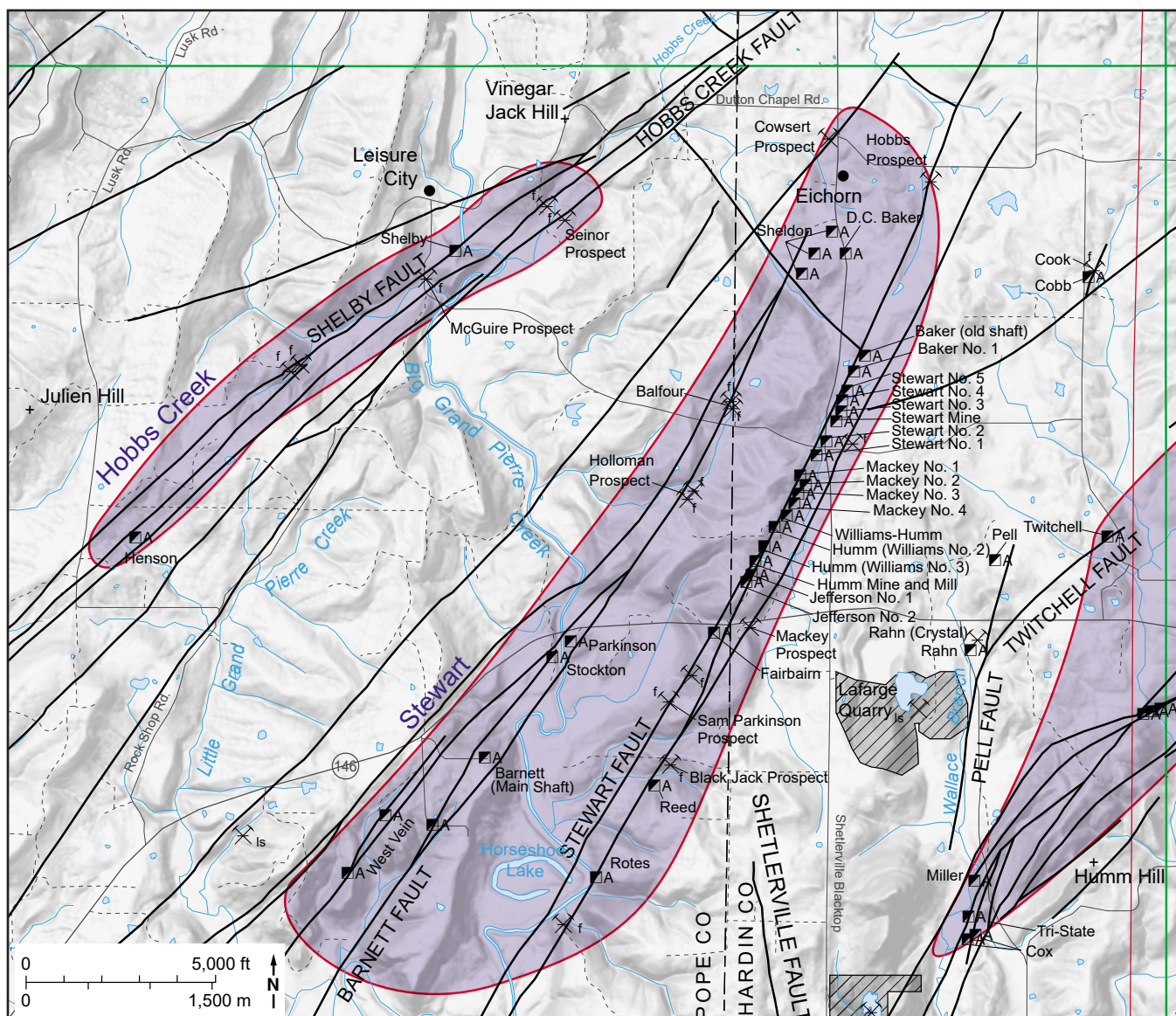


Figure 12 The Hobbs Creek and Stewart Subdistricts.

pits, but several shafts were later sunk to follow the 2- to 4-foot-wide vein. The vein strikes N25°E and dips 80°SE, and it extends 75 to 100 feet below the surface. Some galena and pyrite were reported to be associated with the vein, which was predominantly composed of fluorite and calcite within a fractured limestone host rock (Weller et al. 1952). In 1942 and 1943, this mine was operated by the Fluorspar Products Company and was producing ore (Davis 1945). Weller et al. (1952) reported that the shaft at this mine was between 100 and 300 feet deep and

the vein was 3 feet wide, some of which was high-purity ore. Additionally, some gravel spar was produced at this complex.

Mackey Mine Group (No. 1, No. 2, No. 3, and No. 4)

These mines were located along the Stewart Fault Zone southwest of the Stewart Group mines. In 1953, the Mackey-Humm Fluorspar Mining Company was operating the Mackey-Humm Mine (Holtzinger and Roberts 1956). In 1956, the Humm Mackey-Hicks Creek

Fluorspar Mining Company installed a flotation plant, which was purchased from Inland Steel (McDougal and Roberts 1958a). In 1957, H. Evans Roberts purchased the Mackey-Humm Fluorspar Mining Company and Hicks Creek Mining Company, and the newly formed company, Southern Illinois Mining Company, established an office in Rosiclare, Illinois (McDougal and Roberts 1958b). In 1961, the N.F.Z. Corporation of Cincinnati, Ohio, purchased this mine and announced it was reopening the Mackey-Humm Mine (Kuster and Schreck 1962).

Humm and Mackey Mine

C.C. Mackey operated the Humm Mine and mill as early as 1940. Beecher Williams sunk a shaft 160 feet deep on the Humm property in 1941 (Davis 1943). This mine was in production in 1949 (Davis 1951). The Humm Mine is sometimes considered part of the Mackey complex, and historical information refers to some mines as Mackey-Humm. Other references call at least one mine in the immediate area the Williams Mine. An isolated Mackey Prospect is located to the south of the Jefferson complex. Weller et al. (1952) indicated that several shafts were present at this location. The shafts were 130 to 180 feet deep and were aligned along a 6-foot-wide vein.

Jefferson Mines (No. 1 and No. 2)

The Crystal Fluorspar Company owned the Jefferson No. 1 and No. 2 Mines. The company sank a shaft at this location in 1946 (Davis and Greenspoon 1948). In addition, in 1946, the shaft was deepened from 208 feet to 260 feet (Davis 1949). Later, the No. 2 shaft was sunk south of the No. 1. Weller et al. (1952) indicated the vein was aligned N 30° E, dipping 80° SE, and was only about 3 feet wide. Fluorspar of high purity was common, and sphalerite and galena were also present in this mine. Ozark-Mahoning mine maps indicate that the No. 2 shaft had working levels at 200, 260, 320, and 380 feet (Figure 13). The No. 2 shaft was approximately 450 feet deep. In 1948, development in this mine consisted of 538 feet of drifting, 147 feet of raising, and 38 feet of crosscuts (Davis 1950). A 100-foot winze from the 260-foot level began in 1949 (Davis 1951). The Crystal Fluorspar Company owned the mine until 1951, when it was sold to the Minerva Oil Company as part of a package (Holtzinger and Arundale 1955). The Minerva Oil Company reopened this mine in 1959–1960 (McDougal and Roman 1961). The company closed the mine in 1971 in compliance with regulations of the U.S. Bureau of Mines, Health and Safety–Illinois Division (Wood 1973). Ozark-Mahoning files indicate that more than 150,000 tons of concentrate was shipped from the Jefferson Mines.

Fairbairn Mine

The Minerva Oil Company sought financial assistance to explore for additional reserves along the Fairbairn Vein in 1952. Drawings and mine maps concerning this mine were abundant in the Ozark-Mahoning files. The mine was located west of the Jefferson complex to which it was connected. This resulted in the mine sometimes being referred to as the Fairbairn-Jefferson. The Fairbairn Vein was located west of and parallel to the Jefferson Vein and was interconnected by a west-trending entry at the 380-foot level. The Fairbairn Shaft was sunk between the Jefferson and Fairbairn Veins, and working levels were at 380, 400, and 450 feet. The three working levels were connected near the shaft by three raises (Figure 13). Ozark-Mahoning files indicate this mine was active in 1966 and core drilling was being conducted in 1969 through 1970, but it is unclear when the mine closed. It most likely ceased operations at the same time as the Jefferson Mine around 1971.

Holloman Prospect

Baxter et al. (1967) spelled this site as Holliman, whereas Weller et al. (1952) spelled the prospect as Holloman. The prospect was aligned along a vein that trends N 25° E and dips 85° NW (Weller et al. 1952). The pit was dug to 85 feet. The prospect appears to be located along and an extension of the Barnett Fault.

Parkinson Mine

This mine is located east of Big Grand Pierre Creek just south of Illinois Route 146 (Baxter et al. 1967). The site has a concrete pad, and pieces of ore can be found nearby. The mine is located along the Barnett Fault, which lies between the Hobbs Creek and Stewart Faults. The mine was worked in 1850 to a depth of 50 feet (Reinertsen et al. 1994). In the late 1800s, the Grand Pierre Mining and Manufacturing Company deepened the shaft to 300 feet to mine galena (Reinertsen et al. 1994). From 1957 to 1965, Ozark-Mahoning mined 89,898 tons of ore from this facility (Reinertsen et al. 1994). The mine closed in 1965, but the shaft was utilized as a ventilation shaft and secondary

escapeway for the Barnett Mine, which was located about 4,000 feet to the southwest (Reinertsen et al. 1994).

Barnett Mine

Ozark-Mahoning operated the Barnett Mine as early as 1966. The Barnett Shaft connected to the sixth working level of the older Parkinson Mine. Two air shafts, now plugged, were identified during field mapping in the Shetlerville Quadrangle (Denny and Counts 2009). The Barnett Mine had a main (production) shaft about 800 feet deep and three air shafts. Workings were on two parallel northeast-striking veins about 1,800 feet apart. The two mineralized faults dipped away from each other, outlining a horst. The throw on both faults was normal, with an approximately 100- to 120-foot offset and some oblique-slip components, as shown by slickensides and mullion. Ore was concentrated at the levels of the Renault Limestone and Rosiclare (Aux Vases) Sandstone. In 1979, Ozark-Mahoning drove a drift 1,800 feet to the west to intersect a western vein system named the West Vein (Kostick and DeFilippo 1980). Ross Lillie stated that the ore from both veins was hoisted to the surface from the main shaft but that several additional shafts were drilled for ventilation or emergency escape purposes. Information in the USGS Mineral Resources Online Spatial Data System (<https://mrdata.usgs.gov/mrds/>) indicates this complex was active until at least 1984 (data extracted March 12, 2018).

In 1982, John Nelson went underground in the Barnett Mine. Both veins were served by a single hoisting shaft and connected underground via a drift cutting through barren rock. At the working level, the upper Ste. Genevieve Limestone and Aux Vases Sandstone were in the footwall and Paoli Limestone was in the hanging wall on both faults. Operations on both the West and Barnett Veins took place by shrinkage stoping. After ore was drilled and blasted with ammonium nitrate, it was pulled into cars by cable “slushers” or scrapers, which are buckets or scoops pulled along the floor scooping up ore. These cars ran on rails in the Barnett Vein

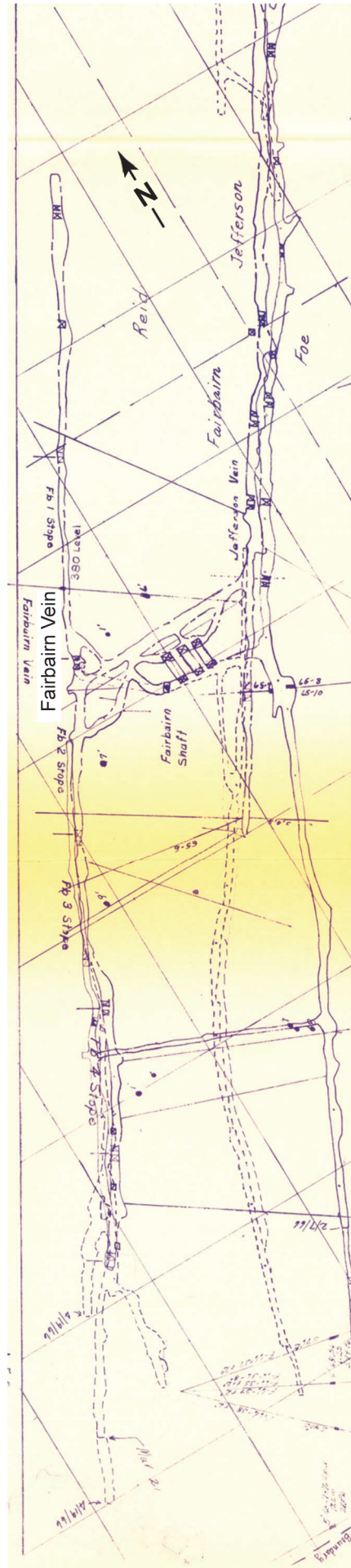


Figure 13 Plan view of the Fairbairn Vein and the southern portion of the Jefferson Vein. Data from unpublished Ozark-Mahoning scanned documents.

and on rubber tires in the West Vein, hauled by diesel power in both cases. As Nelson observed during the visit, the Barnett Vein was 7 to 8 feet wide and composed of coarsely crystalline calcite containing blocks of country rock and pockets of fluorite, galena, and sphalerite. The West Vein had a similar width and composition but also contained considerable barite. Prominent slickensides and mullion along the West Vein fault plunged 21°–52° NE, indicating a component of right-lateral motion.

The total tonnage produced at the Barnett complex is difficult to determine, but estimated production for the Barnett, including the West Vein, would be about 550,000 tons. In addition, Ozark-Mahoning ore reserve calculations from 1981 indicate that an estimated “proven” reserve of more than 600,000 tons composed of 40% barite and 20% CaF₂ was present in the West Vein on just the Churchill and Gates tracts. By 1988, the Churchill tract, with 518,000 tons, and the Gates tract, with 111,000 tons, had not been mined. Notes in the Ozark-Mahoning files indicate that the Gates and Churchill tracts were considered sub-economic at the time because of the low CaF₂ grade and the low price of barite.

Although underground fluorite mines were relatively safe, with few documented fatalities compared with coal mining, deaths occurred in 1971 at the Barnett Mine because of hydrogen sulfide (H₂S) gas. In small concentrations, this gas, which miners call “stink damp,” carries the familiar odor of rotten eggs (as observed by Nelson in 1982). In high concentrations, it becomes sweeter smelling, but in higher concentrations, the gas quickly numbs the olfactory receptors and becomes odorless to humans—and deadly. The April 1971 fatalities were the result of a watercourse being encountered during mining operations, which temporally flooded the 800-foot south working area in the Barnett Mine. The area was temporarily evacuated to allow the water to be pumped away from the working face. The next day when workers examined the area, H₂S gas had become concentrated enough to cause workers to experience eye and lung irritation. A ventilation fan for the mine stopped working, and before the fan was repaired, a worker went to retrieve equipment. When this first worker did not return, another

worker went to find the first miner. Several attempts to save the fallen miners resulted in the deaths of seven miners (Denny and Counts 2009).

Stockton Mine

This mine lies along a fault that trends N25° E and was operated by Barnett, Karber, and Adams (Weller et al. 1952). Weller et al. (1952) reported that in 1942, water was pumped down into this shaft to 140 feet and no ore was seen at the bottom of the shaft.

Mackey Prospect

Baxter et al. (1967) identified this prospect along the projection of a northeast-trending fault. No other information is available concerning this prospect.

Sam Parkinson Prospect

Baxter et al. (1967) identified this prospect. No other information is available.

S. Rotes Prospect, aka Black Jack Prospect

Denny and Counts (2009) located this prospect near the base of a gully (sec. 27, T12S, R7E). The prospect pit was sunk to about 20 feet deep (Weller et al. 1952).

Reed Shaft

The Reed Shaft was located in sec. 27, T12S, R7E. No further information is available about this shaft.

Rotes Prospect

The Rotes Prospect (sec. 27, T12S, R7E) was located on the east bank of Big Grand Pierre Creek. A limited amount of fluor-spar was produced at this site, which was operated by Skinner and Randall (Weller et al. 1952). A vein 1.5 feet wide trending N25° E was mined in a shaft 40 feet deep (Weller et al. 1952). Barite was very abundant at this prospect (Weller et al. 1952).

Hobbs Creek Subdistrict

The Hobbs Creek Subdistrict lies to the west of and parallel to the Stewart Subdistrict (Figure 12). The subdistrict lies along a fault zone called the Hobbs Creek Fault Zone. Segments of this fault zone have been subdivided and named, such as the Shelby Fault (Weller et al. 1952). The

majority of production in this subdistrict came from the Henson Mine.

Henson Mine

Ozark-Mahoning operated this mine. Vein ore was present along a northeast-trending fault. The Henson Mine was in operation during the 1980s. It had a shaft 950 feet deep to what was called the Hobbs Creek Vein. The fault was normal, striking northeast and dipping steeply northwest. Ore from the Henson Mine was trucked to a mill and concentrator in Rosiclare, Illinois, in Hardin County.

John Nelson, Donald K. Lumm, and James C. Baxter of the ISGS toured the Henson Mine in 1982. At a working level about 900 feet below the surface, the northeast-striking, northwest-dipping normal fault juxtaposed Ste. Genevieve Limestone in the footwall with Bethel Sandstone in the hanging wall. The fault surface was a clean, sharp break, and normal drag was well developed in the hanging wall. Slickensides and mullion plunged at 70°–90° (vertical), indicating a small right-lateral component. Ore veins contained white and purple fluorite in a breccia of sandstone and shale fragments. Mining procedures were much the same as in the Barnett Mine. Ozark-Mahoning files indicate that 112,000 raw tons was extracted from this complex and that mining conditions were not favorable.

Shelby (Spiller) Mine

In March of 1942, Horace G. Spiller drove an adit 56 feet into the hillside just above the level of Grand Pierre Creek and then drove a winze to a mineralized fault zone (Bishop 1947a). Spiller then commenced to sink a shaft on the hillside above the adit but halted work at a depth of 110 feet without reaching the vein. The target mineralization lay along a segment of the Hobbs Creek Fault Zone, a normal fault striking N50° E, dipping 62° SE, and having about 250 feet of throw down to the southeast. The Hardinsburg and Golconda Formations in the hanging wall were juxtaposed with Cypress, Ridenhower, and Bethel in the footwall. About 25 tons of ore from the winze was processed at Rosiclare, where the shipment assayed about 27% fluorspar and 5% zinc. These values were deemed too low to repay the cost of mining, so further development was halted. Two years later, the

U.S. Bureau of Mines drilled three angled diamond drill holes across the fault to explore for mineralization below the depths of the Shelby workings. Only small calcite veins were encountered (Weller 1943a; Bishop 1947a). Weller located the mine entrance 1,570 feet from the south line and 2,040 feet from the east line of sec. 9, T 12 S, R 7 E.

This mine was also located along a north-west boundary fault (Shelby Fault) in the Hobbs Creek Fault Zone. During geologic mapping in 2008–2009, fluorite was observed in fractured sandstone scattered on the surface near this abandoned mine. Although the fault was not well exposed, nearly vertical fractures trending N 40° E could be observed in the sandstone bluff southeast of the mine (Denny and Counts 2009).

McGuire Prospect

The McGuire Prospect was located about 1,200 feet southwest of the Shelby Mine along the same vein and fault. The location from the map of Baxter et al. (1967) was 800 feet from the south line, 2,400 feet from the west line, sec. 9, T 12 S, R 7 E. Although poorly exposed near the mine site, the fault could be observed to the south in sec. 16–12 S–7 E (400 feet from the north line, 500 feet from the west line), where fractures in the limestone trend N 55° E. The rock at this prospect is moderately brecciated, and thin veins of calcite are present along vertical slickensides. Excavation and core drilling failed to locate ore of commercial grade, so no production took place at this prospect (Weller 1943a; Bishop 1947a).

The Seinor Prospects

The Seinor No. 1 and Seinor No. 2 were located along the northeasterly projection of the Shelby Fault (Weller et al. 1952). The Seinor No. 2 Prospect was a pit that exposed a normal fault trending N 60° E and having vertical slickensides on the sandstone footwall. Sandstone also composed the hanging wall, and the fault dipped to the southeast. The amount of displacement was not readily observable because sandstone was on both sides of the fault. A vein of colorless and purple fluorite 1 to 2 inches wide was observed along the fractured sandstone in this pit. This prospect may be on a fault subsidiary to the Shelby Fault. Several small

shallow pits are present at the Seinor No. 3 Prospect. The pits contain gray fissile shale and porous weathered sandstone with thin layers (less than half an inch) of purple fluorite. The fluorite appears to be horizontal along bedding surfaces. The Seinor No. 3 Prospect is located along the southeast side of the Hobbs Creek Fault Zone, whereas the Seinor No. 1 and No. 2 are located along the northwest side of the Hobbs Creek Fault Zone. Brett Denny observed a trace amount of fluorite in limestone along the northeast projection of the Shelby Fault in sec. 3, T 12 S, R 7 E (1,300 feet from the west line, 200 feet from the south line) during mapping in 2008–2009 (Denny and Counts 2009). Baxter et al. (1967) mapped the Ridenhower Formation on the southeast side of the fault and the Cypress Sandstone on the northwest side of the fault. The small piece of mineralized limestone Denny found while mapping in 2008–2009 was mapped as Ridenhower.

Empire Subdistrict

The Empire Subdistrict is located in eastern Pope County less than 3 miles west of the apex of Hicks Dome (Figure 14). The mines in this region have also been called the Empire-Knight-Douglas Group (Hatmaker and Davis 1938). Both surface and underground mines have extracted ore, which is predominantly fluorite with only minor to moderate amounts of galena and sphalerite (Weller et al. 1952). Most of these mines exploited veins, but some bedding replacement ore was mined at the Gaskins, Pierce, Oscar Crabb, and Redd Mines. Weathered gravel spar was mined in fairly significant volumes in the Pierce and Slapout Open Cuts. The mineralized veins appear to be mainly along normal faults with slight to moderate displacement. The faults strike predominantly northeast to east-northeast, with some merging to the southwest. These faults may be radial fractures created by the vertical uplift at Hicks Dome, but some may also be related to the extensional forces that created the Dixon Springs Graben. Baxter et al. (1967) mapped a semicircular fault along the east side of Grand Pierre Creek, which is a northerly extension of the fault mapped by Weller et al. (1952). This fault is concentric, is oriented west of Hicks Dome, and extends northeasterly toward the Hamp Fault. Geologic mapping in the

Gaskins Mine indicated that left lateral movement was present along with dip-slip displacement. Information on several of the larger mines was taken from an unpublished report by Weller (1943b), who prepared a pace-and-compass map of the subdistrict at a scale of 1:4,800 showing mines and prospects, veins, faults, and other geologic information. The prospects and mines of the Empire Subdistrict are discussed from north to south.

Fowler Prospect

The mine was operated by Spiller and Willis, who extracted gravel spar from the limestone bedrock in two open pits that were dug with a dragline to 15 to 20 feet deep (Weller et al. 1952). The maximum width of the gravel ore was 15 feet, but below the weathered gravel ore, only traces of fluorspar in small veinlets were found. The trend of the ore was N 34° E, but traces of spar were detected in several other test pits dug in this area (Weller et al. 1952).

Williams (Beecher Williams) Mine

The Williams Mine, operated by Beecher Williams, was located 200 feet northeast of the Rainey Mine. The shaft, sunk in 1938, was 90 feet deep along a vein of fluorspar (Weller et al. 1952). The fault was normal, striking N 32° E and dipping 80° NW (Weller et al. 1952). On the 60-foot level, a drift was driven 150 feet northeast and fluorspar was reported at 50 to 75 feet deep (Weller 1943b). The vein was reported to be locally 6 feet wide but averaged about 2 feet (Weller 1943b).

Rainey (Hutchinson) Mine

The Rainey Mine is located along a steep hillside on the north side of Hicks Branch. The mine lies along a vein that trends N 32° E and dips 80° NW (Weller et al. 1952). However, Bain (1905) indicated that the vein trends N 25° E, is 12 to 18 inches wide, and is composed of fluorspar, galena, and sphalerite, with minor amounts of zinc carbonate associated with the blende (sphalerite). Knight, Knight, and Clark operated this mine, which consisted of several prospect pits and a shaft 20 feet deep (Weller et al. 1952). In 1939, a drift was driven northerly, and 30 to 40 tons of ore was removed (Weller 1943b).

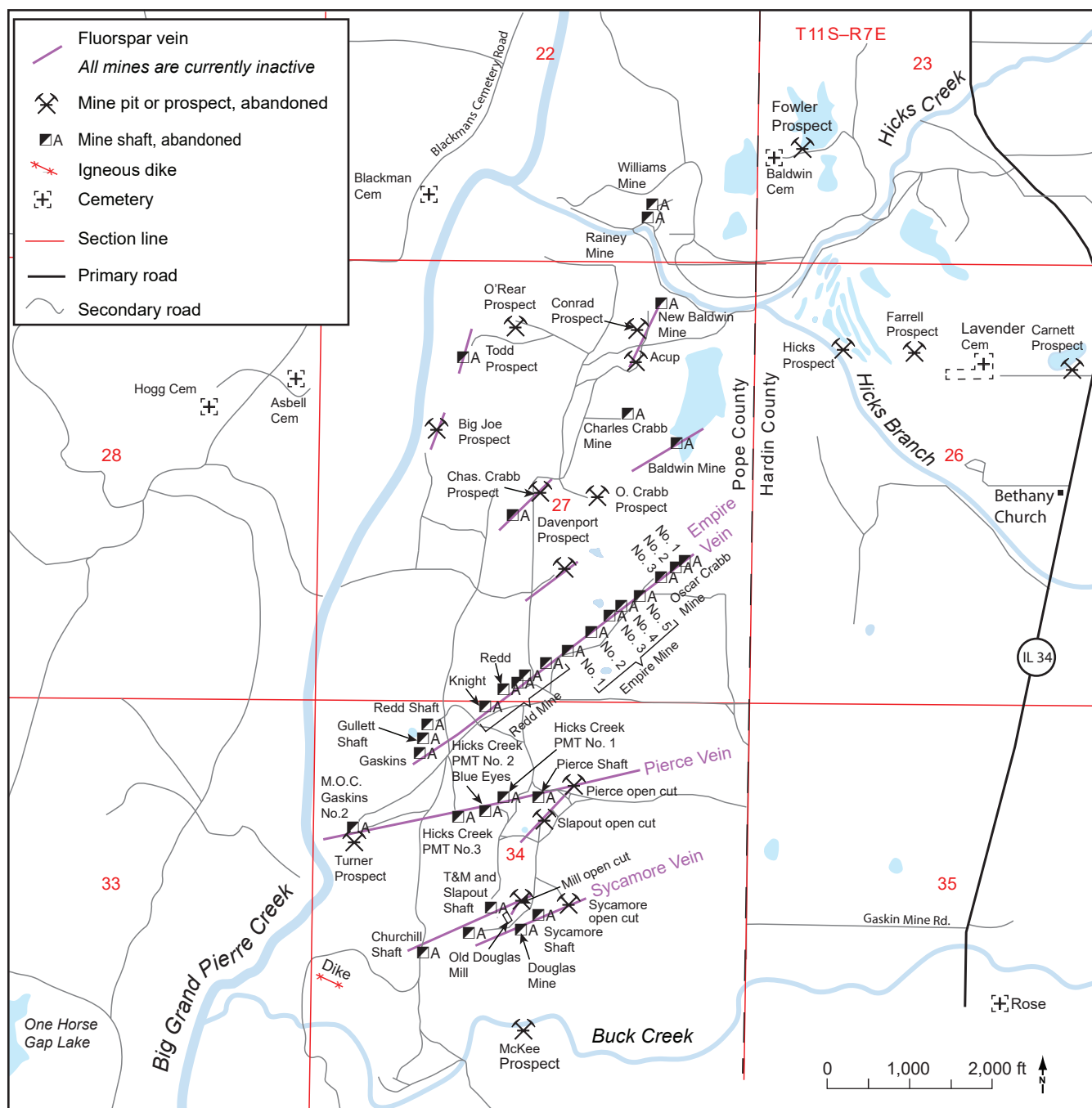


Figure 14 The Empire Subdistrict.

This mine was also known as the Hutchinson Mine (Weller et al. 1952), but Bain (1905) suggested the two prospects were indeed separate and that the Hutchinson was aligned with the Big Joe Prospect well to the west of the Rainey Mine.

Hutchinson Mine

The Hutchinson Mine was an open pit operated by James Hutchinson (Bain 1905). White, purple, and green fluorspar and a small amount of galena were present (Bain 1905). This mine could not be accurately located but was in the south-west quarter of sec. 22, north and more or

less in line with the Big Joe Prospect. It is not depicted on the accompanying maps.

Baldwin and New Baldwin Mines

The Baldwin Mine was owned by R.F. Taylor and was located about one-half mile north of the Empire Mine (Figure

14). According to the *Hardin County Independent* (1919) newspaper, "The mining rights on the Walter Baldwin property situated in Section 27, Township 11, Range 7 in Pope County have been purchased by the Julia F. Mining Company of Evansville, Ind., after careful survey made by well-known engineers" (p. 1). A small surface pit uncovered a vein less than 1 foot wide striking N50°E and dipping 70°SE (Bastin 1931). A shaft located here was sunk to about 70 feet deep, and the deposit was about 100 feet in length, trending N 65°E (Weller et al. 1952). A small amount of gravel spar was produced at this mine, along with some galena and sphalerite (Bastin 1931). The vein was hosted in brecciated Ste. Genevieve Limestone (Bain 1905).

Another mine, called the New Baldwin, was located about 2,000 feet slightly west of north from the Baldwin Mine (Baxter et al. 1967). The New Baldwin, located just northeast of the Conrad No. 2 Prospect, was operated by J.C. Conrad. The ore was mainly gravel spar trending N32°E, and the shaft was dug 40 feet deep (Weller et al. 1952).

Wallace Millikan Prospect

This prospect was located about one-fourth mile northwest of the Empire Vein (Bastin 1931). Exactly where this prospect was located is uncertain, but the location cited by Bastin (1931) is in the approximate area of the Davenport and Crabb Prospects. This prospect is not plotted on the map accompanying this report.

O'Rear Prospect

After sinking a 70-foot shaft, miners were disappointed to find only veins about 3 inches wide, striking N60°E and dipping to the southeast (Weller et al. 1952). Little production was achieved at this site, and Weller et al. (1952) lists the site as a prospect.

Todd Prospect

This prospect produced only small amounts of ore from open pits and a shaft 20 to 60 feet deep (Weller et al. 1952). A vein of fluorspar with abundant galena was reported to be 1.5 feet wide, striking N20°E (Weller et al. 1952).

Big Joe Prospect

This operation consisted of a series of pits dug along the hillside east of Big Grand Pierre Creek (Figure 14). Exposed were two veins about 8 to 12 inches wide trending N15°E and separated by a block of sandstone (Bain 1905). Approximately 200 pounds of lead was shipped from this mine (Bain 1905). A trench approximately 150 feet long was found north of the Big Joe Prospect, near the Todd Prospect (Bastin 1931).

Conrad (Connard) Prospects

Several Connard Mines (Baxter et al. 1967), also spelled Conrad Mines (Weller et al. 1952), are present and were mainly shallow prospect pits. The pits were dug 9 to 16 feet deep and were aligned in a north-south direction along a small fault that dipped to the west at 85° (Weller et al. 1952). Galena was abundant in these prospects (Weller et al. 1952).

Acup Mine

The Acup Mine was operated by Acup and Sons. This mine produced mainly gravel spar from a series of surface pits as deep as 50 feet following a vein striking N30°E (Weller et al. 1952).

Crabb Mine, Crabb Prospects, and Raum Mine

Several mines and prospect pits in the Empire Subdistrict are named Crabb (Figure 14). Bastin (1931) located the Crabb Mine near the center of sec. 27 and stated that a shaft was collared in the Bethel Sandstone, extending 40 feet deep along a vein striking N45°E. Weller et al. (1952) described two Oscar Crabb sites, a Charles Crabb site, and a Chas. Crabb site (assuming Chas. is an abbreviation for Charles). The Crabb Mine located by Bastin (1931) is probably the Chas. Crabb Prospect located by Weller et al. (1952). Bain (1905) also references a Crab Prospect near Jesse Crabb's house not far from the Big Joe Prospect. This is the earliest of the Crabb references and details a 2-foot-wide purple fluorspar vein striking N58°E (Figure 14). The Chas. Crabb Prospect is situated along a vein that strikes N50°E and dips 80°SE. A shaft was dug to 100 feet at this site, but no production records are available (Weller et al. 1952).

The Oscar Crabb Mine, also called the Raum Mine, had three shafts. The No. 1 Shaft was 85 feet deep, the No. 2 was 100 feet deep, and the No. 3 was 85 feet deep (Weller 1943b). The mine was operated by Karber and Adams and was located along the northeast projection of the Empire Vein. This mine was active as early as 1863, but little development occurred until World War II (Weller 1943b). This mine produced ore from a vein and weathered gravel spar deposit. A map in the report by Weller (1943b) shows a No. 1 Shaft at the northeast end of the property and less than 100 feet to the southwest, the No. 2 Shaft. Both shafts were sunk to slightly more than 100 feet and were interconnected to the 70- and 100-foot levels. Good ore up to 9 feet wide was observed southwest of the No. 2 Shaft, and stoping was conducted between the No. 1 and No. 2 Shafts. In addition, the No. 2 Shaft had a 60-foot level running to the southwest, but slightly more than 50 feet along the drift, the ore pinched out. A third shaft (No. 3) was present about 200 feet southwest of the No. 2, but the underground workings were not connected to the No. 1 or No. 2 Shafts. A drift was driven in the No. 3 Shaft about 50 ft to the southwest and 25 feet to the northeast on the 70-foot level. No spar was found to the northeast and 1.8 feet of spar was encountered to the southwest, but no stoping was indicated on the No. 3. Approximately 2,000 tons of spar was produced at this location (Weller 1943b).

The Charles Crabb Mine is located south of the Acup Prospect and west of the Baldwin Mine. The Charles Crabb Mine was operated by Knight, Knight, and Clark. The mining was conducted for a length of 225 feet following a 7- to 11-foot-wide vein. The vein was located along a N20°E trend. The diggings were up to 55 feet deep (Weller et al. 1952).

The Oscar Crabb Prospect (O. Crabb Prospect) produced mostly bedded fluorite and sphalerite at 35 feet, and the pit was dug to 50 feet deep (Weller et al. 1952). No underground observations are on record, but the mine dumps contained fluorite, calcite, galena, and considerable sphalerite.

Hicks Prospect

Opened before 1905, this prospect consisted of several open pits dug to 30 and 60 feet deep that were in line with the vein at the Baldwin Mine (Bain 1905). However, Weller et al. (1952) plotted the prospect along Hicks Branch near Illinois Route 34. We used the earlier work of Bain to plot the mine for this research. The vein was mainly clear and purple fluorspar a few inches to 2 feet across, trending N20°E (Bain 1905). Slickensides were present in the Ste. Genevieve Limestone, and indications were that the west side of the fault was downthrown (Bain 1905). A reference to James Hicks and Son working the Hicks and Collier Mine indicated that a 3-foot-wide vein of spar was encountered in 1936 (*Hardin County Independent* 1936, p. 5). This may not be the Hicks Prospect, but no other information was found.

Farrell Prospect

Weller (1952) showed the Farrell Prospect as located just west of the present location of the Lavender Cemetery. The prospect traced small stringers of fluorspar. No production was reported.

Carnett Prospect

Weller et al. (1952) located the Carnett Prospect just east of the present location of the Lavender Cemetery (Figure 14). The prospect, operated by George Carnett, uncovered a trace of gravel spar, and an exploration pit was about 10 feet deep. No production was reported.

Davenport Prospect

Oscar Crabb and Son operated the Davenport, driving a shaft 55 feet deep and working a northeast-striking vein that averaged about 10 inches wide (Weller et al. 1952). Weller et al. (1952) listed the mine as a prospect, indicating little production from this site.

Empire Mine

The earliest account of the Empire Mine, the namesake of the Empire Subdistrict, was by Bain (1905, p. 48–50), who made observations underground and in an open pit. Bain (1905) reported that the workings followed a vein running N48°E and dipping 73°SE, with a small amount of normal displacement. Bain (1905)

reported that in the open pit, “a wall of solid white fluorspar was at one point exposed” (p. 49), along with a body of zinc carbonate that assayed at 38% to 40% zinc. Bain (1905) stated that in the shaft, the vein was 6 to 10 feet wide and was composed of “brecciated limestone cemented by fluorspar and calcite intimately intergrown. In this matrix galena, blende [sphalerite], pyrite, and chalcopryite occur, the two first named being frequently in considerable abundance” (p. 49). The Crystal Fluorspar Company was the operator at the time of Bain’s visit. The Crystal Fluorspar Company owned the Empire Mine around 1900, but earlier workings exploring for lead were probably present during the late 1800s (Weller 1943b). H.B. Pierce, of the Grand Pierre Mining and Manufacturing Company, purchased the property from the Crystal Fluorspar Company around 1925 and leased the property to the Rosiclare Lead and Fluorspar Company (Weller 1943b). The Rosiclare Lead and Fluorspar Company operated the Empire Mine from 1924 through 1927 (Bastin 1931). About 7,800 tons of finished spar was recovered from this mine from 1924 to 1927 (Bastin 1931). The ore from this mine was hauled on one-ton trucks to the Stewart Mine, where it was transferred to rail cars and shipped to a mill in Rosiclare (Bastin 1931). In 1927, the property was leased to Knight, Knight, and Clark, who operated it through 1935. When Weller (1943b) visited the Empire Mine in 1943, the property was tied up in litigation and had lain idle since 1935. Weller estimated total production up to that date at 25,000 tons. A.D. Knight and E.A. Knight mined the southwestern extension of this vein in 1949 (Davis 1951). The last known operator was the Egyptian Mining Company in 1953 (Holtzinger and Roberts 1956).

The workings comprised a series of open pits and several shafts sunk along a fault that trends N48°–55°E and dips 70°–73°SE (Figures 14 and 15). The vein varied from 2 to 3 feet wide and contained purple fluorite along with calcite, galena, and sphalerite (Bastin 1931; Weller et al. 1952). The early shafts were less than 50 feet deep, but some shafts were later deepened to 180 feet (Weller et al., 1952). The ore was mainly from below the Rosiclare (Aux Vases) Sandstone within the upper part of the Ste. Genevieve Limestone (Bastin 1931). A conspicuous,

large open cut about 40 feet deep located between Shafts No. 1 and No. 2 (Figure 15) was present during Weller’s examination of the area (Weller 1943b).

A cross-section map from the Ozark-Mahoning file database indicates that Shaft No. 1 was inclined in the vein and that working levels were below the Rosiclare Sandstone in the Ste. Genevieve Limestone at 80, 155, 255, 300, and 340 feet (Weller 1943b). This map also indicates that ore was present at the 475-foot level and that 10 shafts or exploration pits were dug along the vein, along with two open cuts.

Redd (Red), Knight, and Roberts Mines

Reflecting changes in ownership, the mines in this area were also known as the Knight and Roberts Mines. This mine is sometimes spelled Red, but many reports use the name Redd. The Knight Mine was developed by E.A. Knight to the southwest of the Empire Mine, and a drift was driven along the fault northeastward to the Empire Mine property line (Bastin 1931). This mine was first operated by Knight, Knight, and Clark around 1927 or 1928, producing about 3,000 tons prior to 1941, when they sold the property to Roberts and Frazer (Weller 1943b). The mine was in production in 1942 and was equipped with a log washer, a picking belt, and screens (Davis 1943). Roberts and Frazer of Illinois, a Kentucky Fluorspar Company affiliate, operated the mine in 1943 at much higher levels than in 1942 (Davis 1945). The Redd Mine was operated by H.B.C. Mining in 1948 (Davis 1950) and by the Redd Mining Company and Humm and Partain in 1949 (Davis 1951). The Redd Mine was adjacent to the Empire Mine, and a map from 1943 shows that ore was being extracted along working levels at 120 and 160 feet (Ozark-Mahoning scanned document; Weller 1943b). Notes on the original Ozark-Mahoning map indicate that additional working levels were at 260 and 325 feet (Figure 15). At the northeast end of this mine, the Rosiclare Sandstone was present on both sides of the fault, which indicates the displacement is small. The vein dips to the southeast at 70°–75°SE and was reported to average 4.5 feet thick, with portions widening to about 12 feet wide (Weller 1943b). Weller (1943b) reported that the fluorspar was primarily

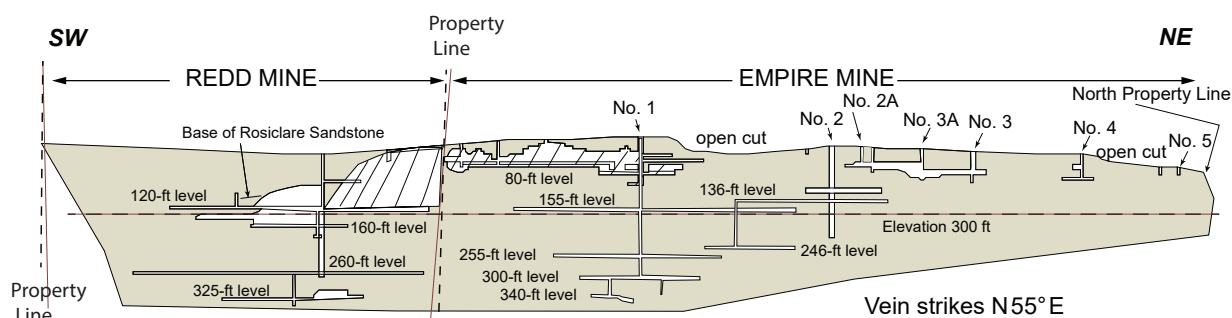


Figure 15 Cross section, longitudinal section, or vertical projection of underground workings along the Empire and Redd Mines, circa 1958. Data from Burgess (1958) in unpublished Ozark-Mahoning scanned documents and from Weller (1943b).

vein type and some bedding replacement and that considerable sphalerite was present. The estimated total production from this mine was about 12,000 tons (Weller 1943b).

Pierce Mine

This mine has operated intermittently through open pits and shafts that ranged from 35 to 200 feet deep (Weller et al. 1952). Bastin (1931) reported the vein as striking about N45°E, but Weller et al. (1952) indicated that the fault trend was N70°–80°E, dipping 85°SE, as seen in open cuts. According to Bain (1905, p. 50), H.B. Pierce began mining operations circa 1905 about one-half mile south of the Empire Mine on the tract that bears his name (Figures 14 and 16). Throughout the 1910s and early 1920s, the mine passed through a series of owners, who dug several open pits. A shaft 200 feet deep was sunk at the intersection of two open cuts, and drifts were driven at the 100-, 140-, and 200-foot levels (Weller 1943b). The levels were driven approximately 175 feet to the southwest and 260 feet to the northeast. Pogue (1918) reported that optical-grade fluorspar was shipped from this mine in 1917. In 1925, Knight, Knight, and Clark sunk four shallow shafts east of the old open pit and removed shallow ore (Weller 1943b). Further developments continued through the 1930s, but by 1940, the mine lay idle. In 1943, Smothers, Bruckner, and Winkler of Champaign, Illinois, brought in a dragline and resumed mining shallow ore along a vein about 4 feet wide northeast of the Pierce Shaft for 350 feet (Weller 1943b). The ore was a combination of gravel spar, bedding replacement, and

vein deposits consisting mainly of fluor-spar with small quantities of galena and sphalerite (Weller et al. 1952). The width of weathered ore in open cuts was about 9 feet, and the vein was weathered deeper than at the Empire Mine. Weller (1943b) estimated total production at 10,000 to 15,000 tons.

Hicks Creek P.M.T. Mine

Before 1952, the Hicks Creek Mining Company sank three shafts to work a 6-foot-wide vein striking N70°E, an assumed southwest extension of the vein exploited at the Pierce Mine (Weller et al. 1952). Operations continued until 1954 under the P.M.T. Mining Company (Holtzinger and Roberts 1956). A map obtained when scanning Ozark-Mahoning records during the summer of 2018 showed the cross section of a property owned by Hicks Creek-Metz. Three shafts, labeled P.M.T. No. 1, P.M.T. No. 2, and P.M.T. No. 3, were located southwest of the Pierce Shaft. P.M.T. No. 3 was called the Hicks Creek Mine, and P.M.T. No. 2 was called the Blue Eyes Shaft. A notation on this map by DBS (Donald B. Saxby) indicated that as of 1980, 17,000 tons of 30% CaF₂ was still in the ground. Several working levels were driven, including at 96, 126, 185, 235, 255, and 290 feet. The P.M.T. Mine was interconnected with an incline–decline to the adjoining property to the southwest, but it was apparently not interconnected with the Pierce underground workings to the northeast. The Ozark-Mahoning map also indicated that the vein was up to 12 feet wide but averaged about 6 feet over most of the workings. Another Ozark-Mahoning map indicated that the Conns log washer was

located just northeast of the P.M.T. No. 1 Shaft.

Conns Mine

The only available information on the Conns Mine is that it was composed of several surface pits along the Pierce Vein. This location may have been active in the 1980s (www.mindat.org). A map in the files of Ozark-Mahoning located a Conns log washer between the P.M.T. No. 1 and Pierce Shafts. This is probably where the Conns Mine was located.

Turner Prospect, aka Turtle Prospect

A shaft 60 feet deep was sunk to reach veins striking N70°E and dipping south-east along an apparent continuation of the Pierce Vein (Weller et al. 1952). Vein-lets of spar were observed in a prospect shaft at this location (Weller et al. 1952). The prospect was reported by Weller (1943b) as being west of Grand Pierre Creek. However, a later report (Weller et al. 1952) and an Ozark-Mahoning map showed the prospect east of Grand Pierre Creek as being in line with the Pierce Vein. About one-fourth mile south, in the bed of Grand Pierre Creek, a 28-inch vein of fluorspar has been reported (Weller 1943b).

T&M Slapout Mine

According to the map by Weller (1943b), the T&M Slapout Mine was located in Pope County between the Pierce and Sycamore Veins. Weller related that H.B. Pierce (of the Pierce Mine) opened the Slapout in 1903, sinking a shaft after preliminary open-cut prospecting between

the Pierce and Sycamore Veins extending along a trend of N45°E. Subsequently, Douglas interests worked the mine until about 1925. A map in the Ozark-Mahoning files indicates that the shaft was just west of the old mill pond, which might have been the area of the open-pit prospecting (Figure 16). The map indicates that this mine was leased from Douglas by the Yingling Mining Company, but no date is shown on the map. Karber and Adams reactivated the Slapout Mine in 1942, excavating open pits and driving a new shaft 130 feet deep to extract a combination of gravel spar, bedded replacement, and vein ore. Weller (1943b) remarked that the Slapout Vein differed from others in the Empire Subdistrict in comprising a series of irregular orebodies along a complicated set of intersecting fractures, as opposed to a single large fissure along a fault. Individual veins ranged up to about 4 feet wide and, in some cases, the fractures were accompanied by bedding replacement ore. Host rock was the Ste. Genevieve Limestone. Ozark-Mahoning maps indicate that the Slapout open cuts intersected the Pierce open cut just east of the Old Pierce Shaft. Approximately 3,000 tons of fluorspar was mined in the Slapout Open Pit.

Douglas Mine (Sycamore Vein)

Situated along the southern edge of the Empire District, shafts and pits of the Douglas Mine are aligned along a vein called the Sycamore Vein that trends about N45°–65°E and dips steeply to the southeast. Ozark-Mahoning maps indicate that the Douglas Mill was located between the Slapout Shaft and the Sycamore Shaft (Figure 16). The mill was equipped with twin log washers, which fed shaking screens (Bastin 1931). A “mill open cut” was also extended north-northeast from the Old Douglas Mill. According to Weller (1943b), operations began here as early as 1903, and the main shaft was constructed in 1921–1922. Weller (1943b) described the Sycamore Vein as dipping steeply to the southeast and ranging from 2.5 to 7 feet wide between limestone walls. In places, ore was weathered to a depth of 200 feet, facilitating open-cut mining. As of 1943, shallow deposits of “coontail” ore (i.e., light- and dark-banded ore of sphalerite, barite, and fluorite) were being worked

with a dragline. Weller (1943b) reported that according to the Douglas Mine boss, J.C. Conrad, the shaft was sunk to 200 feet with drifts at the 45-, 100-, 140-, and 200-foot levels, but very little stoping was conducted except at the uppermost level. Knight, Knight, and Clark milled ore from the Douglas Mine in 1941 (Davis 1943). Subsequent owners included the Yingling Mining Company (Davis 1945), Hicks Creek Fluorspar Company (Davis 1950), P.M.T. Mining Company, and finally, the Hicks Creek Mining Company (Davis 1950, 1951; Holtzinger and Roberts 1956). Weller (1943b) reported approximately 10,000 to 12,000 tons of production from this mine. Around 1943, Willis and Spiller, and later Frank Summers, were conducting several cuts utilizing a dragline northeast of the Douglas Mine. Weller (1943b) reported that 6 feet of high-grade weathered ore, possibly related to a replacement-style mineralization, was found in the pits, which were dug up to 40 feet deep.

Gaskins Mines

Of the two Gaskins shafts, the primary production appears to be from the Minerva Oil Company's Gaskins No. 2 Shaft along the southwest extent of the Pierce Vein. A mine along the southwest portion of the Empire Vein was also labeled Gaskins on an Ozark-Mahoning map and was labeled the Tamora Mine on a second Ozark-Mahoning map. Tax records concerning the Tamora Mine published in the *Hardin County Independent* newspaper indicated the company was active as early as 1957. In 1964, the Tamora Mining Company was assessed at \$1,250 by the local tax assessor (*Hardin County Independent* 1964, p. 7). In 1968, Gill Montgomery stated that the proposed main shaft, the Gaskins No. 2, was planned to be 550 feet deep, with three principal haulage levels at 200, 300, and 400 feet. Montgomery further stated that the shaft would be 6 × 13 feet, with a 2.5-ton skip box installed with a man cage on top. Montgomery reported that the mine was being sunk on a vein south of the old Gaskins No. 1 operation and added that the old shaft was in production prior to 1954. He stated that ore would be hauled to the company's mill located on the east side of Hardin County (*Hardin County Independent* 1968, p. 1).

The Minerva Oil Company owned the Gaskins Mines, and in 1968, approximately 250 tons per day was being hoisted from the 534-foot-deep shaft (Wells 1969). Vein ore was mined within a fault from the base of the Bethel Sandstone over an ore zone extending about 250 feet down into the Ste. Genevieve Limestone (Figure 17). Ore was present in two parallel veins averaging 5 feet wide, called the north and south veins. The faults were normal, with 20 to 70 feet of vertical offset, but D.B. Saxby (1973) also reported significant horizontal movement along the fault. According to Saxby, who worked as chief geologist for Minerva, “fault movement was mainly horizontal, with the north side moving west relative to the south side” [i.e., left-lateral] (D.B. Saxby, as cited in Baxter et al. 1973, p. 21). Shrinkage stoping was used in the upper portion of the mine, but the ore was mined down an incline to the west into the lower portions of the mine (Saxby 1973). Bedding replacement ore was also present, which averaged 35 feet wide. The main working levels were at 200, 300, 400, 425, 450, and 475 feet (Figure 17). Ozark-Mahoning files indicate that about 179,000 raw tons was mined from this complex.

Excellent mineral specimens were collected from the Gaskins Mine in the 1970s. A hallmark of the mine was late-stage cubes of zoned reddish-purple and blue fluorite (commonly 2 to 3 cm), typically found as isolated crystals on creamy white, scalenohedral calcite (variable in size, but typically 10 to 15 cm). Galena was a common associated mineral but never in great abundance. A unique mineral pocket of superlative yellow barite was found in August 1974, with crystals up to 4 inches across on zoned blue and purple fluorite. This pocket is well known in the collecting community and represents the finest yellow barite crystals ever found in southern Illinois (Carlson and Winchell 1975).

Gullett Shaft

In 1941 or 1942, Fraley Gullett sank a shaft to about 85 feet deep. Drifts were driven about 95 feet to the northwest and 16 feet to the southeast without intersecting ore (Weller 1943b). The shaft was originally sunk to 85 feet deep but was extended after core drilling identified ore

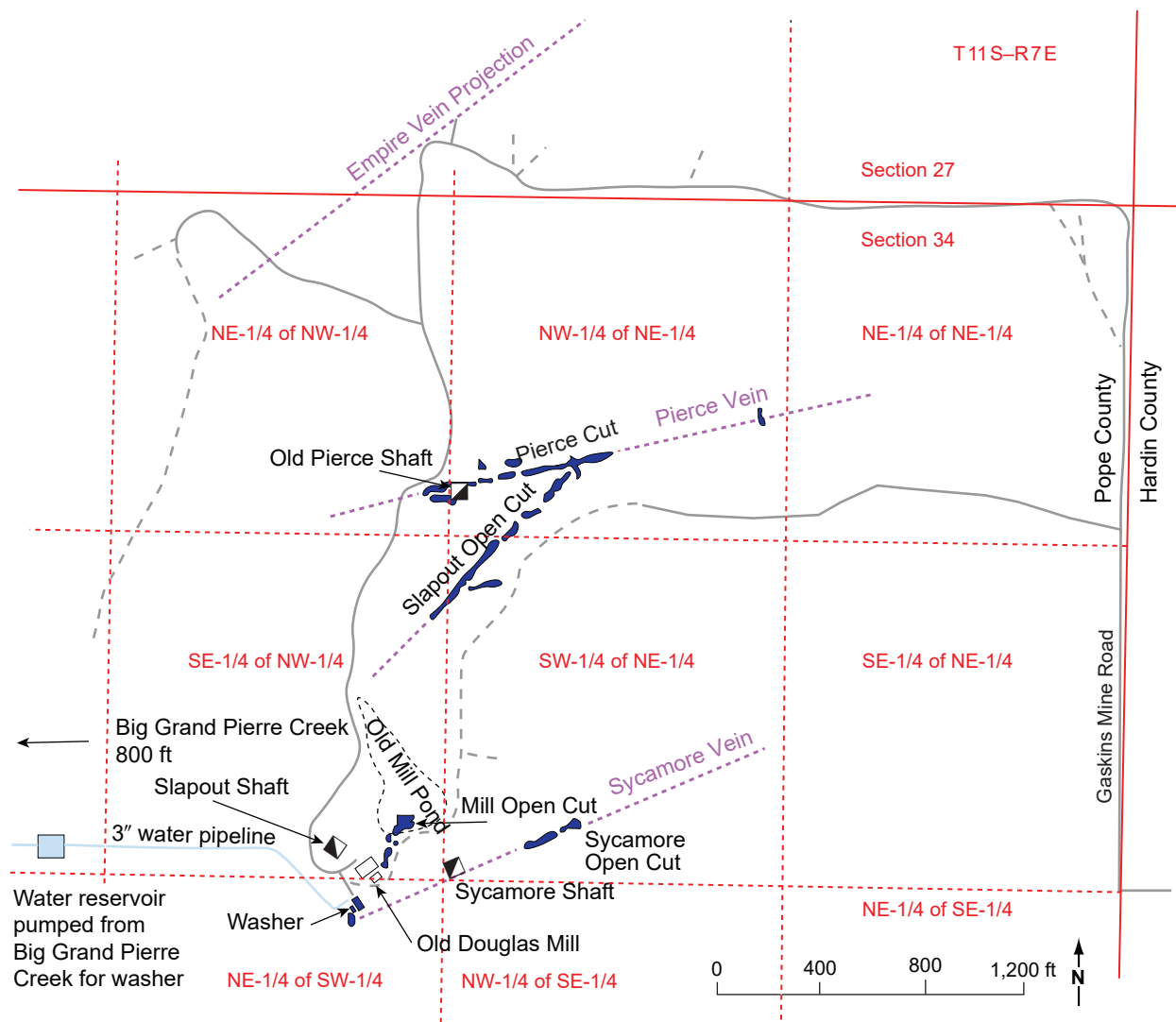


Figure 16 Plan map of the Doug Fluorspar Co. properties leased to Yingling Mining Company (no date). Data from unpublished Ozark-Mahoning scanned documents. Solid polygons indicate area of open pits.

at deeper levels (Weller et al. 1952). This site appears to be near the approximate location of the Gaskins No. 1 and Tamora Mines.

Churchill Shaft

The Churchill Shaft was located along the southwest extension of the Sycamore Vein (Figure 14). Ozark-Mahoning mine maps indicate that the shaft was 300 feet deep, with working levels at 40, 208, and 290 feet. The mine was not large, and to the northeast, a shaft labeled C&J was present on Ozark-Mahoning maps. Ore was apparently just below the Rosiclare (Aux Vases) Sandstone in the top of the Ste. Genevieve Limestone.

Hubbard and Glass Shafts

H.B. Pierce and his associates within the Grand Pierre Mining and Manufacturing Company sank the Hubbard Shaft 60 feet deep on a site southwest of the Empire Mine (Bain 1905). The main fracture trend is N45°E, as seen in an open cut by Bain (1905). The shaft was described by Bain (1905) as collared in the Ste. Genevieve Limestone. The precise location of this shaft is unknown. On a figure in Bain's publication, the Glass Shaft was plotted just south of the Hubbard Shaft. No further information could be found on the Glass or Hubbard Shaft. They are both probably south of the Douglas and Slapout properties, but precise locations are not available.

McKee Prospect

The Southern Fluorspar Company opened several exploratory pits at the McKee Prospect. The company reported no economic mineralization (Weller et al. 1952). In 1942, a 40-foot-deep shaft was sunk by a Dr. McKee and the Southern Fluorspar Company. No production from this site was reported (Weller 1943b).

Interstate Subdistrict

The Interstate Subdistrict is located west of the Rosiclare and east of the Stewart Subdistricts. The subdistrict is named for the Interstate No. 1 Mine, which lies between the Cullum and Gibbons Mines, and the Interstate No. 2, which lies to the

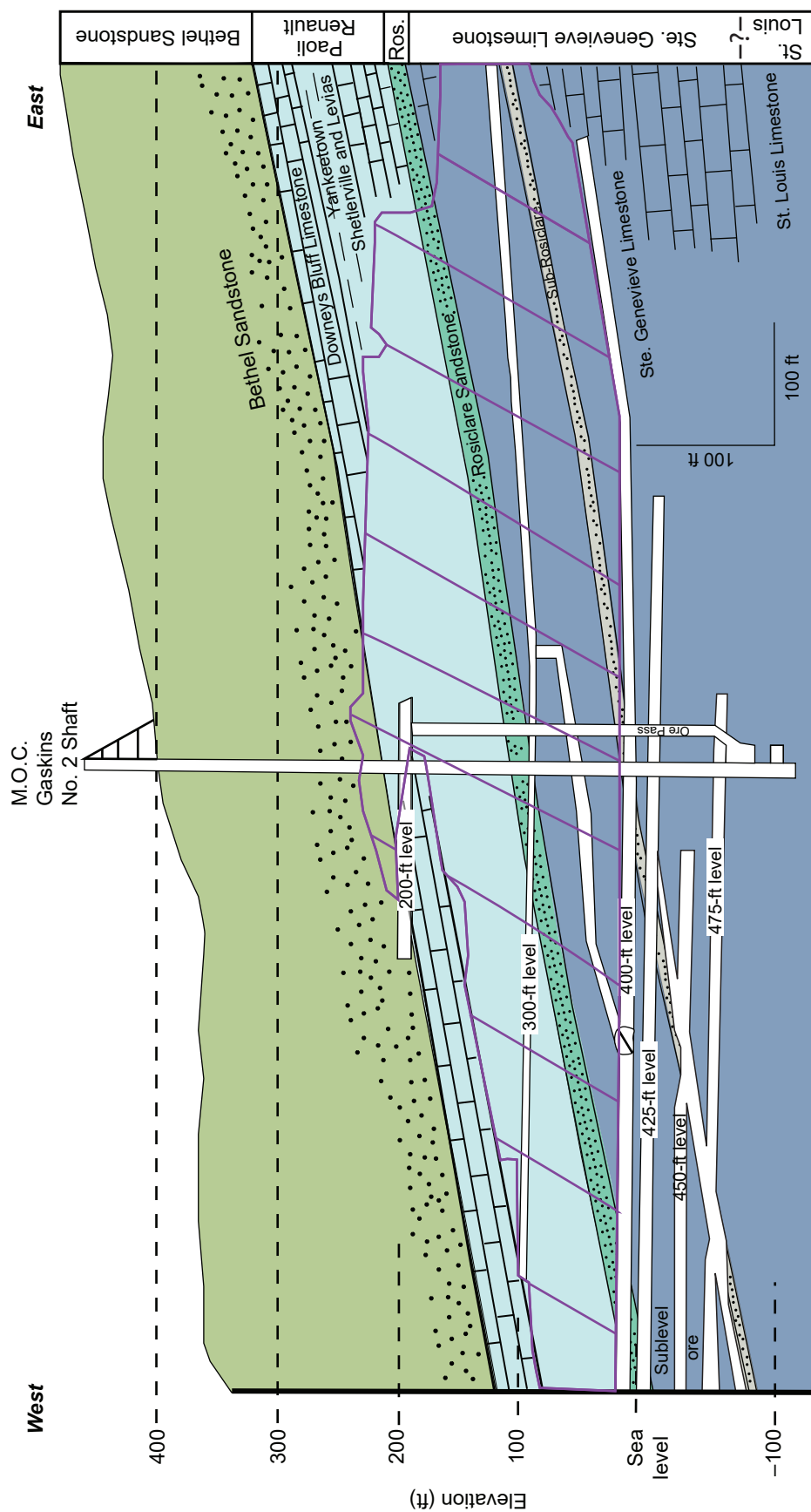


Figure 17 Longitudinal projection of the Gaskins Mine. The extent of stoping along the two parallel veins is shown by diagonal lines. From Saxby (1973) and Baxter et al. (1973).

northeast. These mines worked mainly vein ore along the Interstate Fault Zone. The Interstate Fault Zone aligns with the Wallace Branch Fault Zone to the southwest and the Iron Furnace Fault Zone to the northeast. These fault zones lie along the northwest side of the Rock Creek Graben. The mines of the Interstate Sub-district (Figure 18) are discussed below.

Cox Mine Shafts and Prospect Pits

The Cox Mine was operated by Beecher Williams (Weller et al. 1952) and expanded into an open pit where gravel spar was mined. The pit was aligned along a vein that trended N20°E and was about 4 feet wide. This pit was dug to about 70 feet below the surface, but the amount of production achieved is not documented. The ore was mostly fluorspar, with a minor amount of galena (Weller et al. 1952).

Miller Mine, Tri-State and Melcher Hills Mines

The Miller Mine, also called the Tri-State and Melcher Hills Mines, operated in the early 1900s. Horizontal drifts into the hillside east of Melcher Hill were first driven to mine bedding replacement deposits. In 1917, a shaft was sunk and encountered veins trending in a northeasterly direction. The veins were reported to be unusually rich in galena (Weller et al. 1920). Weller et al. (1952) also reported that gravel spar was worked at this location over a trend of N15°E.

Dubois and Fisher Shafts

A Mr. Fisher of Detroit, Michigan, sunk the Fisher Shaft to a depth of 100 feet along the northeast side of Three Mile Creek in 1901. Shaft No. 1 was sunk to 40 feet in 1903, Shaft No. 4 was sunk to 20 feet in 1904, and Shaft No. 3 was reported to have been sunk to approximately 75 feet deep, but the year it was dug is not available (Swanson 1948). In 1942, Clifford Stone dug several shallow pits, sank another shaft to a depth of 38 feet, and shipped about 200 tons of processed ore (Swanson 1948). Ultimately, this property had at least eight shafts or pits, with unnamed shafts 75 and 175 feet southwest of Shaft No. 1 and another unnamed shaft about 30 feet south of

Shaft No. 4 (Swanson 1948). In total, this complex produced an estimated 1,000 to 2,000 tons of processed ore (Swanson 1948). The Crown Fluorspar Corporation operated the nearby Dubois Mine along the Iron Furnace Fault Zone, sometimes called the Illinois Furnace Fault Zone (Weller et al. 1952). These faults trend N60°–70°E and are nearly vertical.

In 1944, the USGS drilled four core holes to a total combined depth of 1,106 feet (Swanson 1948). Two of the holes crossed the main fault and as many as five to six minor faults in the southeast sidewall through Chesterian strata. Very little fluorite was detected in the cores. Thus, the test drilling indicated a highly faulted area, with several nearly vertical faults and fractures trending N60°–65°E that offset the strata vertically by about 850 feet (Swanson 1948). The dip of the fault is 85°SE near Shaft No. 1 and 85°NW near Shaft No. 4 (Swanson 1948).

Lavender Mine

C.H. Stone recovered small quantities of gravel spar from a vein that strikes north-south and dips at 80°W (Weller et al. 1952). A shaft was dug to 40 feet, but only minor production is documented (Weller et al. 1952).

Indiana Mine

The Indiana Mine property was owned by the Indiana Fluorspar and Lead Company from 1923 to 1925, which leased the property to the Hillside Fluorspar Mines Company (Bastin 1931). Ownership later passed to the U.S. Fluorspar Company, and it was later called Hillside Mine No. 2 and the Rogertown Mine (Weller et al. 1952). The mine produced a small amount of fluorite from two northeast-trending parallel veins about 130 feet apart, which dip very steeply to the west (Bastin 1931). The west vein was reported to be 4 feet wide, trending N15°E and dipping 80°NW (Weller et al. 1952). Bastin (1931) reported that a 100-foot-deep shaft was driven on the west vein and that drifts were run at the 39- and 100-foot levels. A crosscut was driven to the much less productive eastern vein, but little ore was extracted from the vein. Total production from this mine was nearly 6,000 tons (Bastin 1931).

Preen Prospect

The Preen Prospect was composed of a few shallow pits dug in a general north-south direction. A small amount of spar was produced from a shaft that was 75 feet deep (Bastin 1931). This mine was producing ore in 1937 (Davis 1938). Ozark-Mahoning documents indicate that just south of the Preen Prospect, the Mann and Ferrell Prospects were present. No further information on either of these two prospects was found.

Pell Mine

The Pell Mine (sec. 24, T12S, R7E) had a mill served by a shaft 95 feet deep that was located near the St. Joseph Church. The shaft accessed a vein of fluorite, galena, and blende (sphalerite) trending N20°–30°E and dipping to the east (Bain 1905). Galena content was moderately high in this vein (Bastin 1931). Development work was ongoing at this site in 1939 (Davis and Trought 1940). The mine was in production and operated by the Rosiclare Lead and Fluorspar Company by 1947 (Davis 1949) and by the Thurmond Coal Company by 1949 (Davis 1953). Weller et al. (1952) reported that a dragline was used to dig gravel spar to about 20 feet below the surface over a vein that was 4 feet wide.

Rahn-Crystal Prospect and Rahn Prospect

The Rahn-Crystal Prospect comprised two shafts about 20 feet deep (Weller et al. 1952). Core drilling was also conducted, but no production is on record. A shaft 90 feet deep was sunk at the Rahn Prospect, a separate operation south of the Rahn-Crystal Prospect, and “very minor showings of fluorspar” were encountered (Weller et al. 1952, p. 143).

Twitchell Mine and F. Twitchell Mine

Opened by Frank Twitchell before 1920, the Twitchell Mine (sec. 24, T12S, R7E) was later acquired by the Fluorspar Products Corporation and remained active into the 1940s. At least three shafts were sunk, one at least 70 feet deep, along a vein that averaged about 3 feet wide, trending N10°E. The vein evidently followed a fault of small displacement that

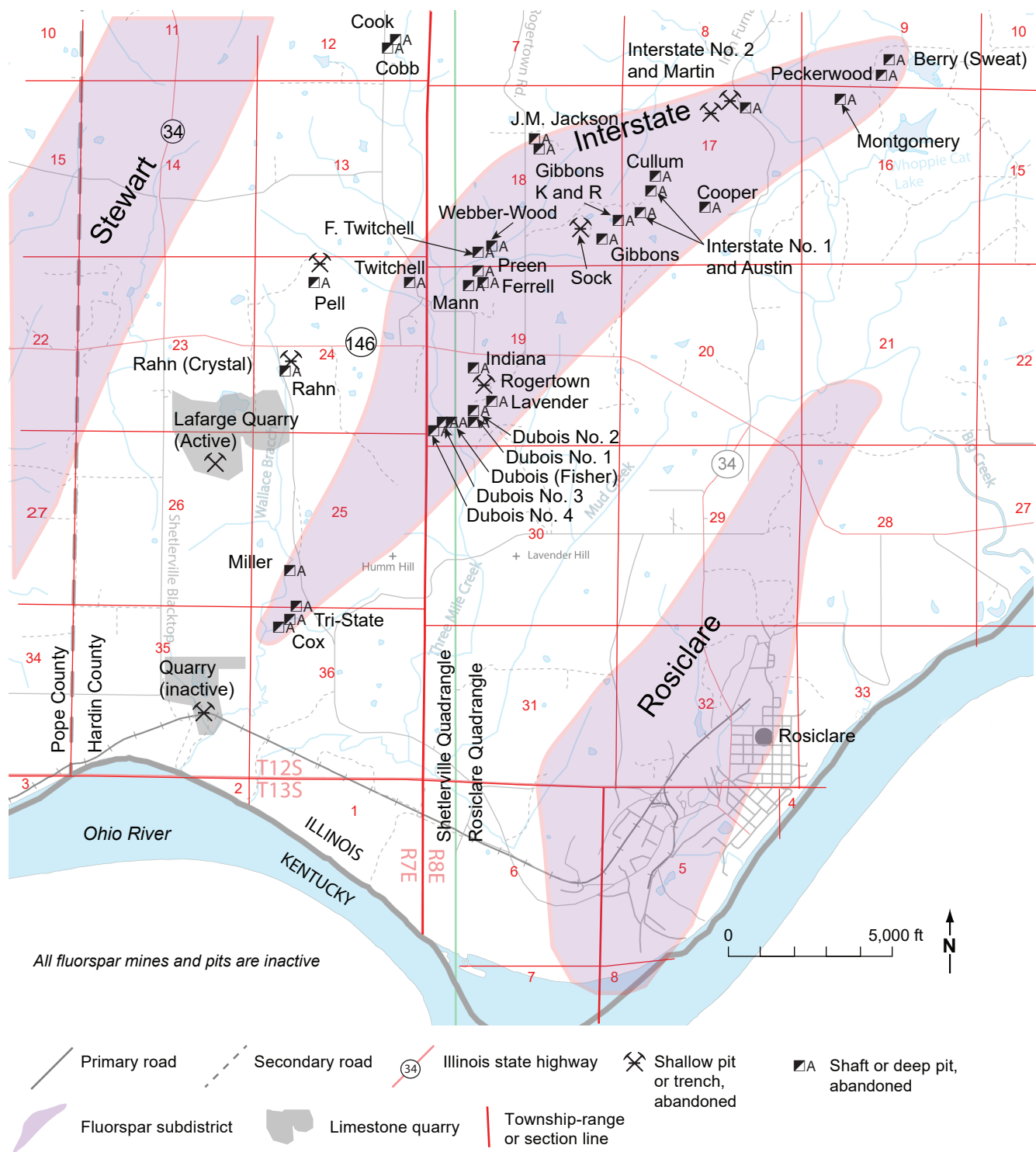


Figure 18 Mines of the Interstate Subdistrict.

was not evident at the surface (Weller et al. 1920; Bastin 1931). Another F. Twitchell Mine (sec. 18, T 12S, R8E) was probably located along an extension of the same structure as the Preen Pros-

pect (Weller et al. 1952). This mine had a 70-foot-deep shaft and produced a small quantity of ore (Weller et al. 1952). The F. Twitchell plots very close to the Webber-Wood Mine.

Webber-Wood Mine

The Iron Age (1922) reported the following information:

The Webber-Wood Spar Mining Co.,
911 Third Street, Eldorado, Ill., recently

incorporated with \$50,000 capital stock, will soon open a fluorspar mine on land which the company owns five miles from Rosiclare, Ill. A force is now at work cutting the vein to determine how much fluorspar is available. Until this has been ascertained, no mining machinery will be purchased. Officers are O.E. Webber, president; D.L. Wood, vice-president; W.E. Troutman, second vice-president; Charles Burks, secretary-treasurer. (p. 478)

According to Bastin (1931), the Webber-Wood Mine was worked for 200 feet along a vein trending N 20° W. Several shallow pits and shafts were opened, and the ore was washed with a log washer and transported to a rail siding at the Stewart Mine Complex. This mine is located just east of and trends parallel to the Preen Prospect.

Jackson Mine

J.M. Jackson opened the Jackson Mine and produced a small amount of gravel spar from pits less than 65 feet deep. Weller et al. (1952) reported that the vein trends N 25° N, an obvious typographical error that probably should read N 25° W.

Gibbons Mine

This mine was located along the Illinois Furnace Fault Zone, which trends N 50° E and dips to the southeast (Weller et al. 1952). A slope pitching 30°–45° and extending about 120 feet replaced an early 55-foot-deep shaft (Weller et al. 1952). A small amount of fluorspar was recovered from this mine (Weller et al. 1952). An Ozark-Mahoning map indicated the Sock Mine was located just west of this mine. No further information concerning the Sock Mine was found. The USGS 7.5-minute Rosiclare topographic map (photography updated in 1996) labeled this location as the K and R Mine.

Interstate No. 1 and Austin Mine

This mine lies along the major northeast-trending fault between the Cullum and Gibbons Shafts. The Rosiclare Lead and Fluorspar Mining Company developed the mine from a shaft 100 feet deep to reach a vein running N 50° E and averaging about 1 foot wide (Weller et al. 1952). The USGS 7.5-minute Rosiclare topographic map labeled this mine complex as Austin.

Cullum Mine

Weller et al. (1952) reported at least two shafts at this mine along a vein trending N 50° E and dipping to the southeast. The deepest shaft was more than 150 feet. Weller et al. (1952) reported that the vein ranged up to 26 feet wide and was composed predominantly of fluorspar. Production figures are unknown despite the apparent richness of the deposit.

Cooper Mine

The Cooper Mine operated intermittently along a 3-foot-wide vein trending N 30° E dipping 80° NW (Weller et al. 1952). The depth of the shaft is reported to be 20 to 65 feet (Weller et al. 1952).

Martin Mine and Interstate No. 2

These mines were located in a complexly fractured area where several fault zones converge. To the northwest, a major fault juxtaposes the lower part of the St. Louis Limestone, with the Caseyville Formation along the northwest side of the Rock Creek Graben. The throw is approximately 1,500 feet, and many lesser faults strike parallel to the largest one. Several unnamed prospect pits and a shaft 128 feet deep in the north-central part of sec. 17, T 12 S, R 8 E worked gravel spar and deeper vein deposits (Weller et al. 1952). Another shaft at least 30 feet deep accessed veins of clear fluorite and pyrite in fractured sandstone. The Rosiclare Lead and Fluorspar Company recovered a considerable amount of ore in this area (Weller et al. 1952). More than 500 tons was produced in 1925 and 1926, and probably 400 additional tons was mined before 1925–1926 (Bastin 1931). Production continued through the 1940s. In 1948, the Rosiclare Lead and Fluorspar Company opened a gravel spar deposit 250 feet long and 16 feet wide (Davis 1945, 1950).

Some historical references to the Interstate Mine do not differentiate between Interstate No. 1 and Interstate No. 2. However, Weller et al. (1952) and Baxter and Desborough (1965) indicated that the Interstate No. 2 property was located at the older Martin Mine property and that the Interstate No. 1 was located at the Austin property. The Austin property is marked on the most recent USGS Rosiclare 7.5-minute topographic map.

Montgomery Prospects

These prospects, pits, and shafts were dug from 40 to 140 feet deep (Weller et al. 1952). The general trend of the vein and accompanying fractures was N 45° E (Weller et al. 1952).

Peckerwood Prospect

In 1917 or 1918, a shaft 40 feet deep was sunk by unidentified parties southwest of the Berry Mine (600 feet from the south line, 1,550 feet from the west line, sec. 9, T 12 S, R 8 E). No production is on record (Weller 1944d).

Berry (Sweat) Mine

The Berry (or Sweat), Peckerwood, and Montgomery Shafts all sought ore along more or less the same vein within a complexly faulted area on the northwest side of the Rock Creek Graben. Among these, only the Berry Mine achieved production. In 1917, Roy Berry and H.C. Ferriman sank a shaft to a depth of 175 feet and conducted some drift work. Sometime later, a Mr. Sweat took control and extended the workings. Still later, the Big Creek Mining Company acquired the property and sank a second shaft to 90 feet deep. Finally, the Yingling Mining Company produced a small quantity of ore during the 1940s. The main vein ran N 55° E and dipped to the northwest. Shaft No. 1 was located 910 feet from the south line and 2,230 feet from the west line of sec. 9, T 12 S, R 8 E, whereas Shaft No. 2 was about 270 feet southeast at 810 feet from the south line and 2,470 feet from the west line of the same section (Weller 1944d).

Cave-in-Rock Subdistrict

The Cave-in-Rock Subdistrict is the largest bedding replacement district within the IKFD. It trends in a northeast-southwest direction and lies southeast of the Rock Creek Graben and Peters Creek Fault Zone (Figure 19). Bastin (1931), Weller et al. (1952), and Brecke (1962) provided historical information on the individual mines. The map and report by Baxter et al. (1963) located numerous mines but contained little historical information. Data from the files of Ozark-Mahoning and the Minerva Oil Company were instrumental in determining the location and details of some of the properties.

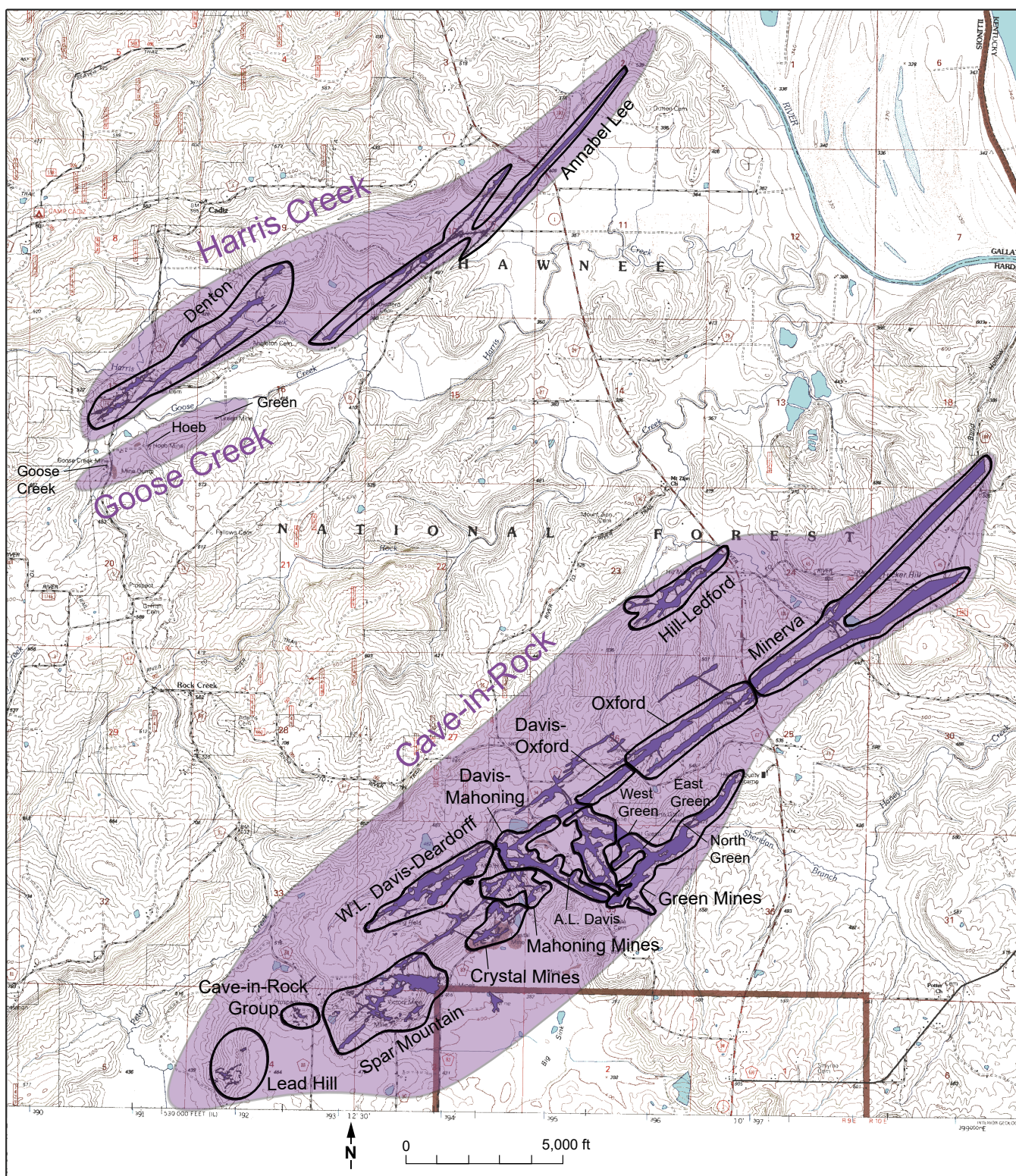


Figure 19 The Cave-in-Rock, Goose Creek, and Harris Creek Subdistricts. The light purple polygons indicate the locations of the subdistricts. The dark purple polygons indicate areas of underground workings. The black lines indicate mine groups. Base map is a portion of the 1996 U.S. Geological Survey (USGS) Saline Mines 7.5-minute topographic map, used courtesy of the USGS.

Orebodies in the Cave-in-Rock Subdistrict are typically 3 to 15 feet thick and 50 to 150 feet wide and extend for more than 2,000 feet along strike (Weller et al. 1952). Banded-texture or concretionary ore is common in bedding replacement deposits and has been observed along the periphery of some of the veins. Banded ore is not exclusive to the Cave-in-Rock Subdistrict and has been reported associated with vein ore in the Empire District, Redd Mine, Oscar Crabb Prospect, Slapout Mine, Sheldon Property, Seinor Prospects, Stewart Mine, Compton Mine, and others (Weller et al. 1952). Some of the mines at the southern end of this district dug gravel spar, but most in the district were underground operations using a modified room-and-pillar mining method. The rooms were up to 150 feet wide and commonly trended in a northeasterly direction. Pillars were left in random configurations to extract as much fluorspar as possible without causing roof failures.

Mines worked multiple stratigraphic levels, including the Ste. Genevieve Limestone (oldest) and the Levias, Shetlerville, and Downeys Bluff Members of the Paoli Limestone. The levels were named for the unit overlying the mineralized strata. Thus, mineralization in the “Bethel Level” occurred within the underlying Downeys Bluff Limestone beneath the thin, shaley sandstone and indurated gray sandstone of the Bethel. The top of the Ste. Genevieve Limestone, just below the Aux Vases Sandstone, was called the “Rosiclare Level.” The lithology of the strata occurring at the contact between the Aux Vases and Ste. Genevieve is variable. Brecke (1962) described the roof in the Rosiclare Level as green plastic shale, silty shale, and limestone interbedded with sandy limestone. The “sub-Rosiclare Level” occurs in the Ste. Genevieve below the Rosiclare Level, and the “Spar Mountain Level” occurs below the sub-Rosiclare Level approximately 60 feet below the base of the Aux Vases Sandstone. At this level, calcareous sandstone overlies oolitic to dense limestone (Brecke 1962). The Spar Mountain Sandstone is lenticular, being 0 to 3 feet thick in the Hill Mine and absent in some places at the Davis-Deardorff Mine. Weller et al. (1952) pointed out that although impermeable roof rock such as shale halted the upward movement of ore-bearing fluids,

some orebodies in the Cave-in-Rock area lacked an impermeable cap rock (i.e., barrier to gas or fluid movement). Finally, a working level near the base of the Ste. Genevieve Limestone has been named the Cadiz Level.

Lead Hill Mines

These mines were located along the southwestern edge of the Cave-in-Rock Subdistrict. Lead Hill is a 3,000-foot-long north-south-trending topographic high that is located north of Illinois Route 146, northwest of Cave-in-Rock, Illinois (Figures 19 and 20). Early mining at Lead Hill was confined to adits and pits along the hillsides. The early mines produced lead but wasted or stockpiled the fluorite because the market for fluorite had not yet developed. The deposits on Lead Hill were known by the late 1800s but probably did not come into important commercial production until a few years before 1917, when ownership passed into the hands of the Basic Minerals Company (Weller et al. 1952). Currier (1944) stated that the Pittsburgh Fluorspar Products Company operated several adits and short irregular drifts along the south side of Lead Hill (Figure 20). In 1934, Pittsburgh Fluorspar Products was succeeded by the Fluorspar Products Corporation and later by the Fluorspar Products Company (Weller et al. 1952). The Fluorspar Products Company was operating at Lead Hill in 1942 and 1943 (Davis 1945). Myers and Chenoweth (2009) listed the mines at Lead Hill as the E.W. Frazer Mine (Fluorspar Products Company) and the Robinson Lead and Fluorspar Mine. Weller et al. (1952) listed all the pits at the southwest end of Lead Hill as the Fluorspar Products Mines-Lead Hill Group, and the adjacent mines to the north end of Lead Hill as the Grischy Lead Hill Mine. Other mines in the area were owned by the Basic Minerals Company (Currier 1944).

Pittsburgh Fluorspar Products Mines

This company operated several mines along the south and east sides of Lead Hill (Currier 1944). The mines extracted banded ore from the Rosiclare Level, as well as from some additional exploratory drifts about 40 feet below the Rosiclare (Aux Vases). The ore on the south end of Lead Hill was relatively pure and quartz free, but on the north end, quartz was fairly abundant. The mushroom-shaped

structures observed in some of the mines suggest that ore-bearing solutions traveled upward along fractures until they encountered an impermeable stratum, such as shale or dense limestone.

Robinson Mine

The Robinson Mine began operation before 1931 and was operated by George Robinson (Bastin 1931). Weller et al. (1952) reported that open pits and adits or drifts into the hillside owned by the Fluorspar Products Mines (Figure 20) and the Grischy Mines were working in the same area. Two to three feet of bedding replacement ore was mined below the Aux Vases (Rosiclare) Sandstone at the top of the Ste. Genevieve Limestone or on the Rosiclare Level, along with a 6-inch-wide vein of fluorite striking N45°E and dipping 80°NW (Bastin 1931).

Miller Mine

The Basic Minerals Company of Pittsburgh, Pennsylvania, last worked this mine, which was located 500 feet northwest of the No. 1 adit of the Pittsburgh Fluorspar Products Company (Currier 1944). Fluorite, galena, and sphalerite along with quartz and the alteration minerals cerussite and smithsonite were identified in this mine (Bastin 1931). At several small pits and drifts in the hillside, 6-foot-thick white and purple bedding replacement ore was mined. Clear optical-grade fluorite of high purity was reported in some of these mines (Bastin 1931). The ore was located below the Aux Vases Sandstone at the top of the Ste. Genevieve Limestone.

Lead Hill Mine; Wolf Mine; Oxford Mine; Miller, Shipp, and Convert Mines; and Fluorspar Products Company Mines

Myers and Chenoweth (2009) listed mines by these names in the southern area of Lead Hill. Most of these mines were small operations owned by the Fluorspar Products Company or the Pittsburgh Fluorspar Products Company (Currier 1944). Some of these mines were also named the Grischy Lead Hill Group (Baxter et al. 1963). The majority of production occurred after 1934 at Lead Hill (Weller et al. 1952). Currently, the Hastie Mining Company is quarrying this area, and its quarry operations occasionally

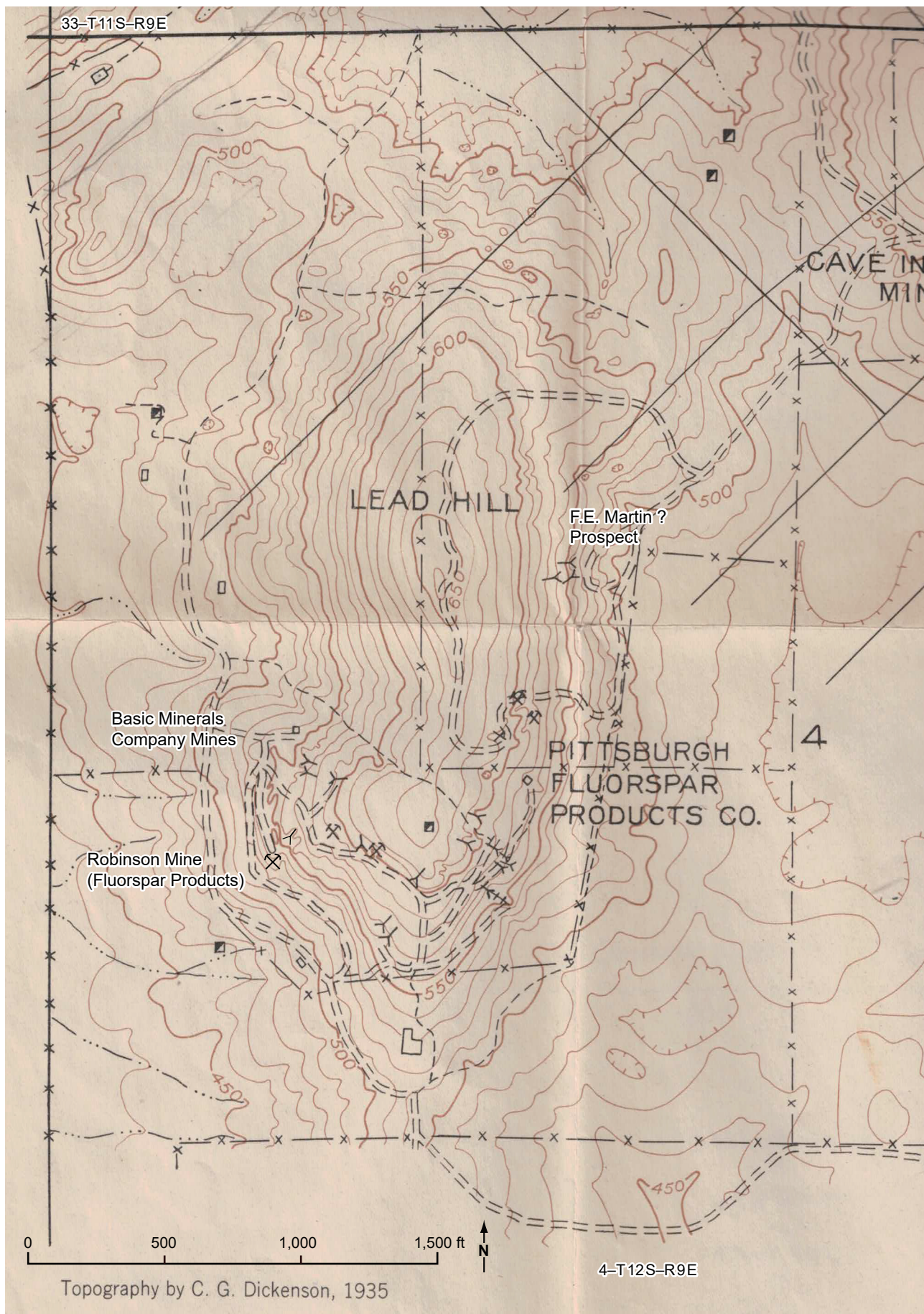


Figure 20 Topographic map (10-foot contours) of the western half of sec. 4, T12S, R9E at Lead Hill showing the numerous shaft and drift locations at Lead Hill. Modified from Currier (1944).

reveal abandoned underground workings. Weathered bedding replacement ore below the Aux Vases (Rosiclare) and lower in the sub-Rosiclare Level was exposed in the new Lead Hill Pit at the Hastie Quarry in 2019.

Magazine Mines

Using a map from the ISGS library, Myers and Chenoweth (2009) identified the Magazine Mines north of Lead Hill and west of Spar Mountain. Several pits, drifts, and shafts relate to this poorly documented operation. Baxter et al. (1963) located the Grischy Mines–Cave-in-Rock Group in this area. Plan maps (Grogan and Ellingwood 1943) place the Magazine Mines in the “Cave-in-Rock 40,” about 400 feet west of the Cave-in-Rock Mine under ownership of the Grischy Mining Company.

Cave-in-Rock Group

This mine was located along the southwest slope of Spar Mountain about 1,200 feet northwest of the Oxford Pits (Currier 1944). The Cave-in-Rock Mine comprised a series of drifts driven into the hillside at both the Rosiclare (Aux Vases) Level and about 40 feet lower in the sub-Rosiclare Level (Currier 1944). Considerable amounts of galena were extracted. The primary orebody lay at the top of the Ste. Genevieve Limestone, where several adits were driven into the hillside. Currier (1944) noted a small fault trending north-northwest near the adits, with ore 1 to 4 feet thick. Fieldwork in 1934 and 1935 reported this mine as inactive (Currier 1944). Development work was ongoing at this site in 1939 (Davis and Trought 1940). Myers and Chenoweth (2009) and Weller et al. (1952) listed this mine as operated by the Grischy Mining Company.

In 1980, Ross Lillie examined underground workings on the sub-Rosiclare Level of the Cave-in-Rock Mine. Quartz pseudomorphs after fluorite cubes to 10 centimeters were collected from mud-filled pockets approximately 35 × 60 centimeters across and 25 centimeters deep. A particular pseudomorph specimen, 12 × 22 centimeters across and 13 centimeters high, was covered with colorless quartz crystals to 1 centimeter over a massive quartz core with remnant purple fluorite in the center. Other pockets pro-

duced dark purple fluorite crystals to 3 centimeters, which were associated with both clear and smoky gray quartz crystals to 3 millimeters.

Tems Mines

R.S. Tems excavated several open pits or trenches 15 to 40 feet deep along the western edge of Spar Mountain north of the Cave-in-Rock (Grischy) Group. These operations were known as the Tems Prospects. Although veins of fluorspar were exposed, production is unknown (Weller et al. 1952). Currier (1944) listed the Grischy Mines–Cave-in-Rock Group in the same general area. In 1981, Ross Lillie examined the underground workings on the Rosiclare Level of the Tems Prospects. Workings consisted of narrow northeast-trending drifts with a solid sandstone back and no pillars. Deep purple fluorite cubes to 1.2 centimeters isolated on a silicified limestone matrix covered with 1 mm of smoky quartz and lilac-purple, zoned, transparent cubes to 0.6 centimeter on altered limestone were collected. Specimens were found in open seams and vuggy areas immediately below the base of the Rosiclare.

Little and Walnut Mines, Walnut Drift

These mines were located west of the Cave-in-Rock Mine, as identified by Myers and Chenoweth (2009). No further data are available.

Blue Valley Fluorspar Mine

Owned by the Austin Company (Myers and Chenoweth 2009), this is probably the Austin Mines–Blue Valley Shaft identified by Baxter et al. (1963). The Blue Valley Mining Company, which is probably the source of the name Blue Valley, was operating and producing fluorspar in 1949 and 1950 (Davis 1951, 1953).

Spar Mountain Group, Austin Mines, and Benzon Mines

These mines were located northeast of Lead Hill along an east-west-trending hill, which locally is called Spar Mountain (Figure 19). Numerous adits were driven into the hillside, and later, vertical shafts were constructed along the top of the hill to hoist ore from underground workings to the surface. Galena was mined at Spar Mountain around 1900 (Weller et al.

1952). The Cleveland-Illinois Fluorspar Company developed the early mines. This company sold the galena and discarded the fluorspar (Bastin 1931). By 1919, with fluorspar in demand by steelmakers, the Spar Mountain Mining Company was operating the mines. Large-scale mining of these deposits began when the Spar Mountain Mining Company purchased mineral rights to the area (Weller et al. 1952). Fluorite was very pure in these early mines, and galena and sphalerite were present in restricted areas (Weller et al. 1952). The earliest mining methods were open pit and shallow drift mines into the hillside. In 1925, the Benzon Fluorspar Company assumed control of these operations (Bastin 1931). Currier (1944) stated that the Benzon Fluorspar Company properties extended along the east- and south-facing slopes of Spar Mountain from 1925 through 1939. The Austin Company, also called the Austin Mines Group, operated mines in the same area, including the West Morrison and Oxford Pits, the Lead Adit Mine or Lead Mine, the Cleveland and 32-Cut Mines, the Keeling Mine, and the Green-Defender Mine or Adit (Weller et al. 1952). Myers and Chenoweth (2009) indicated that the Austin Lead & Fluorspar Mine, Blue Valley Fluorspar Mine, Cleveland Lead & Fluorspar Mine, Defender Fluorspar Mine, East Green Fluorspar Mine, Green Fluorspar Mine, and Hillside Lead & Fluorspar Mines were all owned by the Austin Company. More details concerning the individual mines of the Spar Mountain area are discussed below.

Hastie Quarry

The Hastie family began mining fluorspar before 1969 and is currently the only company mining fluorspar in the IKFD. Hastie Quarry is producing limestone from open pits throughout the Spar Mountain and Lead Hill area. These quarries occasionally encounter abandoned underground fluorspar workings, enabling the recovery of fluorite left in underground pillars and sidewalls of the abandoned underground mines.

In 1979, Hastie Mining and Trucking signed an agreement with Allied Chemical to mine a limited amount of ore in the old Victory Mine workings (Kostick and DeFilippo 1980). A highwall at Hastie Quarry revealed underground drifts that

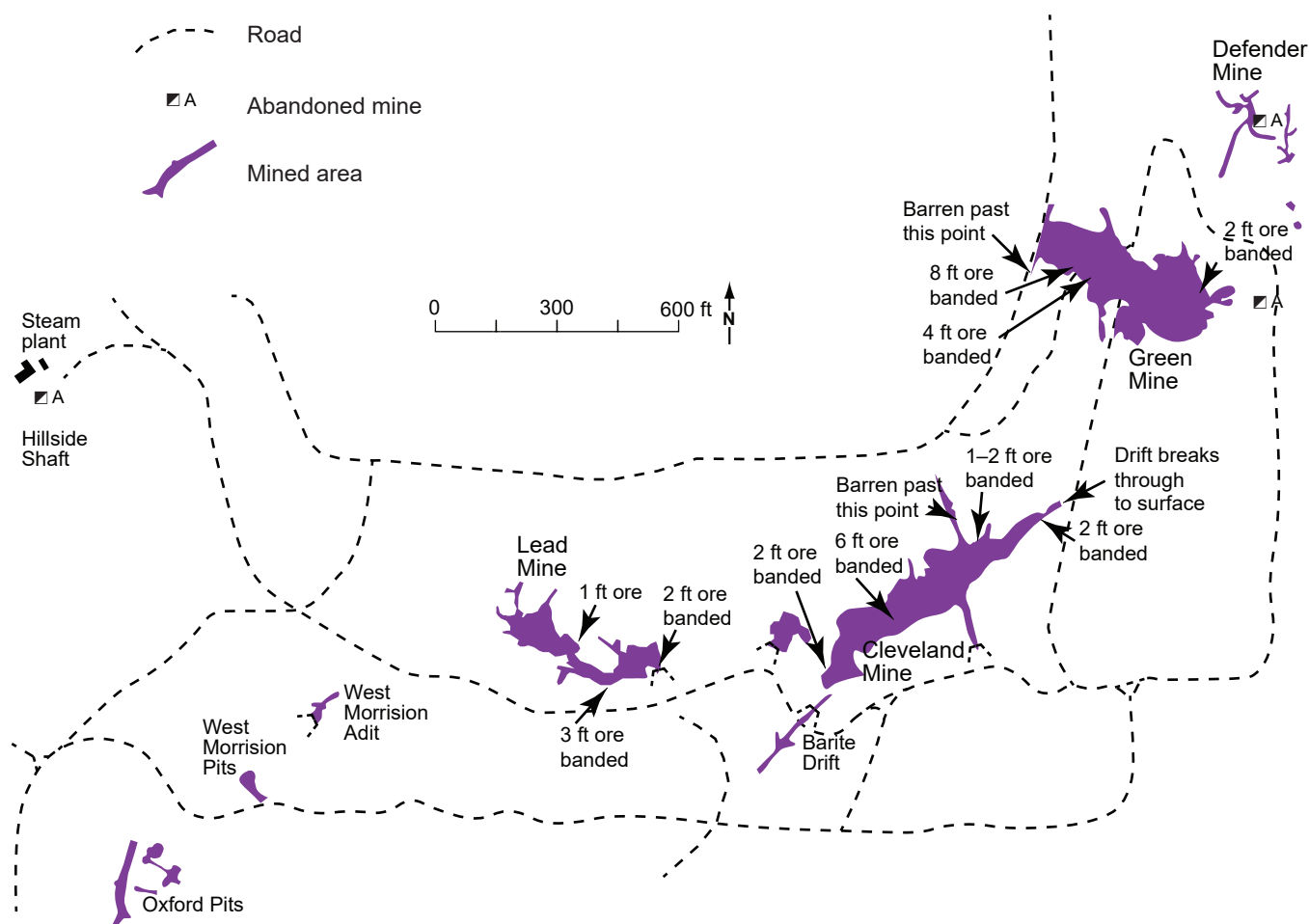


Figure 21 Plan map of the Spar Mountain Mines, circa 1930. Modified from Bastin (1931).

might be extensions of the Lead Mine workings. A small fault with a few inches of offset has been observed in the floor of the quarry, fracturing the Aux Vases Sandstone and apparently serving as a pathway for mineralizing fluids. Fluorite can be observed along this fracture between the breccia clasts. Tracing this small fracture into the highwall is difficult, but it appears to project into the edge of a small V-shaped syncline at the base of the Paoli Limestone (Renault Member).

Oxford Pits

The Oxford Open Pits were located to the southwest of the Morrison Open Pits (1,100 feet south and 300 feet east) of Hillside Shaft (Figure 21). These pits worked fluorite found in residual clays extending from the base of the Aux Vases Sandstone down about 40 feet deep (Bastin 1931).

Weller et al. (1952) listed these pits as part of the Austin Mines Group. Baxter et al. (1963) listed this mine as the Oxford-Morrison Open Pit.

West Morrison Pits and Adit

These mines were located northeast of the Oxford Pits and worked residual ore similar to that at the Oxford. The West Morrison Pits also recovered fluorite from weathered ore in the Ste. Genevieve Limestone (Bastin 1931). Weller et al. (1952) listed these pits as part of the Austin Company mines.

Lead Mine

Also listed as the Austin Mines Lead Mine, this mine was located northeast of the West Morrison Pits. The Lead Mine worked fluorite and galena from below the Rosiclare (Aux Vases) Sandstone

(Weller et al. 1952; Baxter et al. 1963). The bedding replacement ore in this mine trended west-northwest, which is perpendicular to the northeast trend of most of the ore shoots in this district. The Lead Mine appears to be part of the Cleveland Complex, and an adit trending westerly is called the Lead Adit. The Lead Adit workings extend for about 1,000 feet and are less than 350 feet wide, and they trend in a west-northwest direction (Currier 1944).

Cleveland Mine and 32-Cut

The Cleveland Mine was opened in 1903 by the Cleveland-Illinois Fluorspar Company (Figure 21). The ore ranged from 1.5 to 6 feet thick and thinned easterly (Bain 1905). The Keeling Mine was also located in this general area and was operated by the Austin Mining Company. Later, these pits became part of the Austin Mines

Group and were locally called the Benzon Mines (Weller et al. 1952).

Green Mine

Active before 1930, the Green Mine worked ore similar to that of the adjacent Cleveland Mine, but the ore was thinner and less productive (Figure 21). Weller et al. (1952) listed the Green Mine as part of the Austin Mines Group. Baxter et al. (1963) listed the property as Green-Defender. The Green Mine was first operated through the Defender Shaft, but adits were later used (Currier 1944). The ore was located at the base of the Rosiclare (Aux Vases) Sandstone and was 3 to 7 feet thick (Currier 1944). An East Green Mine was also operated by the Austin Company (Baxter et al. 1963). The East Green Mine was listed by Currier (1944) as located about 2,500 to 2,000 feet east of the Green-Defender workings and about 750 feet west of sec. 2 (Figure 19). The East Green was reported to be working at the sub-Rosiclare Level.

Defender Mine

The Defender Mine was about 400 feet north of the Green Mine (Figure 21) and worked ore similar to that in the Green Mine. The mine apparently worked small adits in the hillside (Bastin 1931). Weller et al. (1952) listed this mine as part of the Austin Mines Group. Exactly where the Defender Mine–Victory Mine property boundary is located is unclear.

Victory Fluorspar Mine

This mine opened in 1926 as the Victory Fluorspar Company (Figure 22). In 1948, the Victory Mining Company was owned by the partnership of Outwater, Schwerin, and Barnett (Bishop and Swanson 1948). The ore from the Victory Mine was extracted through shafts located along the top of Spar Mountain (Currier 1944). The Carlos Shaft was sunk in 1927, and shortly thereafter, a washing plant was erected and production began in 1928 (Bishop and Swanson 1948). The Addison Shaft was developed in 1930, but excessive water influx prohibited ore production from this shaft until 1931. The old washing plant at the Carlos Shaft was replaced in 1936 by a jig mill capable of handling 45 tons per 8-hour shift (Bishop and Swanson 1948). The No. 1 (Carlos) Shaft was on the east end of the property,

whereas the No. 2 (Addison) was about 1,100 feet southwest (Currier 1944). As of 1937, the two shafts allowed access to more than 4,000 feet of drifts and cross-cuts in this mine (Currier 1944). The Victory Fluorspar Mining Company was still operating this mine in 1941 and 1942 (Davis 1943). By 1944, about 95,000 tons of concentrate had been produced at the Victory Mine (Bishop and Swanson 1948). In 1952, the Victory Fluorspar Mine, mill, and all equipment were sold to A.H. Stacey and Sons (Holtzinger and Arundale 1955). In 1954, this mine was closed (Holtzinger and Roberts 1956). In 1955, the Minerva Oil Company purchased the mine from A.H. Stacy and Sons (McDougal and Roberts 1958a). In 1965, the Minerva Oil Company hired Conn-Joiner to rob pillars from underground workings at this mine (Biggs 1966).

The ore zone was a single blanket up to 17 feet thick that split into two ore horizons in portions of the mine (Bastin 1931). Brecke (1962) indicated that the two primary working levels were the Rosiclare and 20 feet below the Rosiclare. The orebodies attained 12 feet in thickness, but the individual mineralized beds ranged from a few inches to 4 feet thick (Bishop and Swanson 1948). The ore was localized at the top of the Ste. Genevieve Limestone beneath a shale layer in the basal Rosiclare (Aux Vases) Sandstone (Bishop and Swanson 1948; Weller et al. 1952). Other shaley layers commonly separated the high-grade or pure fluorspar beds and the banded ore, commonly called coontail ore. The ore in this mine followed three separate trends or directions: (1) N40°–60° E, (2) N30°–55° W, and (3) due east-west (Bishop and Swanson 1948). Brecke (1962) indicated that the Victory Mine lay along a fracture that was the primary conduit for the ascending mineralizing solutions, which spread laterally for 70 feet on the upper level and were 50 feet wide on the lower level. Strong mineral enrichment was present along the structure such that the orebodies merged along the primary conduit (Brecke 1962).

Crystal Fluorspar Mine

The Crystal Fluorspar Mine, located to the northeast of the Green and Defender workings (Figure 19), began operations around 1930. Its entrance was an incline at the base of the eastern slope of Spar Mountain. This incline led to two main

drifts 40 to 70 feet apart, striking N35° E and N45° E (Currier 1944). A shaft was later added at the top of the hill to extract ore, and a prospect shaft called the Lackey was dug to the northeast (Currier 1944). Baxter et al. (1963) listed this mine as Minerva Mines, Crystal Adits and Shafts. Weller et al. (1952) reported that seven shafts were present within this mine complex. Most orebodies were on the Rosiclare Level, but Weller et al. (1952) reported that an ore pod was present in the upper portion of the Renault. In 1942 and 1943, James W. Patton and Sons milled mine tailings (Davis 1943). The mine was owned by the Crystal Fluorspar Company and was producing ore in 1941 and 1942 (Davis 1943). In 1950, this mine was flooded because of high water and was not in production until the last half of the year (Davis 1953). In 1953, the mine was operated by the Minerva Oil Company and was producing ore (Holtzinger and Roberts 1956). In 1967, pillars were being robbed, and the mine was temporarily abandoned (Barton 1968). Wood (1974) reported that the flotation mill at this site was shut down by the Minerva Oil Company in 1972 and that only the heavy media circuit was run occasionally.

Wall and Simmons Properties

Several open pits were located along the northern edge of the “Big Sink” (the region’s largest sinkhole) southeast of the Crystal Mines. Weller et al. (1952) reported that highly weathered deposits of fluorite in a clay matrix were mined along the northern rim of the Big Sink. The precise location of these workings is difficult to determine, but they are plotted based on information provided by Weller et al. (1952). Baxter et al. (1963) listed this property as the Frayser Wall property. An article from the *Hardin County Independent* (1940b) newspaper reported that fluorspar was found by the Big Creek Mining Company on the Norman Simmons property along the northeast corner of the Big Sink (p. 1). The newspaper account described about 125 tons of high-grade acid spar being produced at very shallow depths by men using hand-picks and hoisting with a hand-operated windlass. Three weeks later, a crane and shovel were brought to the mine to work the deposits along the Big Sink (*Hardin County Independent* 1940a, p. 6). In 1943, a small amount of ore was being

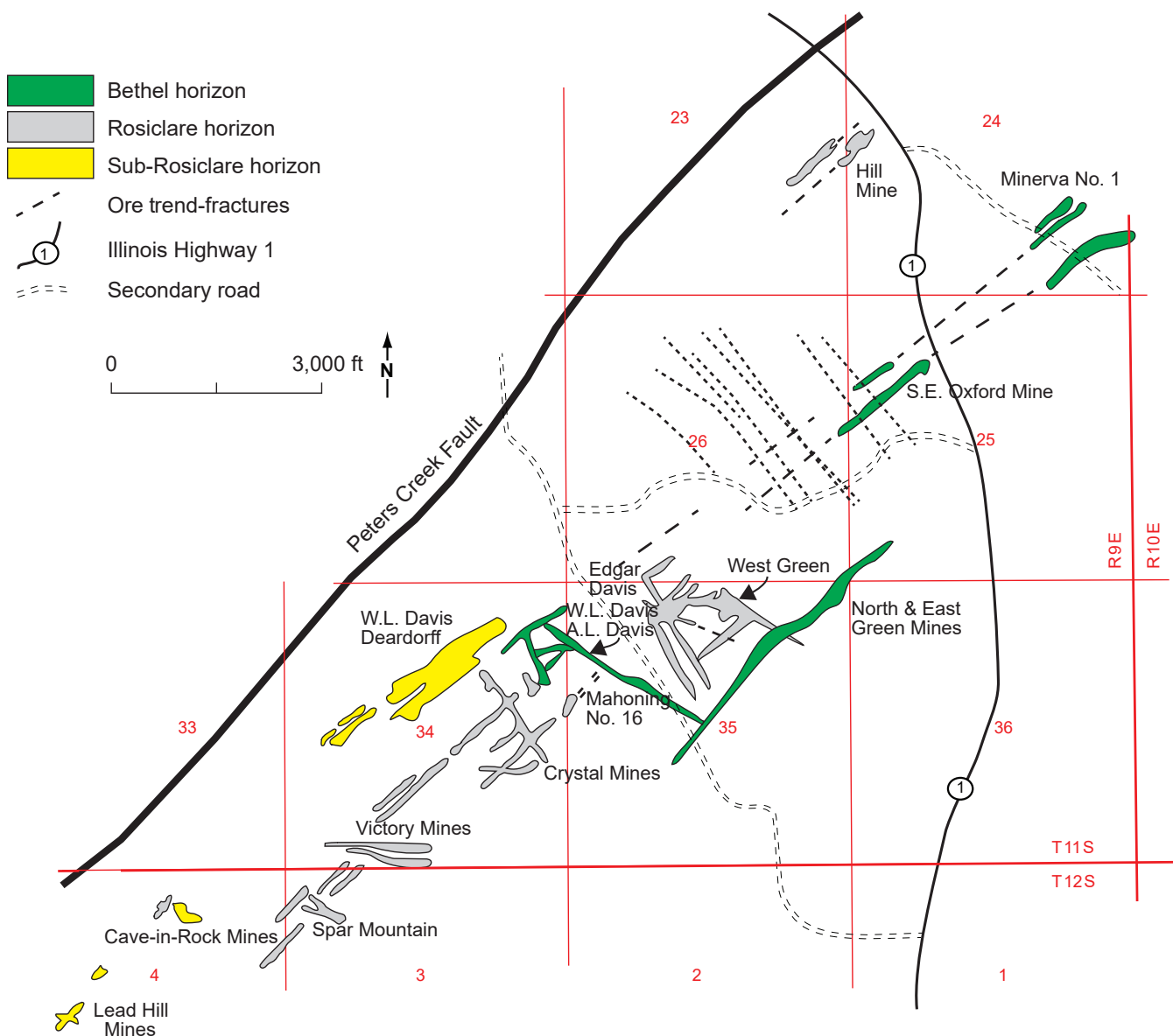


Figure 22 Plan view of the mines and primary working levels within the Cave-in-Rock Subdistrict. Some mines worked multiple levels, which is described in detail within the text.

produced at the Wall Mine (Davis 1945). Davis (1949) reported that in 1947, Inland Steel was milling crude ore from this site.

Mahoning Mines or Ozark-Mahoning Group of Mines

The Ozark-Mahoning Company was the largest producer of fluorite and was the last major producer to operate in the region. This company operated a group of mines primarily northeast of Spar Mountain, but workings were connected to the

older adjacent Spar Mountain Mines, making it difficult to identify individual mine boundaries (Figure 19). These Mahoning Mines had several shafts, four of which (No. 2, No. 3, No. 4, and No. 5) were active in 1950 (Davis 1953). The Penwalt Company purchased the Ozark-Mahoning Company in 1974, which then merged with Atochem North America in 1989 before finally ceasing mining operations in this district in 1995. A heavy media mill was also erected at this location.

Davis Mines (W.L. Davis, A.L. Davis, Edgar Davis, Davis-Deardorff, and Davis-Oxford Mines)

In 1937, a fluorspar-zinc-lead ore deposit was first discovered north of the Crystal Mines. The Mahoning Mining Company leased 2,000 acres, and by 1939, Ozark Mining had proven resources and dug shafts for the A.L. Davis and W.L. Davis-Deardorff. The Davis Mines were located north of the Victory Mine and were owned by the Mahoning Mining Company. The Edgar Davis Mine was located

northeast of the Davis Mines. Baxter et al. (1963) and Myers and Chenoweth (2009) listed the mine as E. Davis and as part of the Mahoning Mines. Several shafts are associated with this complex, which Baxter et al. (1963) identified as the Deardorff Mine, W.L. Davis Mine, W.L. Davis No. 2, and W.L. Davis No. 16 (Figure 19). The W.L. Davis Mine began production in about 1939. The A.L. Davis Mine was located southeast of the Davis-Deardorff Mine and mined a continuation of the ore adjacent to the W.L. Davis No. 2. The shaft at the A.L. Davis is labeled Mahoning Mine on the USGS Saline Mines topographic map. The A.L. Davis Mine was opened in 1941 (Davis 1943). The A.L. Davis, W.L. Davis, and Deardorff Mines were all active in 1942 (Davis 1943). The Deardorff Mine was in production in 1953 (Holtzinger and Roberts 1956). The W.L. Davis and Deardorff Mines closed for 4 months in 1954 because of market conditions (Holtzinger and Roberts 1957).

The A.L. Davis orebody averaged 7 feet thick and produced high-grade fluor-spar ore averaging 50.8% CaF_2 (Brecke 1962). Weller et al. (1952) reported that the W.L. Davis-Deardorff Mine was one of the richest mines in the Cave-in-Rock Subdistrict, with mine-run ore averaging 50% to 60% fluorite, 12% to 14% zinc, and 3% to 5% lead. Cumulative production tonnage estimates from Ozark-Mahoning files indicate that by 1967, about 287,000 tons, at 40% CaF_2 , 12% zinc, and 3% lead, was mined from the sub-Rosiclare Level and 135,177 tons of 50% CaF_2 was mined from the Bethel Level on the W.L. Davis 167-acre tract. Brecke (1962) reported that the W.L. Davis-Deardorff Mine contained abundant quartz associated with the fluorite bodies, which was unusual for this district. Brecke (1962) described a few small northwest-trending cross faults with vertical offsets of less than 1 foot. Enrichment of the ore to acid-grade fluorspar was present where the northeast- and northwest-trending structures coincided. Cross-sectional views of the enriched acid-grade zones showed a V- and U-shaped structure. Perry (1973) discussed a northeast-southwest extension of the M.F. Oxford ore pod to the Davis orebody, which he called the Davis-Oxford orebody. The ore in the Davis-Oxford ore pod was on the Bethel Level, but Rosiclare and sub-Rosiclare ore was mined in many of these mines. These

mines were tremendously productive, and Ozark-Mahoning files indicate that approximately 2.8 million raw tons was extracted from these mines.

Green Mines

The Ozark-Mahoning Company owned the West Green Mine, North Green Mine, and East Green Mine (Figures 19 and 23). Another mine, named the W.C. Green, was active in 1941 (Davis 1943). In 1942, the shaft at the East Green Mine was completed and the West Green orebody was producing ore (Davis 1943). The East Green and West Green Mines were active from 1946 to 1949 (Davis and Greenspoon 1948; Davis 1951). The North and East Green Mines were active in 1953 (Holtzinger and Roberts 1956). Ore was being extracted from the North Green Mine in 1972 (Wood 1974). Ore in this area occurred at several horizons, including the sub-Rosiclare, Rosiclare, and Bethel. The North Green Mine contains a $\text{N}60^\circ\text{E}$ structure and a small thrust fault that uplifts the Renault (Downeys Bluff) Limestone over the Bethel Sandstone (Brecke 1962). This structure is minor and is probably a relief or accommodation structure associated with the Rock Creek Graben. Brecke (1962) observed no displacement along the northeast-trending structures, and the northwest-trending structures had only minor displacement.

A pipelike solution feature is located just east of the North Green Mine Shaft, which probably served as a primary conduit for ascending ore solutions. Structure contours on the overlying Bethel Sandstone indicate that the unit has slumped downward approximately 100 feet and that the Rosiclare is slumping down about 60 feet (Brecke 1962). Brecke (1962) envisioned the ore fluids upwelling from the pipes and noted, "The solutions that moved up-dip to the southwest moved upward and in the direction of diminishing pressure. Therefore, the major part of the solution moved up-dip and most of the deposition took place in this area" (p. 512).

The ore zone extended along this trend for 4,500 feet to the southwest and 1,500 feet to the northeast, and the collapse feature and stratigraphy of the host rock controlled mineralization (Brecke 1962). The East Green and North Green ore pods formed in a fracture zone extending away

from the collapse feature, which contained up to 7% sphalerite, with mineralization on both the Bethel and Rosiclare Levels (Brecke 1962). In 1980, Ross Lillie examined the underground workings on the Bethel Level just east of the North Green Shaft and viewed an enormous open area, hemisphere shaped in cross section, approximately 80 feet in diameter and 30 to 40 feet high.

Oxford, S.E. Oxford, and M.F. Oxford Mines

These mines were operated by Ozark-Mahoning, which began sinking the 365-foot Ida Oxford Shaft in 1949 (Davis 1951). The mines apparently extended along northeast-southwest-trending fractures, which were traced to the southwest into the southeast portion of sec. 26. Baxter et al. (1973) stated that this orebody connected with the Davis workings, so this ore pod was sometimes called the Oxford-Davis orebody. The Oxford-Davis ore was primarily confined to the Bethel Level and consisted of purple replacement fluorite along with yellow high-grade zones (Perry 1973). Barite was concentrated along the periphery of the ore zones, and sphalerite was concentrated along minor faults or fractures (Perry 1973). Brecke (1962) speculated that the U- or V-shaped structure over the top of ore zones was a result of volume reduction resulting from replacement of the limestone host rock by fluorite. Ozark-Mahoning files indicate that 883,807 raw tons was extracted from these mines.

Hill-Ledford Mine

The Hill Mine was located north of the Oxford Mine along the west side of Illinois Route 1 (Seid et al. 2013a). The mine operated from the late 1950s until the 1970s. This mine was located west of the Minerva Mine and is commonly called the Hill-Ledford Mine. Sinking of the C.N. Hill Shaft began in July of 1953, and the bottom was reached in November of 1956. Further development activities continued until March of 1957 (Bailie et al. 1960). The shaft was lined with concrete down to 110 feet. Below 110 feet, the shaft was timbered to the bottom of the 724-foot shaft (Bailie et al. 1960). Two parallel orebodies trend northeast-southwest. Ore is present in the upper portion of the Downeys Bluff Limestone (Bethel Level) and in the Ste. Genevieve

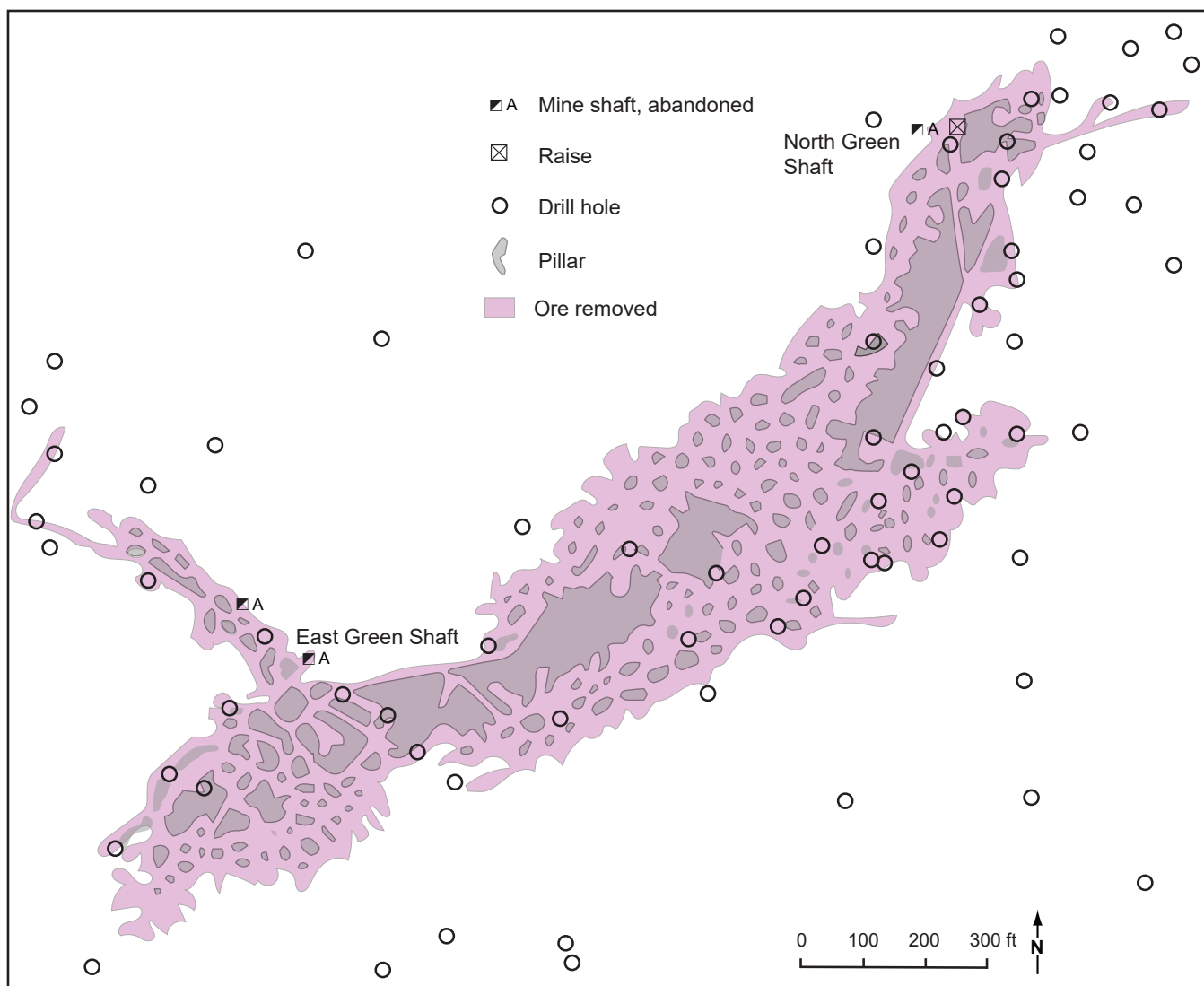


Figure 23 Plan map of the East and North Green Mines showing underground room-and-pillar workings. Data from unpublished Ozark-Mahoning scanned documents.

Limestone (Rosiclare and sub-Rosiclare Levels). Brecke (1962) based his map of a collapse structure or oval depression with a vertical offset approaching 75 feet on structure contours of the Rosiclare (Aux Vases) Sandstone. This brecciated collapse structure was located along a small fault adjacent to the ore zone. Brecke (1962) suggested that this depression was a collapse feature over a feeder pipe for the mineralizing fluids and was similar to the breccia pipe seen in the North Green Mine. The breccia pipe at this mine was at the northeast end of the mineralized area, and Brecke (1962) theorized that the

ore fluids moved up-dip to the southwest. These structures are very local and extend for less than 400 feet across the mineralized zone. Drilling in the mine floor indicated that sphalerite-fluorite mineralization extended down into this feature for more than 170 feet. The downward position of the brecciated strata indicated the breccia was created by solution slumping, which created open space for the mineralizing solutions (Pinckney 1976). Ozark-Mahoning closed this mine in 1971 in compliance with the U.S. Bureau of Mines, Health and Safety-Illinois Division (Wood 1973).

Eureka Lead Mine

The prospect lies along the Peters Creek Fault Zone, which strikes N55°E and dips to the northwest (Weller et al. 1952). Operated by the Eureka Lead Company of Mt. Carmel, Illinois, the Eureka Lead Mine had two shafts (Weller et al. 1952). The east shaft was sunk by W.J. Rogers in 1905 to a depth of 55 feet, where a cross-cut was driven 28 feet to the northwest (Bastin 1931). John E. Hanson sank the west shaft to a depth of 80 feet (Bastin 1931). The only production occurred in the east shaft, which hoisted lead and zinc ore (Bastin 1931).

F.E. Martin Prospect

Little is known of the F.E. Martin Prospect beyond the presence of a single vertical shaft sunk to a depth of 38 feet (Bastin 1931). Quartz, calcite, galena, and fluor spar were found in the mine dump around the shaft (Bastin 1931).

Minerva Mine

The Minerva No. 1 Mine, locally called the Minerva, was operational (with several gaps) from 1944 through 1995. The mine produced some of the finest crystals for mineral collectors. This mine was renowned for fluorite, sphalerite, barite, witherite, strontianite, alstonite, and benstonite crystals.

Following an exploratory drilling program, the Minerva Oil Company constructed a shaft 645 feet deep and erected a differential flotation mill. Mining commenced in 1944 in what was at the time the deepest mine in the IKFD. A second shaft, approximately 590 feet deep, was completed in 1949 as a service and emergency escape route (Figure 24). As the mine progressed, several additional shafts, raises, and declines were driven. The widths of the orebodies ranged from 50 to 300 feet, and the bodies were irregular and ranged from 3 to 20 feet thick (Nackowski 1949). Working levels were the Upper Renault or Downeys Bluff (Bethel), Levias, Rosiclare, and sub-Rosiclare (Nackowski 1949). The ore at the Minerva Mine averaged 4.2% zinc, and the zinc concentrate obtained through processing was 63% (Weller et al. 1952). The mill was reported to be a 250-ton selective flotation plant that produced both hydrofluoric acid and ceramic concentrates. Diesel-driven underground haulage trucks and loaders were first introduced at the Minerva Mine in 1951 (Davis 1953). In 1964, the Minerva Oil Company placed into operation a new mill designed to make fluorspar pellets for steel manufacturers (Peterson 1965). In 1965, new and larger underground loading and hauling equipment was put into service, and a heavy media preconditioner was installed in the mill (Biggs 1966). In 1969, a 600-foot truck incline was being driven from the Renault Level to the Fredonia Level (Readling 1971). Barite was being recovered in 1973 at Mine No. 1, which allowed ore grades as low as 28% CaF_2 to be milled (Wood 1975). In 1974, this mine was producing

steady amounts of barite to be utilized in drilling muds and paint pigments (Wood 1975). Inverness Mining Company mined the Minerva No. 1 from 1980 to April 1982, when it ceased production. Inverness kept the pumps running and maintained the mine until shutting down in 1984. Thereafter, it removed the equipment and flooded the mine. Inverness continued to operate in the district by purchasing foreign spar and drying the product at the Minerva No. 1 mill. Inverness ultimately sold the property to Ozark-Mahoning in December 1988. After extensive dewatering, Ozark-Mahoning began mining in early 1990 and continued until November 29, 1995 (Elf Atochem Company 1995). Ozark-Mahoning then removed equipment and abandoned and sealed the mine. Historical files indicate that several million raw tons of ore were extracted from this mine.

Harris Creek Subdistrict

The Harris Creek Subdistrict is located on the northwest side of the Rock Creek Graben. It is named for the local stream called Harris Creek (Figure 25). Both the Annabel Lee and Denton Mines are located in this subdistrict. Mines in the Goose Creek Subdistrict are sometimes grouped with the Harris Creek Subdistrict, but usually the two are considered separate subdistricts.

Denton Mine

The Denton Mine, owned by the Ozark-Mahoning Company, was located in the southwest portion of the Harris Creek Subdistrict (Figure 25). The shaft was completed in 1980, and production probably began in 1981 (Morse 1981). The main production shaft was 688 feet deep, and several other shafts were present for ventilation and escape routes. The ore was of the bedding replacement type and was similar to the ore in the Cave-in-Rock Subdistrict. The main orebody at the Denton Mine was located on the Rosiclare (Aux Vases) and Bethel Levels, but three other levels were also mined. Substantial ore was also mined from northeast-trending parallel trends accessed by crosscuts from the main orebody. One pod, northwest of the main orebody, mined the Rosiclare Level, and the second, southeast of the main orebody, mined both Rosiclare and sub-Rosiclare ores. In addition, a rich isolated

pod of Rosiclare and sub-Rosiclare ores was mined about 200 feet northeast of the shaft (Ross Lillie, personal communication with Brett Denny, 2018). The ore followed northeast-southwest fractures and extended in a linear fashion. Spry et al. (1990) examined the fluid inclusions in fluorite crystals from the Denton Mine. They determined that several different fluids mixed to form the ore deposits and suggested that the fluids were primarily basinal brine type. Spry et al. (1990) also measured a 2 per mil (2‰) depletion in the $\delta^{18}\text{O}$ values of limestone host rock forming a halo surrounding the ore deposit. The authors attributed this depletion to temperature variations and fluid exchange between the ore-forming solution and the limestone host rock.

John Nelson and Donald K. Lumm of the ISGS made a brief underground tour of the Denton Mine in 1982. The working level visited was in the uppermost Ste. Genevieve Limestone beneath the Rosiclare (Aux Vases) Sandstone. Ore-grade material followed a northeast-trending belt of fractures about 75 to 150 feet wide. From a skip shaft 650 feet deep, mining proceeded in a room-and-pillar pattern. As Nelson observed in field notes, "The ore replaces limestone in roughly horizontal, lenticular bodies that have undulating to crenulated bands of alternating yellowish fluorspar, purple spar, and white to yellowish-brown calcite separated by layers or lenses of unaltered limestone." This style of mineralization is commonly called coontail. In several places, limestone had collapsed in V-shaped zones striking northeast, parallel to the outlines of the orebody. Such zones could be as wide as 40 feet and as deep as 30 feet and contained exceptionally high-grade, coarsely crystalline ore. The northeast-trending fractures that evidently carried ore-bearing fluids were inconspicuous and showed little or no displacement. The Denton Mine closed in 1994 (Miller 1995). Ozark-Mahoning files indicate that 967,503 raw tons of ore was extracted from this mine.

Annabel Lee Mine

The Annabel Lee Mine, operated by the Ozark-Mahoning Company, was located northeast of the Denton Mine just west of Illinois Route 1 (Figure 25). The name alludes to the poem *Annabel Lee* by Edgar Allan Poe, in which the poet mourns for

All mines are inactive

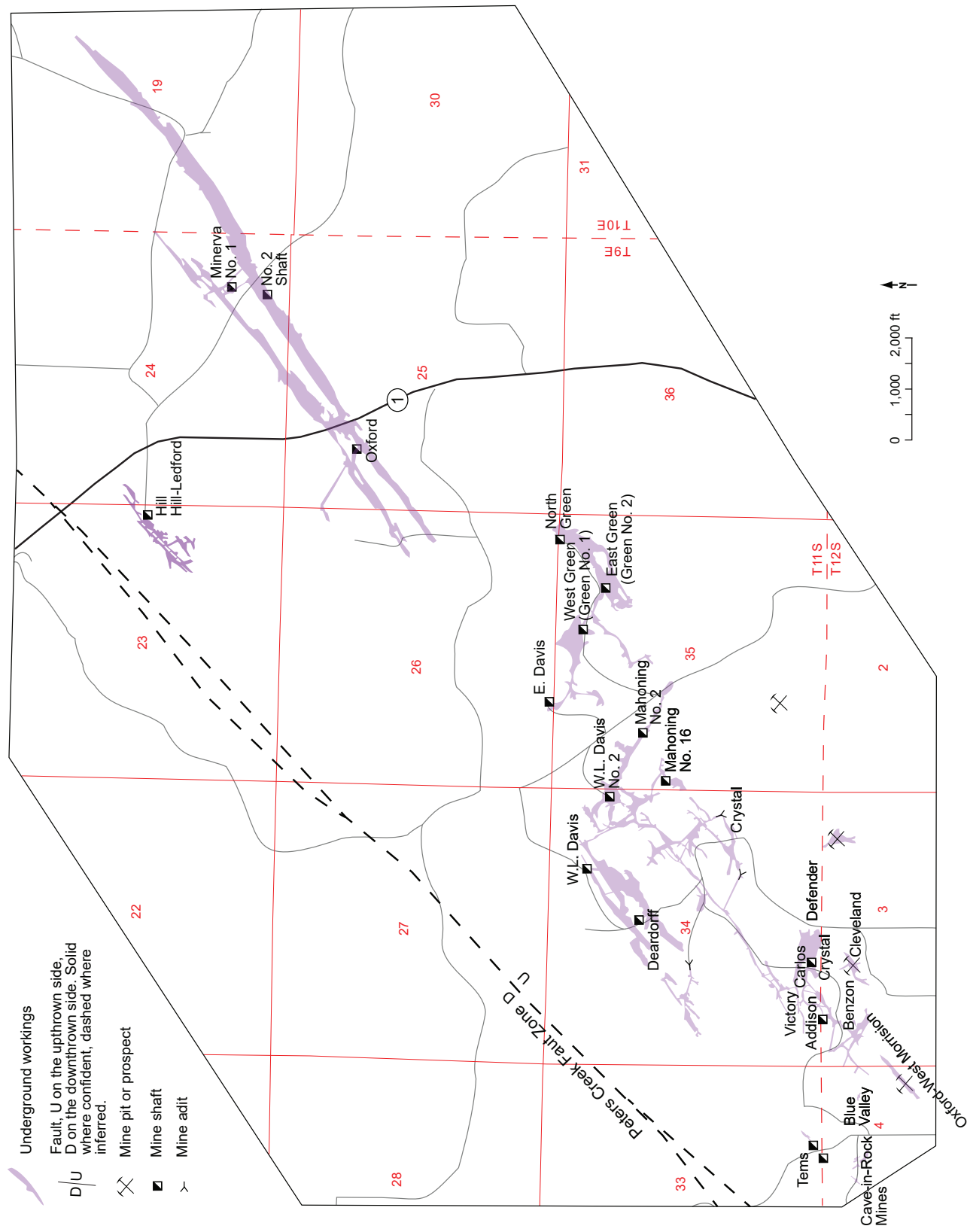


Figure 24 Plan map of the Cave-in-Rock Subdistrict, circa 1964. Data from Ozark-Mahoning scanned documents. Note: This map was created from data circa 1964. Any mining after 1964 will not be depicted. The Minerva No. 1 was later extended to the northeast and the Oxford to the southwest. This mining is not shown.

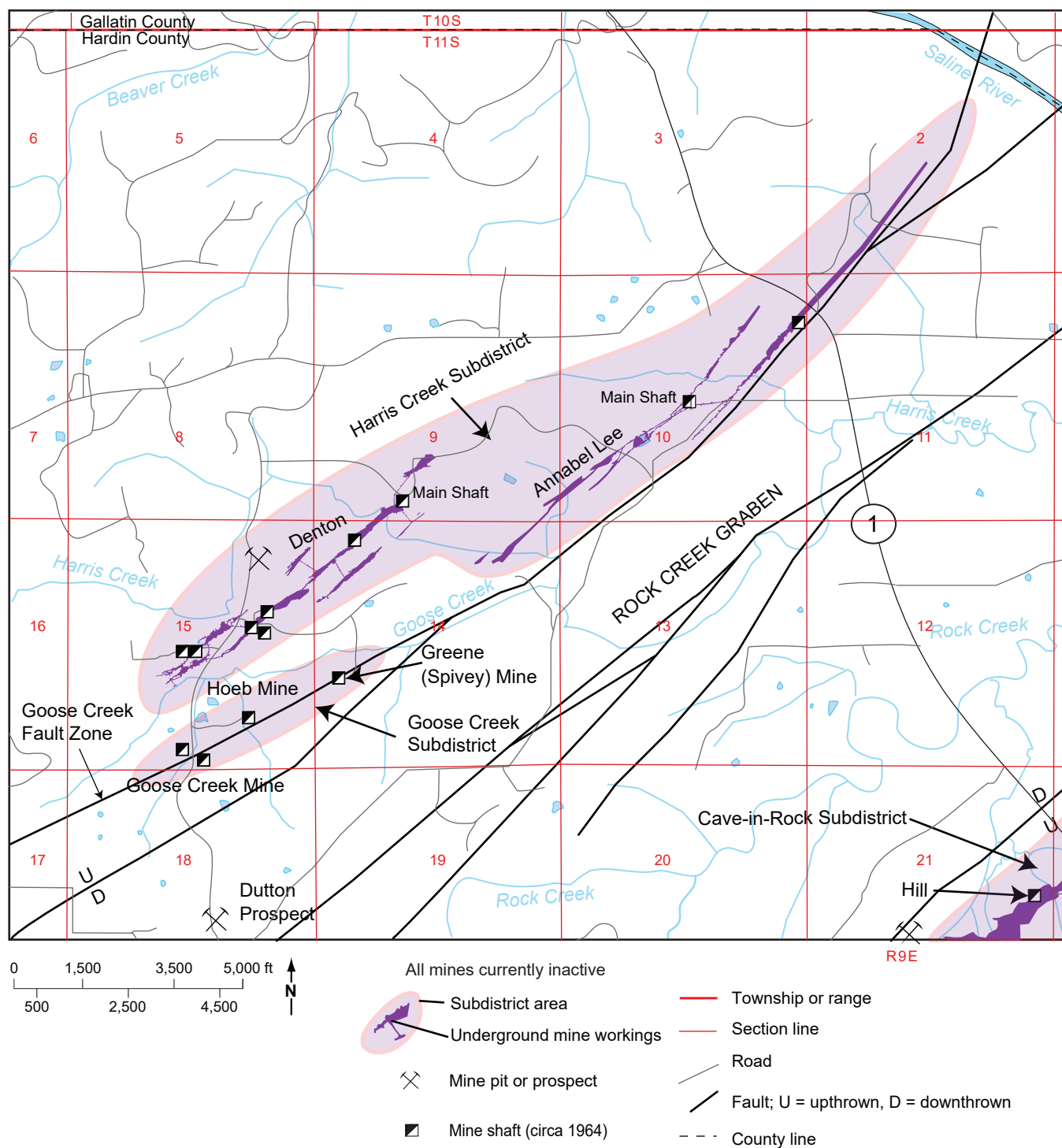


Figure 25 The Harris and Goose Creek Subdistricts, mine shafts, underground mine workings, and faults associated with the Rock Creek Graben. All mines are abandoned.

his lost lover “in her sepulchre there by the sea.” The headframe is still standing and can be observed from Illinois Route 1. The main shaft was completed in 1984 and was nearly 1,000 feet deep. The Anna-
 bel Lee ore pods were narrow, commonly

less than 100 feet wide, and ran parallel to the major northeast–southwest structure of the Rock Creek Graben. The ore was mainly on the Rosiclare Level, but four other ore levels were mined. The ore within the sub-Rosiclare Level occurred

in lenticular masses ranging from a few inches to 12 feet thick. Tilted and jumbled, angular clasts of limestone were embedded, indicating large-scale dissolution that created open cavities. Open voids as wide as several feet were numer-

ous. Calcite and fluorite formed very large crystals, whereas most of the sphalerite was finely to coarsely crystalline. Narrow, planar fractures trending northeast were present but not conspicuous or consistent in spacing. In 1986, the ore from the Bethel Level averaged about 40% CaF_2 , whereas the ore from the sub-Rosiclare Level was slightly lower grade. Ozark-Mahoning ore reserve sheets from 1993 indicate that ore from this mine averaged about 30% to 35% CaF_2 and 2% to 5% zinc. In 1990, Ozark-Mahoning geologists estimated that ore from the Annabel Lee equaled 961,084 raw tons, and other Ozark-Mahoning documents indicate that 868,000 raw tons was extracted. They also suggested that mineralization might extend northeast to the Saline River. When the mine closed in 1996, it was the last working fluorspar mine in Illinois.

According to Dan Pilcher, the mine superintendent, bedding replacement ore was worked from several levels: the Bethel Sandstone, Levias Limestone, Rosiclare (Aux Vases) Sandstone, sub-Rosiclare, Lower Rosiclare, and St. Louis ("Cadiz," explained below). Geologists John Nelson and Jim Baxter from the ISGS toured the St. Louis Level in 1988 and described crudely banded ore comprising alternating layers of calcite of various colors with fluorite and sphalerite on the St. Louis Level. They observed many vugs one foot or more across and vertical to steeply inclined fissures lined with large, well-formed crystals. On the basis of their lithological observations underground, both Nelson and Baxter questioned whether the country rock was St. Louis Limestone and speculated that it really was within the Ste. Genevieve Limestone. Because of the misleading correlation with the St. Louis Level, Ross Lillie proposed the name "Cadiz" for this working level, stating that the level was near the base of the Ste. Genevieve Limestone. The term St. Louis Level is misleading because the level is actually in the Ste. Genevieve. Therefore, the new term "Cadiz" is preferred for this level.

Goose Creek Subdistrict

The mines within the Goose Creek Subdistrict are vein type and bedding replacement type that are aligned along the northeast-trending Goose Creek Fault Zone (Figure 25). The fault zone apparently comes together to the north and is

a northwest boundary for the Rock Creek Graben. The mines in the Goose Creek Subdistrict are sometimes considered part of the Harris Creek Subdistrict.

Goose Creek Mine

The Goose Creek Mining Company was operating this mine in 1952 from a shaft about 300 feet deep (Holtzinger and Roberts 1956; Baxter et al. 1963). Ozark-Mahoning files indicate that working levels were at 95, 120, 200, 256, 295, and 355 feet. An extension of this mine apparently connected with the Hoeb Mine along the 256-foot level. Ozark-Mahoning files indicate that at least 150,000 tons of raw ore was extracted from this mine.

Hoeb Mine

In 1958, the Hoeb Fluorspar Mining Company discovered two blanket-type deposits adjacent to the Goose Creek Fault (McDougal and Foley 1959). These orebodies were at the 160- and 260-foot levels. The lower level was located just below the Bethel Sandstone (McDougal and Foley 1959). These contain ore deposits were 25 to 30 feet wide and contained fluorspar, lead, and zinc. Information in the Ozark-Mahoning data set indicates that some stopes were also present along this vein and that working drifts were at the 100-, 160-, 260-, 335-, and 385-foot levels. Ozark-Mahoning data also indicate that the vein split into an east "main" vein and a west vein (Figure 26). The vein ore was also near the contact with the Bethel Sandstone and Renault Limestone. Maps indicate that along the main or east vein near the Hoeb Shaft, the west wall was the lower portion of the Cypress Sandstone and the east wall was the Glen Dean Limestone to Tar Springs Sandstone. Ozark-Mahoning files indicate that at least 86,000 raw tons of ore was extracted from this mine.

Spivey Mine or Greene Mine

According to Myers and Chenoweth (2009), the Spivey Mine Company operated the Greene Fluorspar and Zinc Mine. The source for their work was Baxter et al. (1963). In Baxter et al. (1963), the mine was named Greene in the text and labeled Green on the map. This mine is sometimes spelled "Spivy," but "Spivey" seems more common. This mine, which lies along the northeast extension of the

Goose Creek Fault, was ready for production by November of 1971 but was placed on standby, awaiting better market conditions (Wood 1973). The Spivey lies northeast of the Hoeb, but the two mines were not connected in 1980. The Minerva Oil Company continued to develop the Spivey Mine by sinking a shaft to 685 feet, and the mine was expected to be in full production in 1975 (Wood 1976). The Spivey Mine was operated by the Minerva Oil Company in the 1970s, by Allied Chemical in 1979 (Kostick and DeFilippo 1980), and by the Inverness Mining Company in 1980 (Morse 1981). Mine maps from the Ozark-Mahoning data set indicate that in 1977, the mine was stope mining on the 300-, 450-, and 600-foot working levels. Both bedding replacement and vein ore were present in this mine. The vein ore was found at the base of the Bethel and extended down to the 600-foot level. Ozark-Mahoning data indicate that fluorspar was present between the Spivey and Hoeb Mines, but the data are insufficient to determine whether the ore was mined.

Lusk Creek Subdistrict

The mines and prospects of the Lusk Creek Subdistrict are aligned along the Lusk Creek Fault Zone, which generally marks the northwestern margin of the IKFD (Figure 27). Arranged in a line more than 4 miles long, all these mines and prospects share a common structural setting. The fault zone is 500 to 1,000 feet wide, is nearly linear, and has an overall trend of $\text{N}35^\circ\text{E}$. Parallel high-angle, southeast-dipping reverse and normal faults compose the fault zone. These faults delimit central slices of Mississippian rocks that are older than the rocks on either side of the fault zone. Two episodes of faulting are thereby indicated. First, compressional stresses induced reverse faulting that raised the southeastern block. Relaxation and extension then induced normal faulting that lowered the southeastern block below its original position, creating the Dixon Springs Graben (Weller 1943c; Nelson et al. 1991). Most of the mineralization took place along the reverse fault on the northwest side of the zone.

The most detailed information on mines in the Lusk Creek Subdistrict comes from a series of unpublished reports authored by J.M. Weller to characterize mineral

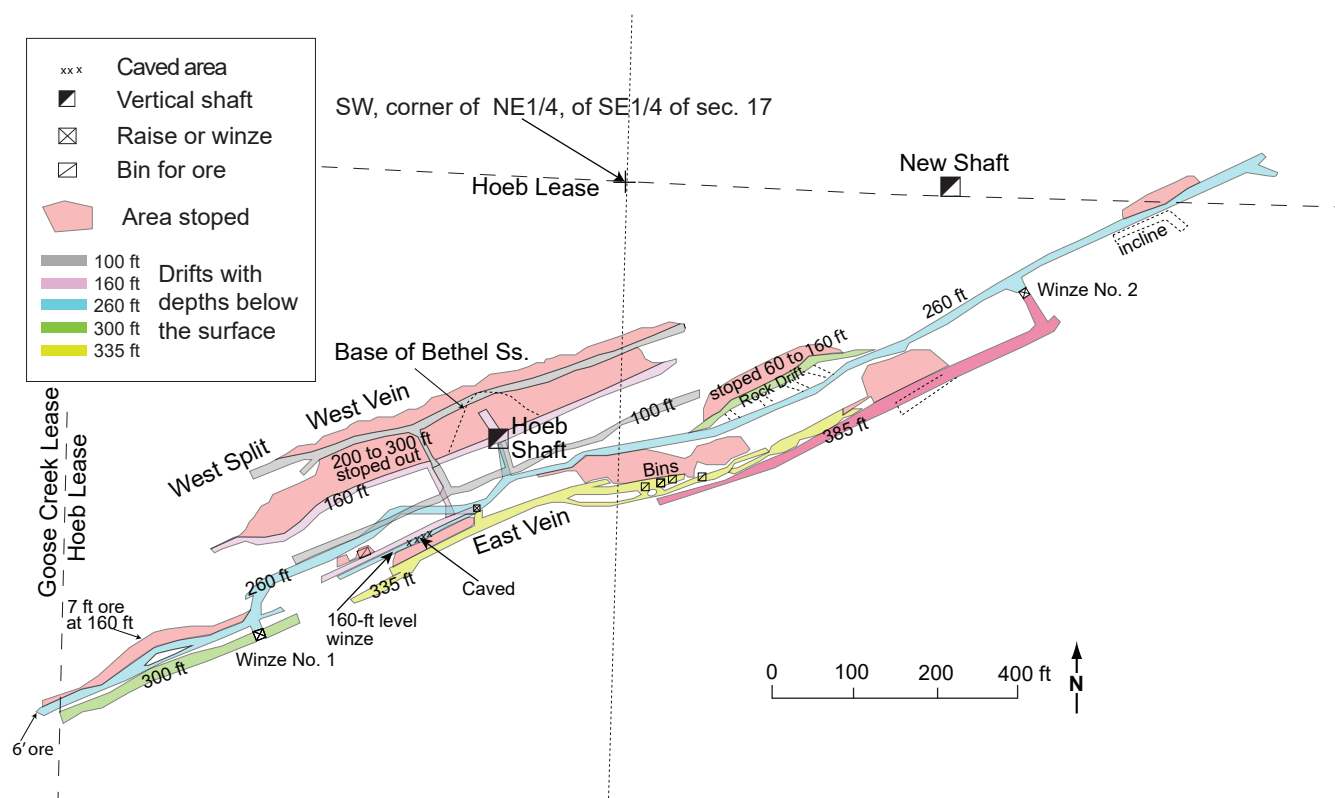


Figure 26 Plan map of the Hoeb Mine, circa 1963. Data from unpublished Ozark-Mahoning scanned documents. Drawing by Walter Gammeter in 1958. Updated by L.B.G. in 1963.

deposits during World War II. Written while several of the mines were active, these reports include large-scale geologic maps surveyed by pace and compass.

Rock Candy Mountain, Moore, DeSautels, Tripod, and Williams Mines

The Rock Candy Mountain Mine (Figure 27) was situated along the Herod Fault Zone close to its juncture with the Lusk Creek and Shawneetown Fault Zones. The name undoubtedly refers to the song “Big Rock Candy Mountain,” first recorded by Harry McClintock in 1928, which describes a hobo’s paradise “where the boxcars all are empty, and the sun shines every day.” Weller (1944a) conducted a detailed survey of the Rock Candy property while the mine was operational. Weller reported that a shaft was sunk in 1901 but was abandoned shortly thereafter. A Mr. McGowan reopened the shaft in 1932 and shipped about 100 tons of ore, but it was unmarketable because of the high silica content. The Big Creek Mining Company sank a new shaft in 1942 and shipped about 6,000 tons of ore over 2

years. The company’s operations continued through 1947 (Davis 1943, 1945, 1949; Davis and Greenspoon 1946, 1948).

The pace-and-compass map of Weller (1944a), at a scale of 1:2,400, located the Rock Candy Mountain Mine shaft 800 feet from the south line and 1,780 feet from the west line of sec. 25, T 11 S, R 6 E in Pope County. This location differs from that shown on the published geologic maps of Baxter et al. (1967) and Denny et al. (2008b). Because Weller surveyed for the map while the mine was active, we must consider his map and geologic interpretation more accurate than later renditions. However, additional excavations may have been made after Weller’s report in 1944. The vein at Rock Candy Mountain lies amid a series of narrow northeast-striking fault slices of Upper Mississippian limestone and shale and Lower Pennsylvanian shale and sandstone. The main workings of the 1940s consisted of a shaft that connected to a series of drifts and winzes. These accessed a vein striking northeast and dipping steeply southeast, with silicified

sandstone in both walls. The vein ranged from zero to 21 feet wide, pinching out into brecciated sandstone. Veins of clear to purple fluorite contained clasts of sandstone, hence the high silica content.

In 1982, John Nelson and Donald K. Lumm of the ISGS inspected an open pit at the mine site. The shaft had been backfilled and all structures had been removed. In the open pit, a fault surface striking N45°E and dipping nearly vertical was well exposed, as were several subparallel fluorspar veins a few inches wide. The fault bore prominent near-vertical slickensides and mullion together with sandstone breccia. Several additional shafts and pits were opened, but these proved unproductive. In addition to the Rock Candy Mountain Mine, the Big Creek Mining Company sank several shafts nearby during the early 1940s. All except Moore proved unproductive.

DeSautels Shaft. The DeSautels Shaft was located 1,490 feet from the south line and 2,300 feet from the west line in sec. 25, T 11 S, R 6 E. The shaft was reported

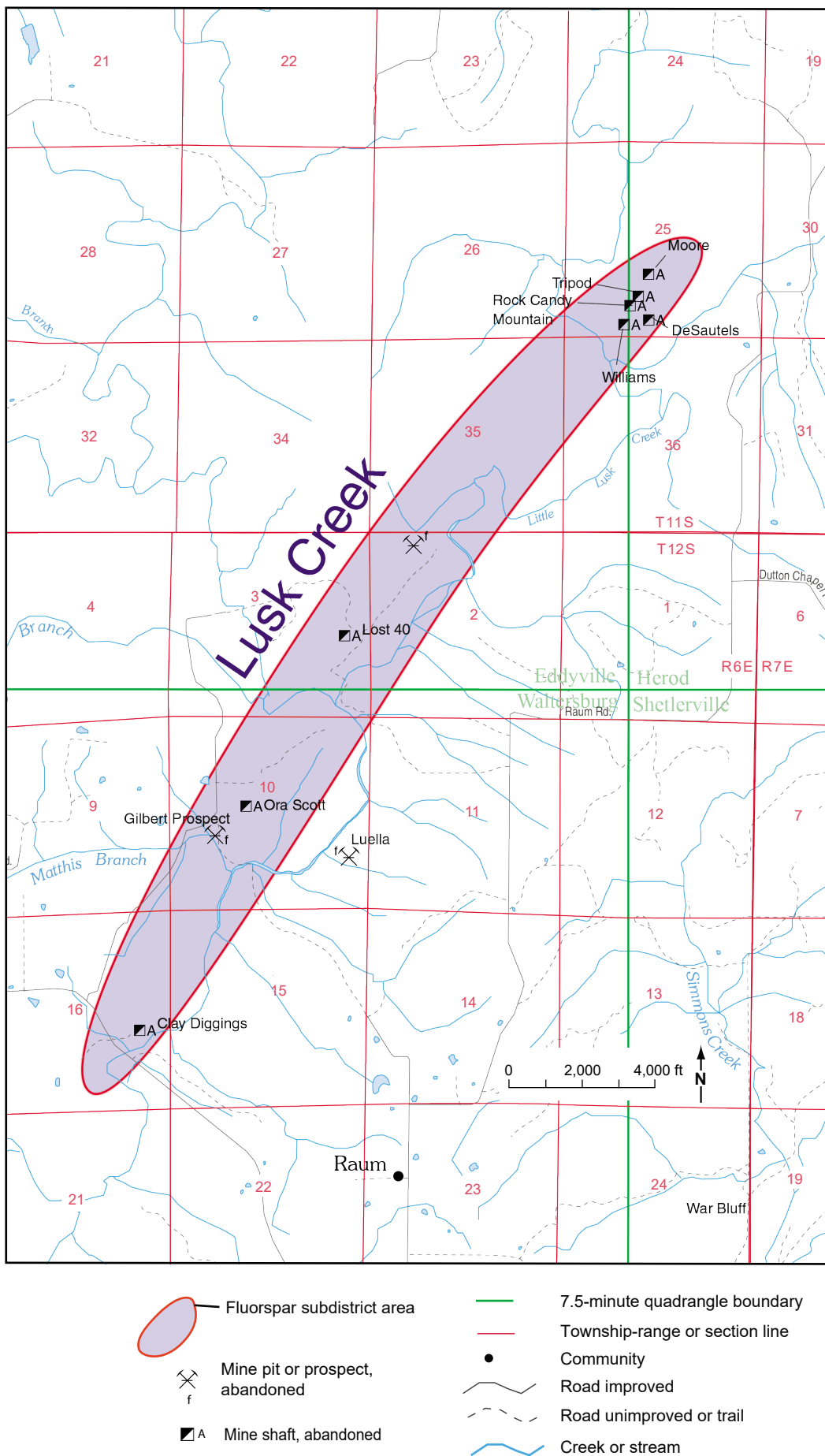


Figure 27 Mines of the Lusk Creek Subdistrict.

to be 100 feet deep and encountered no significant mineralization. It is approximately 850 feet northeast of the Rock Candy Mountain Shaft at the junction between the northeast-striking Lusk Creek and north-trending Shawneetown Fault Zones.

Moore Shaft. The Moore Shaft was located 200 feet due north of DeSautels, 1,690 feet from the south line, and 2,300 feet from the west line in sec. 25, T 11 S, R 6 E. The shaft entered a vein striking slightly east of north and dipping steeply east. Weller stated, "Several tons of spar were raised and sold," and operations were continuing when he completed his report.

Tripod Shaft. The Tripod Shaft was located about 375 feet northeast of Rock Candy Mountain, 1,080 feet from the south line, and 2,020 feet from the west line in sec. 25, T 11 S, R 6 E. A vein of fluor-spar 6 inches wide was encountered at a depth of 40 feet, and apparently no production ensued.

Williams Shaft. The Williams Shaft was located about 450 feet southwest of Rock Candy Mountain, 400 feet from the south line, and 1,570 feet from the west line in sec. 25, T 11 S, R 6 E. Weller (1944b) stated, "At the 75-foot level a drift was started southeast and driven for 20 feet, at which place a large flow of water was encountered, and the shaft rapidly filled nearly to the level of the collar."

Lost 40 Mine

Although a shaft was reported to have been sunk circa 1900, the main development of the Lost 40 Mine took place between 1940 and 1944. The Crown Fluorspar Corporation was the operator (Davis and Greenspoon 1946). Weller (1943c) completed a pace-and-compass survey of the property and made observations underground. Normal and reverse faults striking northeast and dipping steeply southeast outlined a slice approximately 500 feet wide in which upper Chesterian strata, including the Kinkaid Limestone, were faulted against Pennsylvanian rocks on either side. These observations infer reverse faulting that raised the southeastern block, followed by normal faulting that lowered the southeastern block. Mine workings comprised

several open pits together with a shaft 130 feet deep and a series of drifts and cross-cuts off the shaft. Above the 80-foot level, the vein varied from 3 to 10 feet wide and was composed predominantly of fluor-spar. At greater depth, the vein pinched and swelled, reaching a width of 8 feet in places, although mud impeded Weller's observations. The dip of the vein varied from 38° (unusually low for the district) to 73°.

Weller regarded the complex structure and abrupt termination of veins against faults as the primary obstacles to development. Poor road access was another issue. Evidently because of declining fluorite prices at the end of World War II, the Lost 40 was abandoned. Nelson and Lumm (1990) located the Lost 40 Mine during quadrangle mapping (Nelson et al. 1991, p. 60) and interpreted its structure in a cross section.

Ora Scott Mine

The Ora Scott Mine was located 1 mile southwest of the Lost 40 Mine (SE¼ NW¼, sec. 10, T 12 S, R 6 E), and its structural setting was closely similar. Weller (1943d) carried out a pace-and-compass survey of the property, but underground workings were inaccessible and much of his information on them was second-hand. Weller reported that the site was first worked 40 to 50 years earlier (circa 1900) and that subsequently, operations continued sporadically under different owners. The Luella and McClellan Mines that Bain (1905) discussed are in this general area. From compiling various reports, Weller stated that "probably in excess of 1,000 tons of fluorspar" had been shipped. Two shallow shafts, two adits, and numerous prospect pits were observed when Weller inspected the site. As at the Lost 40, the Ora Scott Mine lay within a fault slice 500 to 700 feet wide in which upthrown Kinkaid Limestone and older Chesterian units were faulted against Pennsylvanian rocks on either side. Observed faults trended N 20°–40° E and dipped 65°–80° SE. The lack of continuity of orebodies and poor road access hampered development.

Gilbert Prospects

Lucy and Raymond Gilbert opened several prospect pits along the Lusk Creek Fault Zone between the Ora Scott and

Clay Diggings Mines (Figure 27) without finding significant mineralization. Weller (1943e) prepared a pace-and-compass geologic map of the property and assessed its structure and mineral potential. He observed little beyond outcrops of shattered and silicified sandstone indicating the proximity of faults.

Clay Diggings Mine

Located on the northwest side of Lusk Creek just northeast of the Eddyville-Golconda blacktop, the Clay Diggings Mine took its name from vein deposits of halloysite clay that were mined as early as the 1860s (Engelmann 1866; Purdy and DeWolf 1907; Lamar 1942). Bain (1905) referred to this as the Pittsburg Mine. Weller (1944c) mapped the geology of the area by pace and compass. In addition to halloysite, this site yielded vein deposits of fluorite, sphalerite, and galena; limestone was also quarried. Bain (1905) and Weller (1944c) reported that the main halloysite deposit was a vein as wide as 8 feet along the reverse fault that bounds the northwest side of the fault zone. Excavations along this fault can still be viewed today. This fault is marked by deep red gossan, which is unusual for the IKFD.

Bain (1905) reported that the Pittsburg Mining Company had sunk two shafts and driven a drift and was erecting a mill to concentrate the ore. No definite records of later fluorspar mining have been found. During the 1930s, the Works Progress Administration operated a limestone quarry, and the quarry wall still affords good exposures.

Clay Diggings exemplifies two episodes of faulting along the Lusk Creek Fault Zone. Two parallel faults approximately 300 feet apart outline a central block of Ste. Genevieve or St. Louis Limestone. These rocks are in fault contact with the upper Chesterian Degonia Sandstone, Clore, Palestine, and Menard Formations on the northwest and the Middle Pennsylvanian Tradewater Formation on the southeast. As Weller (1943c) deduced, the northwestern fault is reverse and the southeastern one is normal. Reverse faulting that raised the southeastern block was followed by normal faulting that dropped the southeastern block below its original position.

Hicks Dome

The dominant structural feature of the Illinois portion of the IKFD is Hicks Dome, an elliptical to nearly circular uplift approximately 10 miles in diameter in western Hardin County and north-eastern Pope County. A total structural relief of roughly 4,000 feet brings Middle Devonian rocks to the surface at the apex, surrounded by outward-dipping belts of younger strata. Igneous diatremes are scattered throughout the region, and nearly vertical dike-like intrusive breccia bodies radiate from the center of Hicks Dome (Baxter et al. 1967). Most geologists concur with Bradbury and Baxter (1992) that the dome is the product of large-scale igneous intrusion and brecciation at depth.

In the 1970s, mineral exploration for fluor spar, beryllium, thorium, and rare earth elements was conducted through a cost-sharing agreement between the USGS Office of Mineral Exploration and a private entity operated by John Lee Carroll named the Hicks Dome Account (Office of Mineral Exploration docket no. 6873). The geologist in charge of the Hicks Dome project for Carroll was Joe Porter. Several test holes drilled near the crest of Hicks Dome disclosed significant mineralization in the Ordovician strata over a thickness of more than 2,000 feet. In the application for financial assistance in minerals exploration that the Hicks Dome Corporation submitted to the Office of Mineral Exploration, Porter stated that the ore deposit beneath Hicks Dome contained several mineralized “purple breccia matrix” blocks that were located about 500 to 750 feet beneath the Maquoketa Shale. Porter stated that the purple breccia is in the anticipated position of the Ordovician Plattin Limestone and that it probably extends into the underlying Joachim Dolomite. The deepest exploration hole was more than 2,500 feet and the shallowest was 2,200 feet. The Pankey No. 2 hole was drilled to 2,485 feet, and the core was composed of breccia cemented by white calcite, with sparse fluorite in the upper portion, but fluorite averaged between 2% and 8% from 2,000 to 2,240 feet. Hamp No. 3 was composed of brecciated limestone or “crackled” limestone cemented by 4-millimeter-thick bands of purple fluorite and calcite, with the percentage of fluorite increasing at 2,000 feet. The core samples also

contained anomalous concentrations of rare earth elements, thorium, and beryllium. Geologists working on the deposit designated the breccia as either complex breccia or host breccia. Complex breccia is generally a fragment-supported heterolithic breccia with little to no rock flour matrix. Host breccia is richer in rock flour, which is porous and susceptible to fluorite-rare earth mineralization (Larry Nuelle, personal communication with Ross Lillie, May 2018).

Staatz et al. (1979) postulated that a large potential reserve of thorium (ThO_2) was present at Hicks Dome, although their findings are highly speculative. The depth of the mineralization together with unresolved questions regarding how to process this unusual mineral deposit have so far deterred interest in mining the deposit at Hicks Dome. Other mines and prospects in the area of Hicks Dome are described below.

Lacey Prospect

Located southwest of Hicks Dome, this prospect comprises several surface pits that follow veins striking $\text{N}40^\circ\text{--}47^\circ\text{E}$ (Weller et al. 1952). Development work by the Big Creek Fluorspar Company and A.B. Mann was ongoing here in 1939 (Davis and Trought 1940). Shafts 24 to 154 feet deep were driven to a vein that averaged 4 feet wide, but no commercial production is on record (Weller et al. 1952). Denny et al. (2017) reported the geochemical analysis of a sample composed of a mixture of calcite and fluorite collected from the mine dump in this area. Results were inconclusive because of poor fluorine results along with total weight percentage calculations of 68%. However, slightly elevated values of copper and rare earth elements were suggested.

Rose Mine

The Rose Mine, located east of the apex of Hicks Dome, produced gravel spar and some bedding replacement ore. It was operated by W.M. Rohrer (Weller et al. 1952) and may have been owned by D.C. Peyton before 1917 (Pogue 1918). This mine, which was abandoned before 1931, consisted of two pits no more than 20 feet deep and a shaft no more than 100 feet deep (Bastin 1931). A small steam shovel dug the pits to extract gravel spar (Bastin

1931). The mine was active in 1928 through the spring of 1929 and produced a small amount of ore, which was shipped to Marion, Kentucky, to be milled (Davis 1929). In 1969 and 1970, the Industrial Minerals Company excavated additional pits and recovered approximately 436 tons of ore grading 53% CaF_2 . Evidence of bedding replacement ore is present in the tailings at this site in Devonian limestone. In 1982, Ross Lillie examined the tailings of the Rose Mine. Numerous fluor spar fragments were collected and easily cleaved into octahedrons, a property commonly associated with replacement deposits. Lillie surmised that the fluor spar, although colorless, appeared greenish because of copious inclusions of chalcopyrite.

Outlying Areas

The following mines and prospects were isolated from the larger subdistricts discussed above and are grouped by general areas. Most produced only small amounts of ore, although a number of these outlying ore deposits were rich in barite.

Tower Rock Area

Alco Mine or Patrick Mine. The Alco Mine, also known as the Patrick Mine, was operated by the Alco Lead Company and was located about 3 miles west of Cave-in-Rock. The primary mineral extracted was galena, but a small quantity of fluorite was also recovered (Weller et al. 1952). The main pit was approximately 30 feet deep and trended for approximately 500 feet in a $\text{N}45^\circ\text{--}50^\circ\text{W}$ direction (Seid et al. 2013a). Northeasterly fractures in the sidewall of the pit are lined with calcite and a small amount of purple fluorite. The pit was less than 30 feet deep and about 70 feet wide according to Ozark-Mahoning file information. The gravel and residuum in the pit are very cherty and moderately high in iron oxides. The mine lies along a small northwest-trending fracture in the St. Louis Limestone (Seid et al. 2013a). Pinckney (1976) reported that the replacement ore at this site was predominantly galena and cerussite, with a little fluorite or zinc. Ozark-Mahoning files indicate that a smaller pit, called the Frailey Workings, was present about 1,500 feet southeast of the Patrick Mine (Figure 28). Several prospect pits were aligned in a northwest trend at

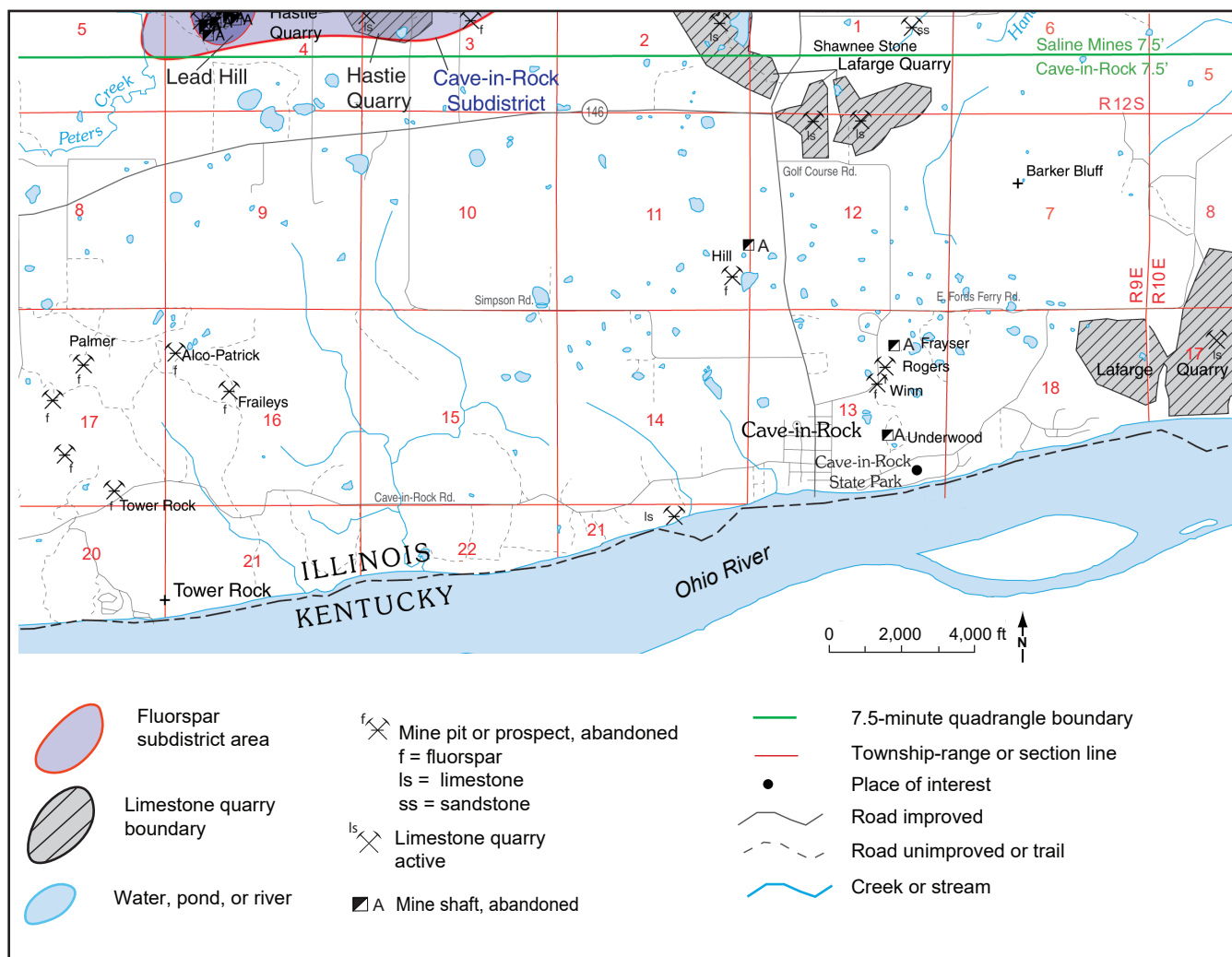


Figure 28 Outlying mines and pits south of the Cave-in-Rock Subdistrict and near the village of Cave-in-Rock.

the Frailey Workings. Several other pits located in this area were found to contain small amounts of fluorspar, galena, or both. Ozark-Mahoning files contain a map and nine-page report describing additional details of these exploration pits. This report indicated that mining in this area began around 1920. A *Hardin County Independent* (1934) newspaper article from 1934 stated that a dragline was being used at this mine and had uncovered a vein of “almost pure” galena (p. 1). The article also indicated that more than 1,000 pounds of galena was recovered on the afternoon of September 28.

Palmer Mine. The Alco Lead Company mined a small amount of galena at the Palmer Mine, but fluorspar was apparently lacking (Weller et al. 1952). Work-

ings consisted of an open pit about 200 feet long and 100 feet wide and a shaft 40 feet deep. Ozark-Mahoning files indicate that a shaft was sunk in 1942 and that several east-west-trending shallow test pits were dug along the north edge of the property (Weller et al. 1952). Old dumps in this area show very little mineralization (Figure 28).

Tower Rock Mine. Jones and Ginn operated the Tower Rock Mine, also known as the Iron Hill Mine. A small amount of fluorspar was extracted from thin veins in a silicified fault zone (Weller et al. 1952).

Hill Mine. Bryan and Wallace operated the Hill Mine, which extended about 700 feet along a N 55°–60° E fault zone. The average width of the vein was

about 2 feet, and the depths of the shafts were between 12 and 60 feet (Weller et al. 1952). Mineralization was bedding replacement ore that was predominantly fluorspar with moderate amounts of barite along two working levels within the Ste. Genevieve Limestone (Weller et al. 1952).

Winn, Underwood, Rogers, and Frayser Mines. The Winn, Underwood, Rogers, and Frayser Mines were located just northeast of Cave-in-Rock along a northeast-trending fault with minor displacement (Seid et al. 2013a). Most of the shafts were shallow (less than 45 feet deep), but the Frayser Shaft extended 110 feet below the surface (Weller et al. 1952). The ore was gravel spar, which resulted from the weathering of fluorspar within

the Ste. Genevieve Limestone (Seid et al. 2013a). Weller et al. (1952) surmised that the Rogers Mine was an extension of the Winn orebody.

Karbers Ridge Subdistrict

Lee Mine. The Lee Mine is one of several small mines clustered about 2 miles east of Karbers Ridge, between the Harris Creek and Hamp Subdistricts. A.B. Thomas opened this mine in 1917 to work a vein of fluorspar 8 feet wide (Bishop 1947b). The Lee Development Company next worked the deposit and recovered 5,000 to 8,000 tons before closing the mine in 1919 (Bishop 1947b). Around 1922, the Illinois Steel Company optioned the Lee property and drilled about 12 boreholes. Information in the *Hardin County Independent* (1927a) newspaper stated that “Capt. Thomas is preparing to haul his spar from the Lee Mines to the railroad at Eichorn; he will also install some new machinery to his mines shortly” (p. 4). The Lee Mine ore was trucked to Eichorn, offloaded onto trucks, and then hauled to the railroad connection at the Stewart Mine (*Hardin County Independent* 1927b, p. 3). Finally, the Hillside Fluorspar Mines Company purchased the property in 1935 and produced about 8,250 tons of concentrate from March 1936 through 1938. The ore was reported to be mainly fluorite and calcite (Bishop 1947b), but some galena has been found.

Several shafts and an open cut mark the Lee Mine site (sec. 14, T11S, R8E). The vein follows a normal fault that strikes N60°E and dips 75°SE, with the southeast side downthrown about 450 feet (Bishop 1947b). The vein was reported to be about 3.5 to 10 feet wide and was traced downward from 20 to 150 feet deep (Bastin 1931; Bishop 1947b; Weller et al. 1952). Bishop (1947b) indicated that the ore northeast of the main shaft was mined along strike for 250 feet from the ground surface to a depth of 125 feet. The ore extending to the southwest of the main shaft was mined for 415 feet along strike. A concrete pad along the top of the hill may be the location of the former mill, which was reported to contain a roller crusher, jig, and log washer (Denny et al. 2010). Between October 1944 and June 1945, the USGS drilled five boreholes to about 300 to 355 feet below the surface to test the Ste. Genevieve Limestone Level

on the Lee Vein. They encountered veinlets and stringers of calcite in the boreholes but detected no mineral deposits of any consequence (Bishop 1947b).

S. Love and J. Love Prospects. Two open pits 30 to 50 feet deep along a fault splay of the Lee Fault are listed as the Love Fluorspar and Lead Mines (Denny et al. 2010). These mines were operated by McAllister and Phelps (Weller et al. 1952). The mineralized fault trends N45°E (Weller et al. 1952). The J. Love Prospect is located northeast of the S. Love Prospect, and the S. Love reported a minor amount of production (Weller et al. 1952).

Jarrells Prospect. The Jarrells Fluorspar Prospect operated by S. Love was located along the Wolrab Mill Fault Zone, which trends N27°E (Weller et al. 1952). A 60-foot-deep shaft was sunk, and traces of fluorspar and sphalerite were observed on the mine dumps (Weller et al. 1952).

Hall Zinc Prospect. Obrad (2005) based this mine on Wallace Lee’s 1915 Hardin County mine location field notes. These notes are now on file at the IGS.

Renfro Prospect. Hastie and Barnett worked the Renfro Prospect. The prospect was less than 22 feet deep, and only minor mineralization was reported (Weller et al. 1952).

Joyce Mine. Thurmond and Gibbons sank a shaft 48 feet deep and extracted a small amount of fluorspar at this location (Weller et al. 1952). The vein averaged about 6 feet wide and was predominantly calcite. It was aligned N70°E and dipped to the southeast (Weller et al. 1952).

Turner Mine. Thurmond and Gibbons opened the Turner Mine northwest of the Joyce Prospect. The shaft was sunk 40 feet to a vein that was aligned N45°–55°E. Gravel spar and a small amount of galena were produced (Weller et al. 1952).

Ridge Mine. The Ridge Mine lies about 1 mile west of the Lee Mine along a small northeast-striking fault that is parallel to the Lee Fault. The shaft has been sealed with a concrete cap, and a small open cut is north of the shaft. The geologic maps of Baxter and Desborough (1965) and Denny et al. (2010) indicate that the collar of the shaft was sunk in the upper portion of the Cypress Sandstone. Ozark-Mahoning maps indicate that the operators of the Ridge Mine drove drifts at the

60-, 100-, and 130-foot levels along a vein striking N30°E and dipping 70°–75°SE. The thickness of the fluorspar ranged from a few inches to about 8 feet wide. Stopes were approximately 35 feet high, and the mine extended 550 feet north of the shaft along the 100-foot level and 200 feet south of the shaft along the 60- and 100-foot levels. No production figures or operational details are available, but the mine was active in 1967 (Bradbury et al. 1968).

Eichorn Area

Cobb and Cook Mines. The Cobb and Cook Mines lie on the southern flank of Hicks Dome between the Stewart and Interstate Subdistricts. Information is meager, and the Cook and Cobb may be the same mine. Weller et al. (1952) reported that the Cook Mine was mostly old workings but that a small amount of ore was produced before World War II and some exploration was conducted in 1942. The Crown Fluorspar Corporation operated the Cook Mine, which produced gravel spar that was aligned N25°E (Weller et al. 1952).

McClusky Prospect. The McClusky Prospect was located along the Wolrab Mill Fault Zone about 1.3 miles northeast of the Cobb and Cook Mines. Saylor, Gibbs, and Frits dug several pits 40 to 65 feet deep and encountered only thin stringers of fluorspar (Weller et al. 1952). They produced mainly gravel spar from thin veins striking northeast.

Southern Pope County

The Grand Pierre Lead and Zinc Smelting Company maintained an office in Golconda around 1902 and may have operated some of the mines in southern Pope County (Questions and Answers 1902). The company is reported to have worked the area in the southern part of the Stewart District and the Parkinson Mine.

Lake Glendale Prospect. The Lake Glendale Prospect is located south of Lake Glendale and about 1.2 miles north of Dixon Springs in sec. 9, T13S, R5E, Pope County (Figure 29). Several prospect pits appear to follow a vein that strikes N40°–45°E. Traces of fluorite and barite have been reported, but no production seems to have taken place (Weller et al. 1952; Bradbury 1959). The Lake Glendale

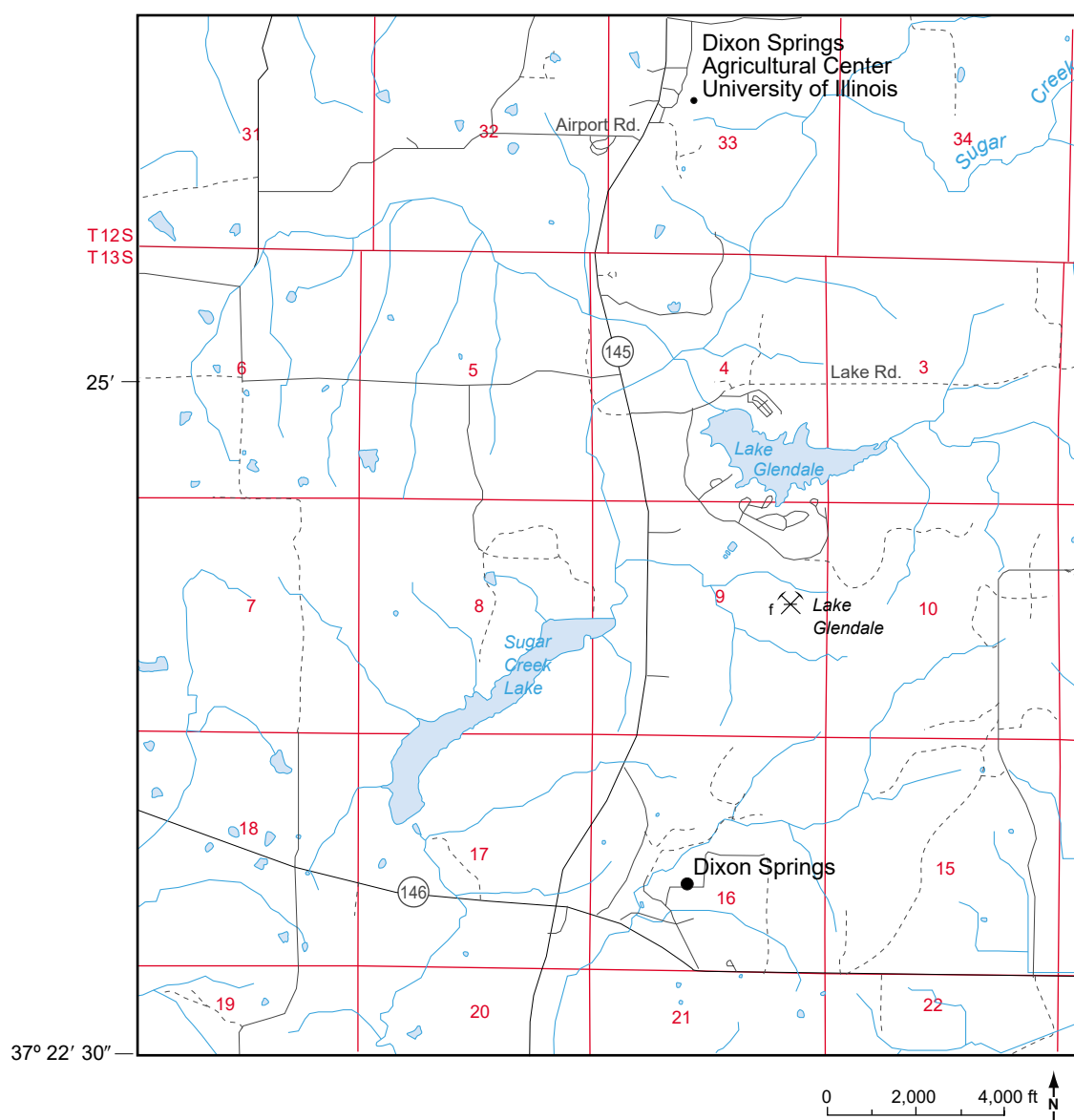


Figure 29 Location of the Lake Glendale prospect.

Prospect is situated along segments of the Lusk Creek Fault Zone. Core drilling and outcrop mapping disclosed Levias, Ste. Genevieve, and St. Louis Limestones occupying a fault slice juxtaposed with Pennsylvanian rocks on the southeast and middle Chesterian formations on the northwest. Numerous shallow prospect pits that had opened before 1944 showed small amounts of barite and fluorite in oolitic limestone adjacent to the northwest-bounding fault (Tippie 1944a; Devera 1991). Tippie (1944a) concluded that mineralization was sparse and largely confined to near-surface weathering of veins. The structural setting is thus

similar to mines and prospects along the Lusk Creek Fault Zone farther northeast in Pope County.

Little Jean Mine. The Little Jean Mine is located just south of Golconda at the base of the east-facing bluff along the Ohio River. This is one of the few mines in Illinois that principally produced barite, albeit in small quantities. Between 1918 and 1922, James Wardrop mined barite and small amounts of fluorite from a vein 1.5 feet wide oriented N70°W (Weller et al. 1952). Bradbury (1959) reported that the mine had two shafts about 150 feet apart and 60 to 80 feet deep, from

which drifts followed barite veins for short distances. The Little Jean Mine lies on or near a fault that strikes nearly east-west and is part of a larger fracture zone oriented about N70°E that has been mapped on both sides of the Ohio River. The Bethel Sandstone has been mapped at the surface, and the Paoli Limestone lies at a shallow depth at the Little Jean site (Amos 1966).

Compton (Bay City) and Mary Mines. The Compton Mine, or Bay City Mine, is located on a small hill at the edge of the Ohio River floodplain near the mouth of Bay Creek (SW¼, sec. 26, T13S, R5E).

Weller et al. (1952) detailed that the mine was owned by the Illinois Fluorspar and Lead Company and that shafts were sunk from 60 to 300 feet deep along a vein striking N45°E and dipping 60°SE. Tom Compton sank the “Tom Shaft” shortly after 1900 and mined a little fluorspar and galena at a depth of 60 to 70 feet (Tippie 1944b). In 1904, an individual named Kerr from Pittsburgh, Pennsylvania, deepened the shaft to 110 feet and sank a new, deeper shaft, named the Kerr Shaft, on the hill 90 feet west of the Tom Shaft. Mr. Kerr ran drifts northeast on the 196-foot level and encountered 8 feet of spar along a fault, which was stoped 40 feet long × 25 feet high (Tippie 1944b). He operated the mine and mill intermittently until about 1930. In 1938, the old shaft was retimbered and the drifts were reopened (Davis 1938). The Illinois Fluorspar and Lead Company sank a new 125-foot shaft, called the John Shaft, at the foot of the hill 60 feet southeast of the Tom Shaft (Tippie 1944b). In 1939, the company drove a crosscut on the 63-foot level to the Tom Shaft, drove another drift on the 110-foot level, and drove another crosscut 25 feet to the fault. Very little ore was encountered in drifts on the 77- and 125-foot levels of the John Shaft, but a small amount was recovered in sandstone on the 40-foot level (Tippie 1944b). Tippie (1944b) reported that 200 tons of bedded ore was recovered on the 63-foot level. The last known operator was S.N. Edelman, who worked the mine briefly in 1944 (Tippie 1944b). Ozark-Mahoning files contain a map of the area by F.E. Tippie, constructed in 1956, that indicated three shafts in a general west-to-east orientation: the Kerr Shaft, the Tom Shaft, and the John Shaft (Figure 30). These mines are depicted collectively as the Compton Mine on the accompanying map.

The Compton Mine lies along the northwest margin of a fault zone that strikes N60°E and displaces middle and lower Chesterian rocks at the surface (Nelson and Denny 2008). Sandstone (probably Tar Springs or Palestine) was in the hanging wall (downthrown), whereas Paoli Limestone was in the footwall. The mineralized high-angle normal fault bounds the northwest side of a graben that is 500 to 1,000 feet wide.

The Compton Mining & Milling Company began erecting a mill of the Joplin type at their Mary Mine to separate fluorspar, lead, and quartzite (Fohs 1907). The Mary Mine was located southwest of Golconda, but the precise location has not been verified. Information in a mining journal detailed that drifts in the Mary Mine encountered an overthrust fault pitching 35° that had 3 to 8 feet of fluorspar, galena, and quartz, which was stoped while driving to intersect the master fault (Ingalls 1907).

Black Mine. The Black Mine is located in sec. 26, T14S, R6E near Bay City. It sits on a low hill rising about 25 feet above the Ohio River bottom land and is cut off from the main bluff (Bain 1905). This mine was not field verified but may be located along faults that project northeasterly with the Wallace Branch and Interstate Fault Zones.

Southeastern Saline County

Gibbons Mine. This operation was located southeast of Wamble Mountain (Figure 31) east of Illinois Route 34 near the southern border of Saline County. Dates of activity and whether production was achieved are uncertain. This mine is possibly the same as the Big Four Mine discussed by Bain (1905). Weller et al. (1952) listed Gibbons or Gibbons and Cantrell on a table and remarked, “Shallow prospect workings along fault disclosed no fluorspar, galena, or sphalerite” (p. 134). The pits align with a small fault trending N40°E and having the upper Chesterian Palestine Formation on both sides (Denny et al. 2008a).

King or King and Ferguson Prospects.

These prospects were located due east of Rudement along the Shawneetown Fault Zone (Figure 31) in the SW¼ SW¼ NW¼, sec. 21, T10S, R7E. Bain (1905) reported that the King and Ferguson Mine had three shafts along a fault zone striking nearly north-south. Barite, fluorite, and pyrite were present, along with minor galena and very little calcite. According to Weller et al. (1952), at an unspecified later date, the A.B.C. Mining Company opened a group of pits or trenches aligned N10°E along the fault zone, exposing “sheared remnants of fluorspar veins” (p. 134).

Illinois Coal Reports indicated that the A.B.C. Mining Company reported pro-

duction from 1946 through 1949 and during those years produced approximately 3,500 tons of fluorspar (Davis and Greenspoon 1948; Davis 1949, 1950, 1951). Nelson and Lumm (1986) observed flooded pits at the site and mapped a north-trending fault slice of Chesterian strata juxtaposed with the Lower Pennsylvanian Caseyville Formation on both sides.

This operation and the Silver Mine 40 (below) contain the only known economic mineralization associated with the Shawneetown Fault Zone in Illinois. Barite has been mined on a small scale along its eastern extension, the Rough Creek Fault System in Union County, Kentucky (Anderson et al. 1982).

Silver Mine 40. *Springhouse Magazine* owner Brian DeNeal brought this site to the attention of the authors in 2018. Several *Harrisburg Daily Register* newspaper stories reported the location of this mine, which was owned by George J. Hittinger from Pennsylvania (Brian DeNeal, personal communication with Brett Denny, November 2018). Local sources reported that the ore was unprofitable because it brought only \$18 per ton (Aaron 1947). Brian DeNeal provided the authors with a clipping from November 3, 1878, from the *Daily Bulletin* newspaper in Cairo, Illinois, indicating that the shaft was 10 × 12 feet and 77 feet deep. The article, written by George Hittinger, also indicated that at 60 feet, a drift was turned to the southwest and extended for 32 feet, where another drift was dug 40 feet east. This drift was reported to have encountered mineralization that was 12 feet wide. The article stated that the Shawnee Silver Mining Company was incorporated in Illinois and had issued \$250,000 of capital stock, with \$90,000 reserved as working capital stock. Hittinger stated that the rock or ore contained “lead, silver, antimony, tin, cadmium, copper, etc. and assays \$80 to \$100 of rough ore” (n.p.). The article by Hittinger was a solicitation to potential investors; as such, the veracity of the value of the ore is questionable. However, the dates the mine was in operation, the orientation, and the dimensions of the workings provide corroborating evidence to document the mine.

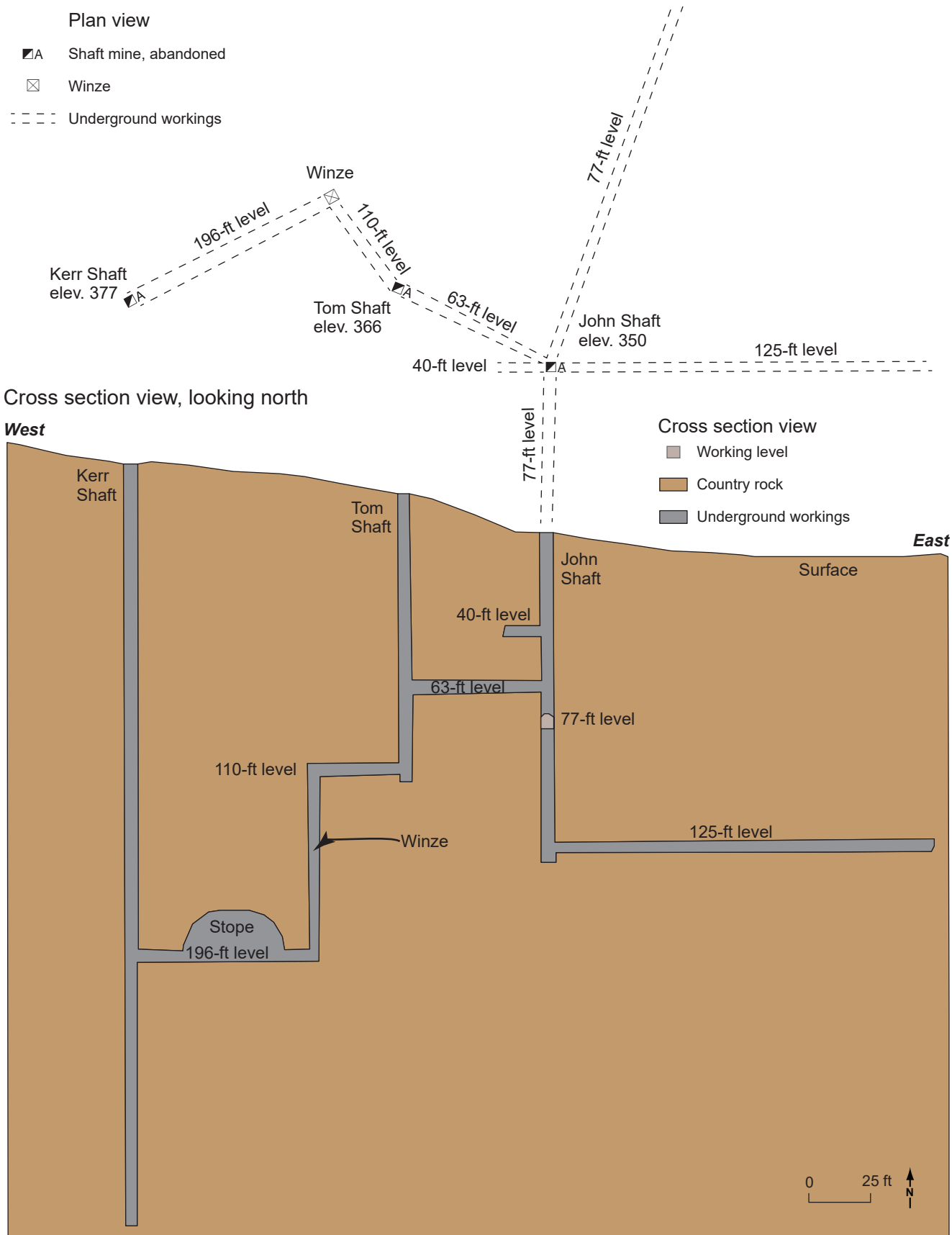


Figure 30 Plan view of the orientation of drifts and shafts at the Compton Mine site. Modified from Tippie (1944b).

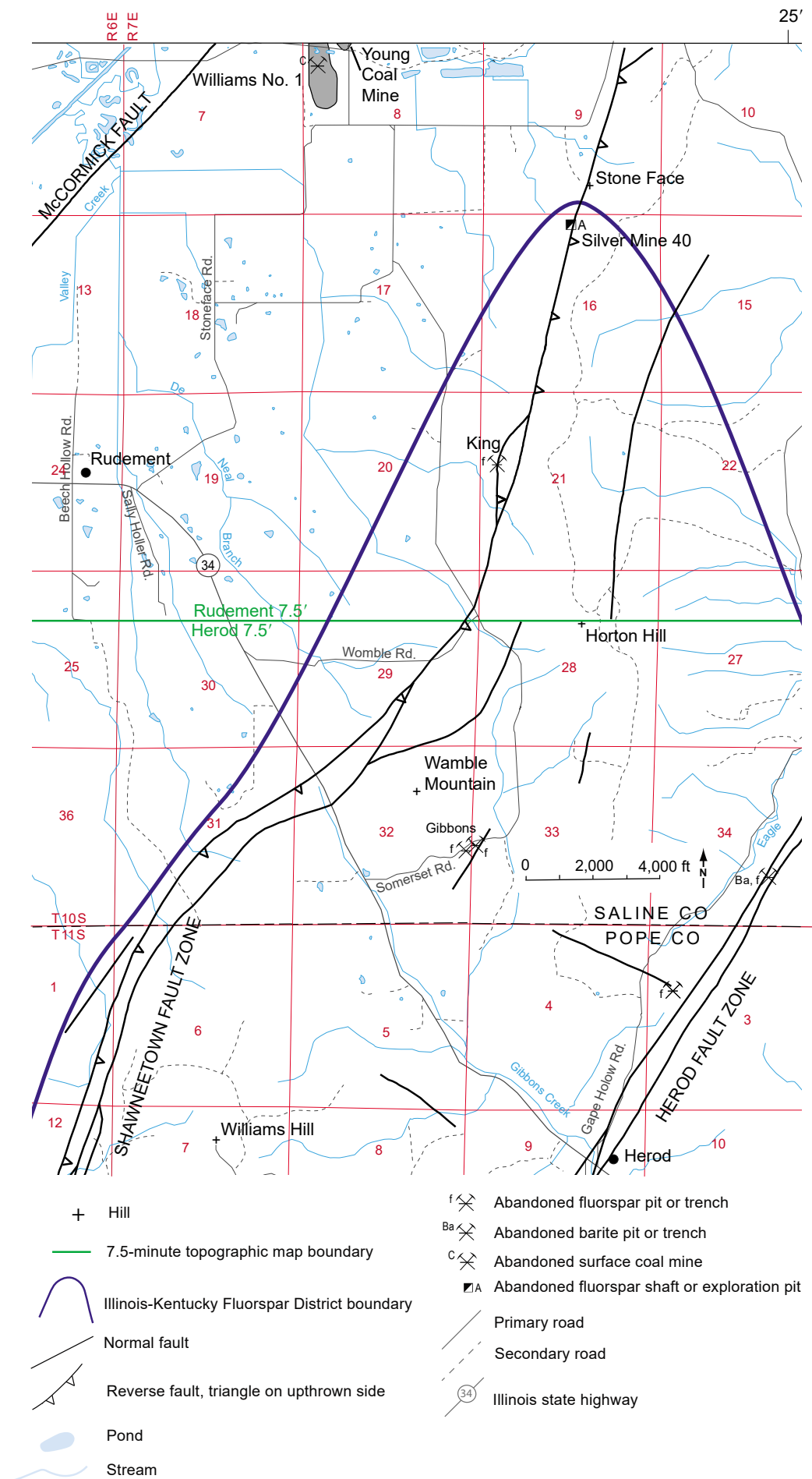


Figure 31 Mines in the outlying Saline County area.

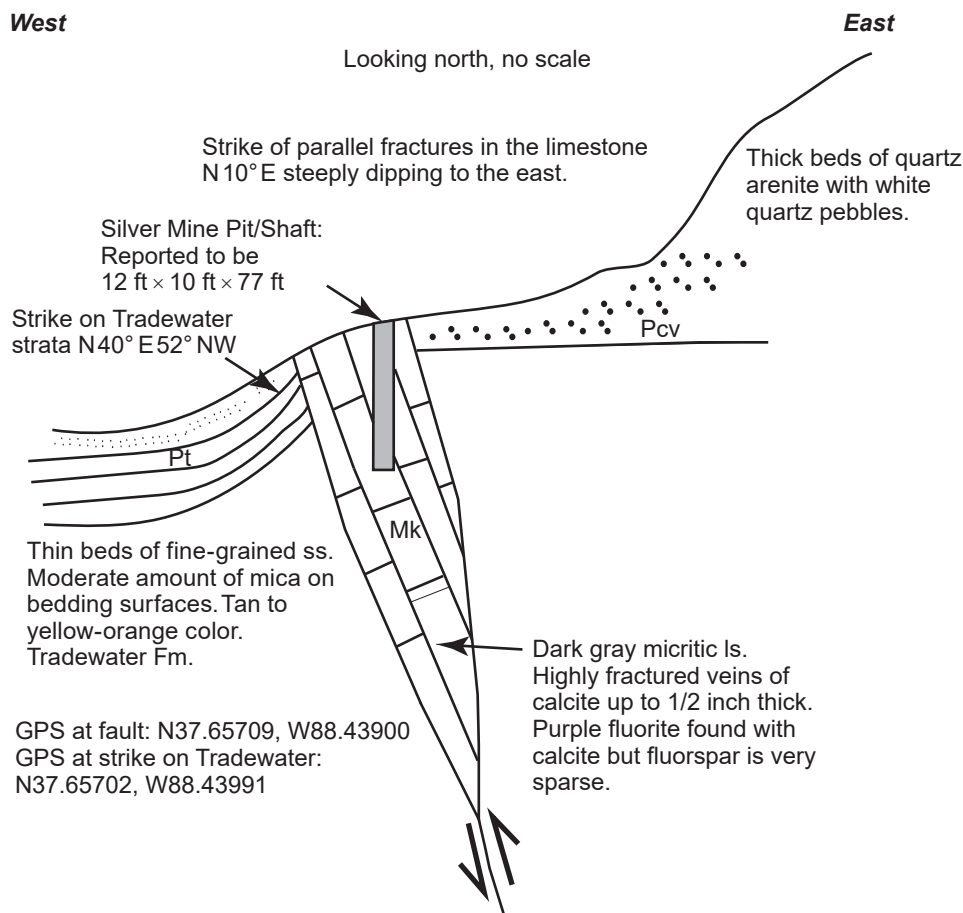


Figure 32 Generalized cross section of the Silver Mine 40 in Saline County. Pt, Pennsylvanian Tradewater Formation; Pcv, Pennsylvanian Caseyville Formation; Mk, Mississippian Kinkaid Limestone.

When Brett Denny and Brian DeNeal visited the mine in November 2018, they observed a pit near the base of the gully. A fault was indicated by steeply dipping beds, calcite veining, brecciation, and slickensides. Beds of Kinkaid Limestone strike N 10° E and dip steeply to the east, whereas the Tradewater strata on the west side strike N 40° E and dip 52° NW (Figure 32). The configuration of the beds indicated the presence of a reverse fault, with the east side being upthrown, followed by a later normal component. Abundant calcite and a few fractures were filled with purple fluorspar in the rocks collected.

Unnamed Prospect. Bradbury (1959) described an unnamed prospect on the east bank of the north-flowing Eagle Creek in the NE¼ SE¼ SW¼ of sec. 34, T 10S, R 7E. The location is close to another unnamed pit observed at SE¼ NW¼ SE¼ of sec. 34, T 10S, R 7E mapped

by Denny et al. (2008b). As described by Bradbury, a vein of fluorite and barite up to 15 inches wide was traced 50 feet along strike through shattered Pennsylvanian sandstone. The trend of the vein was N 30° E, dipping 55° SE. Two shafts and several prospect pits were present. At one location, a pit at least 15 feet in diameter was present, with much barite in the mine dump. Vertical slickensides could be observed along a steeply dipping fault on the east side of the pit. The vein was developed along fractures in the Herod Fault Zone, a northeastern extension of the Lusk Creek Fault Zone.

CONCLUSIONS

The mines in the Illinois portion of the IKFD were active for more than 150 years. Currently, the only fluorspar production in Illinois comes as a by-product of aggregate mining at the Hastie Quarry in the Cave-in-Rock Subdistrict. The demise of

this mineral district was due to dwindling shallow reserves and competition from foreign producers. There is active interest in a relatively low-grade mineralization at Hicks Dome. The mineralization is located in the Ordovician Plattin Limestone at depths below 2,000 feet. With the exception of Hicks Dome, very few deeper exploration borings have been conducted to test for additional fluorspar resources. If this district has future potential, it will most likely come from deeper levels that historically have been unexplored.

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