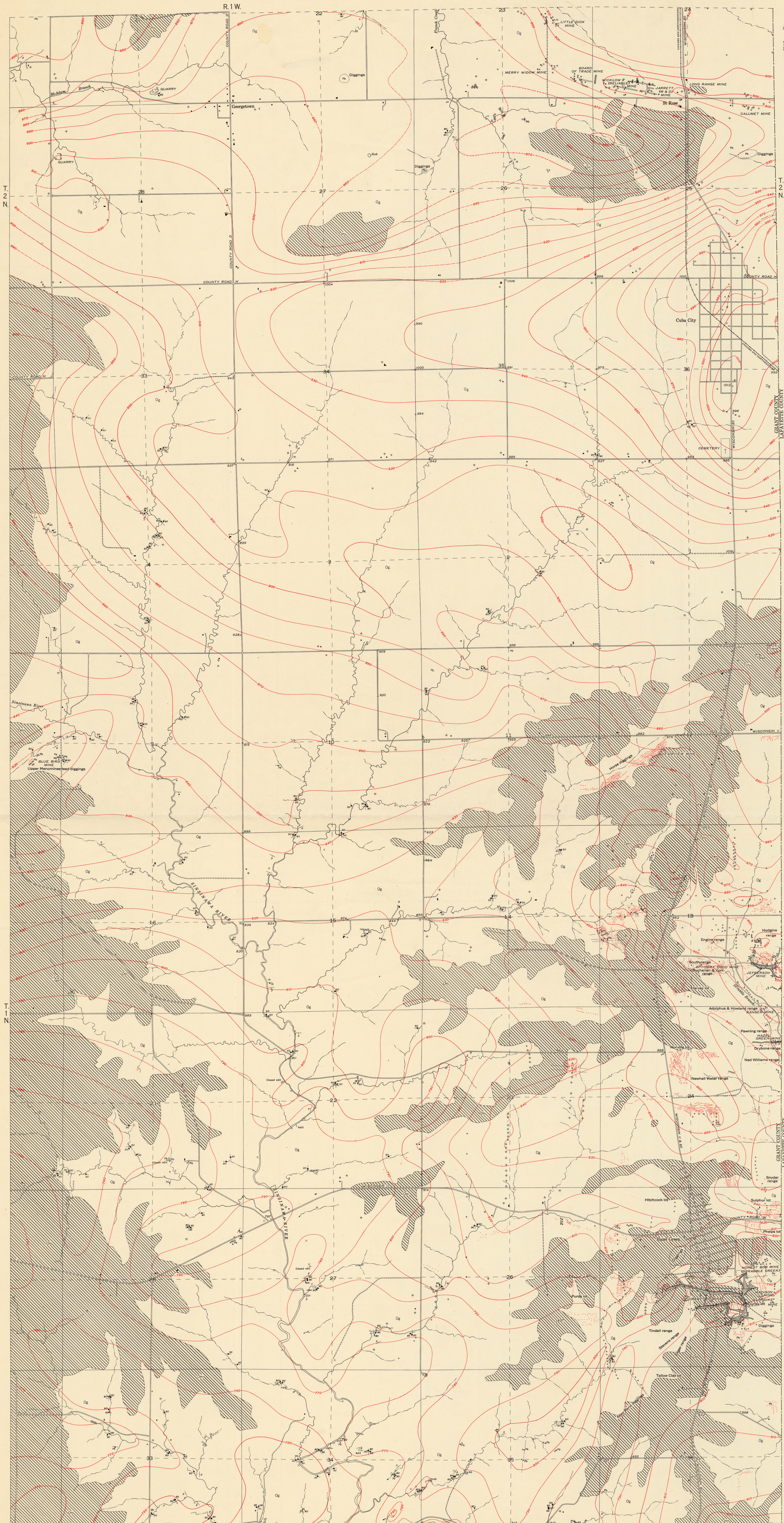
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
W. E. WRATHER, DIRECTOR

PREPARED IN COOPERATION WITH
THE STATE OF WISCONSIN
GEOLOGICAL AND NATURAL HISTORY SURVEY

MINERAL INVESTIGATIONS
FIELD STUDIES MAP MF 40



Base prepared from aerial photos in 1951-1952; by J. W. Allingham, A. E. Flint, and A. F. Agnew.

Geology mapped in 1950-1952.

MAP SHOWING GEOLOGIC STRUCTURE AND ECONOMIC GEOLOGY OF THE SINSINAWA RIVER AREA

Scale 1:12 000
1000 0 1000 2000 3000 4000 5000 Feet
Datum is mean sea level

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1955

EXPLANATION

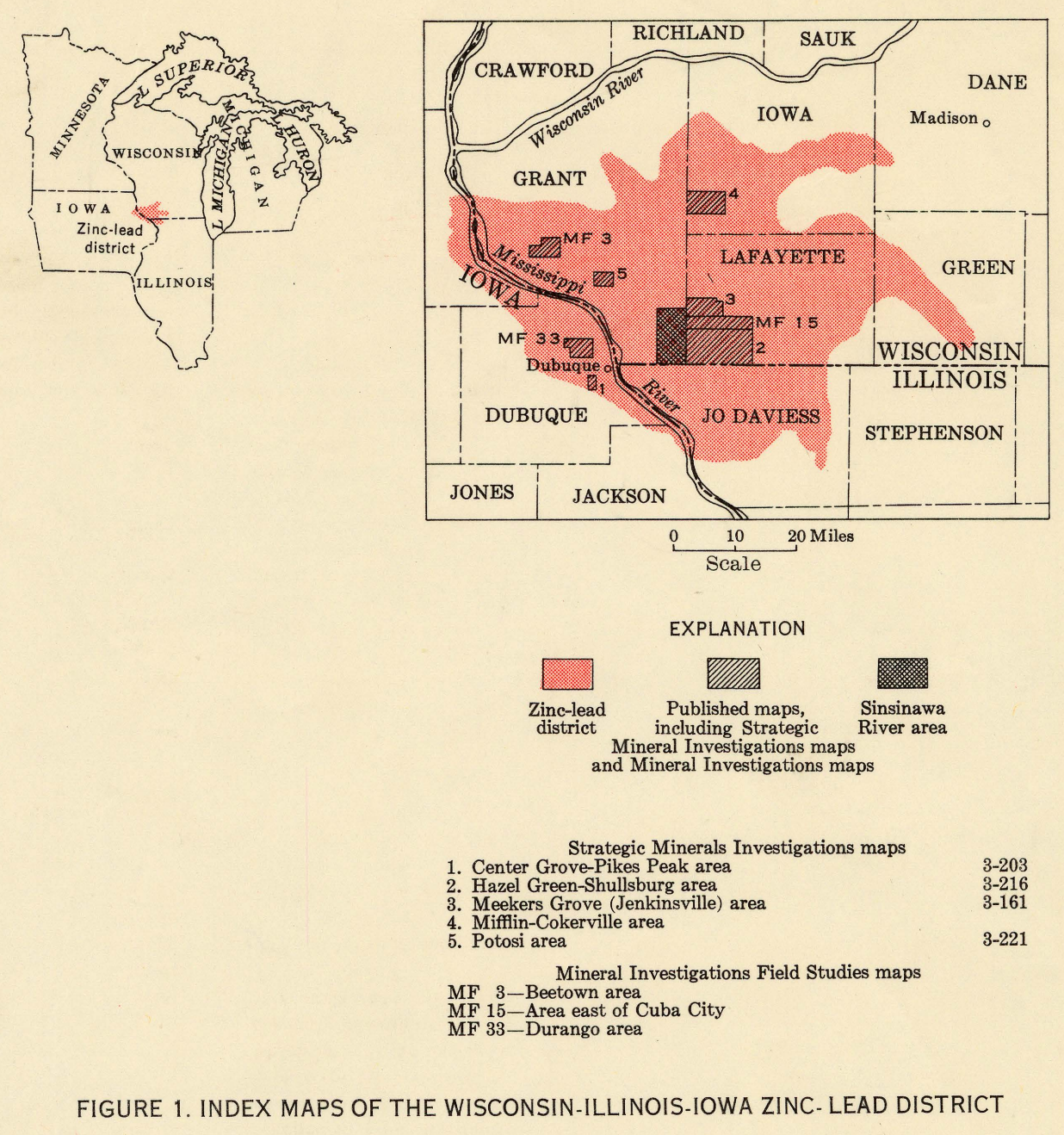
ORDOVICIAN

Upper Ordovician
- ▨ Om — Maquoketa shale

Middle Ordovician
- ☐ Og — Galena dolomite

- Lead mine
  Dots are individual pits
  Line is strike of crevice (vertical joint)
- Lead pits of irregular arrangement
- Diggings — Area containing old prospect holes and pits
- Zinc ore body, worked out
  Dashed where inferred.
  Deposit may extend beyond limits of mapping.
- Approximate contact
  May be covered locally by loess or surficial deposits.
- Fault, showing dip
- 80 — Shear zone, showing dip
- 3 — Strike and dip of beds
- 45 — Strike and dip of joint
- 90 — Strike of vertical joint
- 90 90 90 — Strike and dip of multiple joint system
- 950 — Structure contour on top of Cherty unit of Galena dolomite
  Dashed where approximately located.
  Contour interval 10 feet.
  Datum is mean sea level.
- Inactive shaft
- A — Abandoned or caved shaft
- Small open cut or quarry
- Drill hole intersecting zinc or lead ore
- Drill hole not intersecting zinc or lead ore
- Drill hole
  No record of mineral content.
- × — Outcrop point used for structural control
- ×914 — Spot elevation
- Pb Lead sulfide, Zn Zinc sulfide — Abbreviations for materials at prospect dumps or outcrops

NOTE Structure contours of adjoining maps to the east drawn at base of Guttenberg "oil rock"



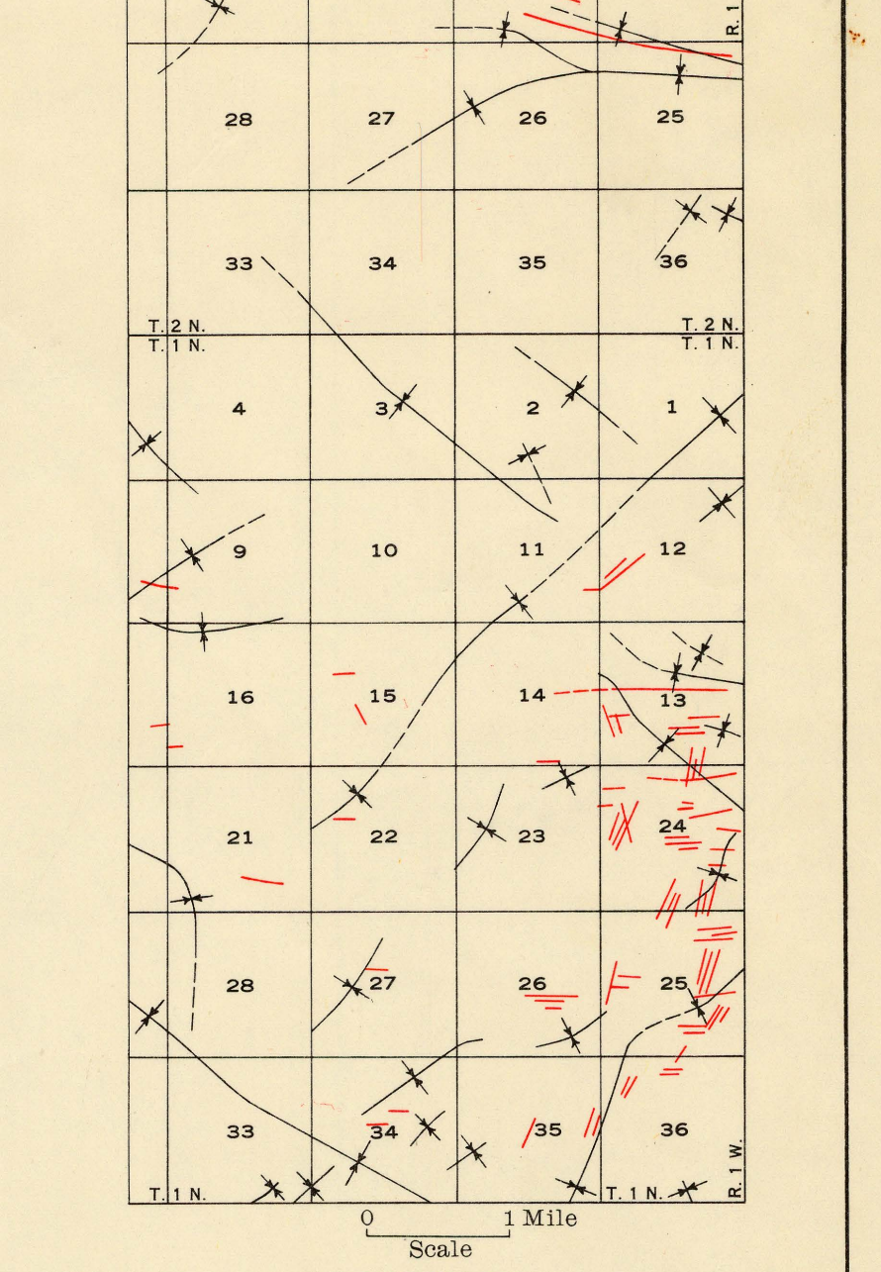
EXPLANATION

- Zinc-lead district
- Published maps, including Strategic Mineral Investigations maps and Mineral Investigations maps
- Sinsinawa River area

Strategic Minerals Investigations maps	
1. Center Grove-Pikes Peak area	3-203
2. Hazel Green-Shullsburg area	3-216
3. Meekers Grove (Jenkinsville) area	3-161
4. Mifflin-Cokerville area	
5. Potosi area	3-221

Mineral Investigations Field Studies maps
MF 3—Beetown area
MF 15—Area east of Cuba City
MF 33—Durango area

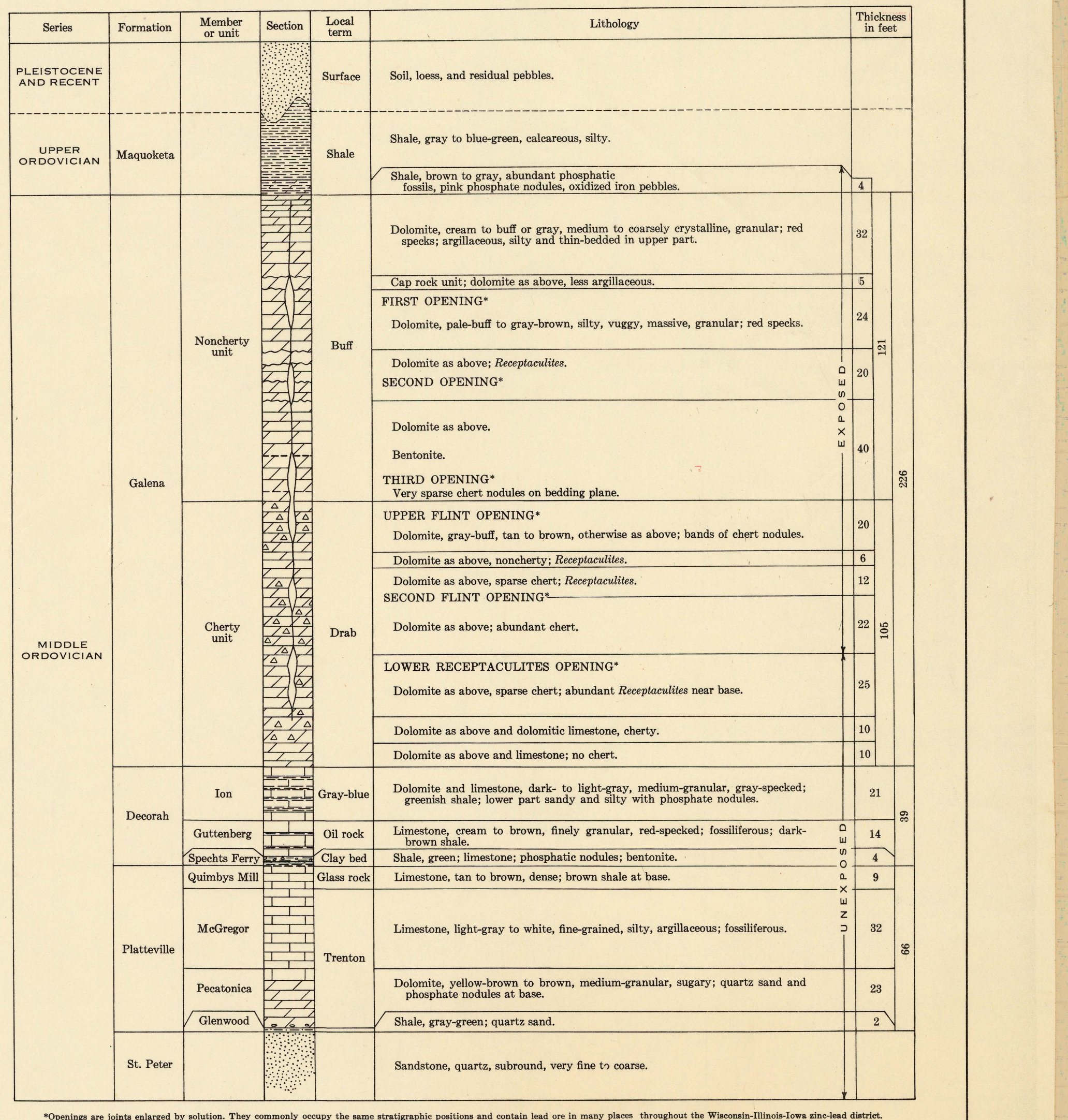
FIGURE 1. INDEX MAPS OF THE WISCONSIN-ILLINOIS-IOWA ZINC- LEAD DISTRICT



EXPLANATION

- Synclinal axis
  Dashed where approximate.
- Mineralized fracture zone
  Dashed where approximate.

FIGURE 2. MAP SHOWING DISTRIBUTION OF SYNCLINAL AXES AND MINERALIZED FRACTURES IN THE SINSINAWA RIVER AREA, WISCONSIN



Series	Formation	Member or unit	Local term	Lithology	Thickness in feet
PLEISTOCENE AND RECENT			Surface	Soil, loess, and residual pebbles.	
UPPER ORDOVICIAN	Maquoketa		Shale	Shale, gray to blue-green, calcareous, silty.	
				Shale, brown to gray, abundant phosphatic fossils, pink phosphate nodules, oxidized iron pebbles.	4
MIDDLE ORDOVICIAN	Galena	Noncherty unit	Buff	Dolomite, cream to buff or gray, medium to coarsely crystalline, granular; red specks; argillaceous, silty and thin-bedded in upper part.	32
				Cap rock unit; dolomite as above, less argillaceous.	5
				FIRST OPENING* Dolomite, pale-buff to gray-brown, silty, vuggy, massive, granular; red specks.	24
				Dolomite as above; *Receptaculites.* SECOND OPENING*	20
				Dolomite as above. Bentonite. THIRD OPENING* Very sparse chert nodules on bedding plane.	40
		Cherty unit	Drab	UPPER FLINT OPENING* Dolomite, gray-buff, tan to brown, otherwise as above; bands of chert nodules.	20
				Dolomite as above, noncherty; *Receptaculites.*	6
				Dolomite as above, sparse chert; *Receptaculites.* SECOND FLINT OPENING*	12
				Dolomite as above; abundant chert.	22
				LOWER RECEPTACULITES OPENING* Dolomite as above, sparse chert; abundant *Receptaculites* near base.	25
				Dolomite as above and dolomitic limestone, cherty.	10
				Dolomite as above and limestone; no chert.	10
	Decorah	Ion	Gray-blue	Dolomite and limestone, dark- to light-gray, medium-granular, gray-specked; greenish shale; lower part sandy and silty with phosphate nodules.	21
		Guttenberg	Oil rock	Limestone, cream to brown, finely granular, red-specked; fossiliferous; dark-brown shale.	14
		Spechts Ferry	Clay bed	Shale, green; limestone; phosphatic nodules; bentonite.	4
	Platteville	Quimbys Mill	Glass rock	Limestone, tan to brown, dense; brown shale at base.	9
		McGregor	Trenton	Limestone, light-gray to white, fine-grained, silty, argillaceous; fossiliferous.	32
		Pecatonica		Dolomite, yellow-brown to brown, medium-granular, sugary; quartz sand and phosphate nodules at base.	23
		Glenwood		Shale, gray-green; quartz sand.	2
	St. Peter			Sandstone, quartz, subround, very fine to coarse.	

*Openings are joints enlarged by solution. They commonly occupy the same stratigraphic positions and contain lead ore in many places throughout the Wisconsin-Illinois-Iowa zinc-lead district.

FIGURE 3. STRATIGRAPHIC SECTION OF THE MIDDLE AND UPPER ORDOVICIAN ROCKS, SINSINAWA RIVER AREA, WISCONSIN

ZINC AND LEAD DEPOSITS OF THE SINSINAWA RIVER AREA, GRANT COUNTY, WISCONSIN

By

John W. Allingham, Arthur E. Flint, and Allen F. Agnew

INTRODUCTION

A broad geologic study of the structure and ore deposits of the Wisconsin-Illinois-Iowa zinc-lead district (fig. 1) was begun by the U. S. Geological Survey in 1942. The main object of the present program is to delineate the areas favorable to future exploration for zinc-lead ore deposits. As part of the program the Sinsinawa River area in southeastern Grant County, Wis., was selected for a detailed geologic study. This study was made in cooperation with the Wisconsin Geological and Natural History Survey.

Several early geologic studies of the Upper Mississippi Valley mining district were made by Owen (1840), Whitney (1862), Strong (1877), and Grant (1906). Data from more recent detailed mapping of outcrops and from exploratory drilling have contributed to a better understanding of the stratigraphy, structure, and related ore deposits. Results of the present geologic investigation indicate that further exploration for zinc and lead ores in the Sinsinawa River area is justified.

The slightly tilted rocks of the Sinsinawa River area form the south flank of a large asymmetric anticline near Cuba City and are gently folded into shallow synclines and anticlines. The Sinsinawa River area is bordered by the Hazel Green-Shullsburg zinc-lead area east and northeast of Hazel Green (Agnew et al., 1948), the Meekers Grove zinc-lead area northeast of Cuba City (Heyl et al., 1945), the zinc-lead-barite area east of Cuba City (Agnew et al., 1954), and the Fairplay lead area to the southwest (not shown on index map).

This report is based on field work done in 1950-1951. The most important results of the study of drill-hole and outcrop data indicate that synclines extend westward into the Sinsinawa River area from the adjacent Hazel Green-Shullsburg area and from the area east of Cuba City. These synclines may be ore-bearing in the Sinsinawa River area. Secs. 13, 24, 25, and 36, T. 1 N., R. 1 W., had been mapped previously as part of the Hazel Green-Shullsburg area; however, additional information from exploratory drilling made possible modifications of previous geologic interpretations.

The base map of the Sinsinawa River area was prepared on a scale of 1:7,920 from aerial photographs made by the U. S. Department of Agriculture in 1940 and represents an area of 38 square miles. Altitudes of geologic horizons were obtained by alidade survey from established benchmarks and other elevations shown on the U. S. Geological Survey topographic map of the Ipswich SW quadrangle (1952) and maps of Grant (1906, pl. 2) and Hotchkiss and Steidtmann (1909, pl. 1).

Officials of the Eagle-Picher Mining Co., The New Jersey Zinc Co., the St. Joseph Lead Co., and the Vinegar Hill Zinc Co. contributed to this study by furnishing exploration and mine data.

ROCK UNITS

The sedimentary rocks of the Sinsinawa River area are of Middle and Late Ordovician age. These strata and older Paleozoic rocks aggregate more than 2,000 feet in thickness and lie on a pre-Cambrian granitic complex.

A brief description of the ore-bearing rocks of the area is given in figure 3. These strata overlie the St. Peter sandstone and are dominantly limestones, dolomites, and shales of marine origin. The green Glenwood shale member, at the base of the Platteville formation, provides a distinctive marker in exploratory drilling, although this zone is commonly not reached in prospecting. Similarly the overlying Pecatonica dolomite member and the McGregor limestone member are commonly not reached in prospecting. The hard, brittle limestone of the Quimbys Mill member at the top of the Platteville is the next higher distinctive unit and is referred to locally as glass rock. It has an average thickness of 9 feet in the vicinity of Cuba City but thins westward to 6 feet near the southwest edge of the Sinsinawa River area. This dense limestone is the lowest host for large ore deposits. Zinc ore generally occurs as fracture fillings in the Quimbys Mill member.

The Spechts Ferry shale member of the Decorah formation is a thin persistent unit that is easily recognized by drillers and is locally called clay bed. The Spechts Ferry rarely contains ore, but zinc and lead minerals are commonly present. The next younger unit, the Guttenberg limestone member of the Decorah, is locally an important ore-bearing unit and is called oil rock by the miners. Throughout most of the area the Ion dolomite member of the Decorah formation is uniform in thickness. Contacts of the Ion with the underlying Guttenberg and with the Cherty unit of the overlying Galena dolomite provide useful marker horizons. The Ion and the lower part of the Galena are the principal host rocks for zinc ore.

The Galena dolomite is the youngest bedrock in most of the area and has a thickness of about 225 feet. The upper part of its Cherty unit crops out in a deeply dissected part of the Sinsinawa River area near the Wisconsin-Illinois boundary and comprises the lowest beds in the sequence of rock units exposed within the mapped area; the lower rocks mentioned above are known from prospect drill holes and water wells. The Cherty unit, generally that part below the water table, is a favorable host for zinc ore as well as lead; the Noncherty unit, however, is mostly a lead-ore zone.

The top of the Cherty unit is an important marker and, by its closely spaced layers of chert, is easily distinguished from the overlying Noncherty unit. The widespread occurrence of this horizon makes it the most acceptable datum for structure contours. Horizons in the Noncherty unit (fig. 3) that may be used for vertical control are (1) the base of the bentonite bed 18 feet above the base of this unit, (2) the base of the upper *Receptaculites* zone, and (3) the base of the cap rock unit. The bentonite bed is well exposed in a bluff on the Sinsinawa River near the center of sec. 34, T. 1 N., R. 1 W., and in the north side of a road cut on State Route 11 west of the Sinsinawa River bridge in the NW¼NW¼ sec. 27, T. 1 N., R. 1 W. The cap rock unit, three distinctive dolomite beds with intervening beds of shale (Flint and Brown, 1955), is exposed in the same road cut farther west.

Maquoketa shale caps the higher ridges in the Sinsinawa River area. The contact of Maquoketa shale and Galena dolomite is lithologically distinct and locally is marked by small springs and marshy areas. This contact, however, should be used with caution for structure control, because the water-saturated, plastic basal shale tends to move downslope. A variable thickness of soil, loess, and residual rock fragments covers the upland areas (see fig. 3); because adequate data are unavailable the Maquoketa-Galena contact is projected through the overlying mantle to the surface. In some places, therefore, where the Maquoketa shale is indicated, a thick mantle may instead rest on the Galena dolomite. Unconsolidated sediments of Recent age cover the lowlands.

ROCK ALTERATION

The removal of carbonates and the concentration of argillaceous material (shalification) reduces the normal thickness of the Quimbys Mill member of the Platteville formation to a few feet of dark-brown banded dolomitic shale. In many mineralized areas the Guttenberg member of the Decorah formation (normally argillaceous limestone about 14 feet thick) has been altered to brown shale and dolomite and reduced in thickness to only a few feet.

Similar thinning of impure calcareous rocks in the Decorah and Platteville formations, generally within or near mineralized zones, commonly is accompanied by a relative increase in the magnesium content and is accompanied by the growth of dolomite crystals, in a microcrystalline matrix of carbonates, clays, and silica.

Rocks of the Guttenberg and Quimbys Mill members may contain minute fractures filled with tiny veinlets of crystalline quartz. Locally these rocks are partly replaced by silica but retain some of their original megascopic features. In thin section the silica of the matrix is indistinguishable from that of the chert nodules. The introduced silica is closely associated with minerals of the ore suite and is best detected by increased hardness of the host rock.

STRUCTURE

The strata of this region are tilted southwestward with an average dip of 16 feet per mile. The beds are slightly folded into broad, shallow anticlines and synclines. Brittle carbonate rocks are fractured; however, evidence of major dislocations in the strata is lacking. Abundant data on the map give a complex pattern of folding and account for the detail shown in secs. 13 and 25, T. 1 N., R. 1 W., as contrasted with the simple structure shown in secs. 2, 3, and 4, T. 1 N., R. 1 W., where information is inadequate.

Cross folding is characteristic of the structure in secs. 9, 13, 15, 24, 33, and 34, T. 1 N., R. 1 W. Fold axes are dominantly N. 45°-55° W., and N. 45° E. (fig. 2). Other folds trend N. 80° W. to S. 80° W. and N. 15° E. A prominent asymmetric anticline, bounded on its steep north limb by a broad basin, plunges westward from Cuba City and terminates at the junction of northeast-trending and northwest-trending synclines in sec. 33, T. 2 N., R. 1 W. The average amplitude of the folds is 35 feet; the structural relief along the fold northwest of Cuba City, however, is about 140 feet. The amplitude of folds is locally accentuated or diminished by thinning of certain beds.

Vertical and inclined fractures, which have been enlarged locally by solution of the carbonate rocks, are characteristic of parts of the Sinsinawa River area. Many of the prominent mineralized east-trending and north-trending sets of vertical joints in secs. 13 and 24, T. 1 N., R. 1 W., and secs. 24 and 25, T. 2 N., R. 1 W. (fig. 2 and geologic map), are notable for persistence of strike and parallelism. Joints are commonly not parallel to the folds.

The trends of folds and joints are commonly reflected by stream directions. The west branches of the Sinsinawa River in sec. 4, T. 1 N., R. 1 W., and sec. 33, T. 2 N., R. 1 W., indicate northwest-trending structures; the east branches in secs. 14 and 23, T. 1 N., R. 1 W., indicate northeast-trending joints.

Zones of closely spaced inclined fractures, formed by shearing, are exposed in the Galena dolomite in the southern part of the area. The most prominent fracture trend is approximately eastward. Locally, large springs mark the positions of shear zones. Open fractures, locally enlarged by solution to form natural openings (caves), range from several feet to 30 feet in width and are commonly lined with large scalenohedral crystals of calcite.

ORE DEPOSITS

Linear ore bodies are related to fractures generally parallel to the flanks of synclines. Where these fractures bend around the noses of folds, zinc ore deposits have an arcuate form.

Sphalerite and galena are the ore minerals, and they occur as open-space fillings and replacements in calcareous and dolomitic sedimentary rocks. These minerals are intimately associated with pyrite, marcasite, and calcite. In the oxidized zone, generally above the static water table, smithsonite, cerussite, and limonite coat the sulfide minerals or may completely replace them.

Early production.—A series of shallow pits and shafts in the vicinity of Hazel Green are the result of some of the earliest mining operations in Wisconsin (Owen, 1840, p. 35, 58, 93; Percival, 1855, p. 71-87; Whitney, 1862, p. 278-287; Strong, 1877, p. 704-707). The total amount of lead ore mined from the Hazel Green area prior to 1876 was 63,000 tons, of which 13,700 tons had been produced before 1843, and 31,500 tons was delivered to the smelter at Hazel Green between 1845 and 1861. During 1861 the production of lead ore near Hazel Green was 2,000 tons, but by 1876 the annual production had dropped to 400 tons. By 1900 lead was being mined largely as a byproduct of zinc ore.

As much as 1,000 tons of lead was mined from a single group of closely spaced mine workings such as the Hitchcock lot, NW¼ sec. 25, T. 1 N., R. 1 W. (geologic map). Important lead deposits near Hazel Green in the Sinsinawa River area are listed below.

Deposit (T. 1 N., R. 1 W.)	Production	Prior to
Drybone range, NE¼ sec. 24	250 tons	1862
Durley lot, SE¼ sec. 25	500 tons	1843
Hitchcock lot, NW¼ sec. 25	1,000 tons	1862
Horse diggings, SW¼ sec. 12	400 tons	(About) 1870
Phelps lot, NE¼ sec. 25	900 tons	1843
Purdy lot, SE¼ sec. 26	500 tons	1862
Sulphur lot, NE¼ sec. 25	700 tons	1874

Small amounts of lead ore were mined near the Sinsinawa River and along the eastern extensions of the Upper Menominee lead diggings of local usage at the west edge of the Sinsinawa River area.

In contrast to the early lead production, zinc ores were mined sporadically and on a small scale. In the Sinsinawa River area, 10 tons of sphalerite, locally known as jack or blende, was mined in 1874 from the Madison range in the SE¼ sec. 25, T. 1 N., R. 1 W., and 20 tons of smithsonite, locally called drybone, was produced from the Drybone range in the NE¼ sec. 24, T. 1 N., R. 1 W. Zinc production of the mining district, however, steadily increased from twice that of lead in 1874 to a ratio of more than 16:1 in 1904 (Bain, 1906, p. 9).

Recent production.—Since 1904, the zinc production of the mining district has increased periodically, whereas lead has remained a byproduct of zinc production.

About 7,000 tons of zinc metal was produced in 1904, and production of zinc reached peaks in 1917 and 1927, when 64,000 tons and 33,000 tons, respectively, were recovered. The Hazel Green, Jefferson, and Crawford mines produced more than half a million tons of zinc ore since 1927, but only a small amount has been produced since 1935.

Lead ore bodies.—Near Hazel Green, lead ore occurs as veins in long vertical or steeply inclined fractures, locally known as crevices. These gash veins are narrow continuous sheets of galena of limited extent. Because these lead-filled fractures are only a few inches wide and are closely spaced, they are mined in groups by one excavation, as first noted by Whitney (1862, p. 238). Lead ore also occurs as irregular vertical shoots at the junctions of two or more joints. The important mineralized fractures occur as two dominant and distinctive sets; one set trends nearly eastward, the other trends due north to N. 15° E. Joints from which lead has been mined are traced on the surface by an alinement of pits, shafts, and mine dumps as in secs. 13, 24, and 25, T. 1 N., R. 1 W. Many residual lead deposits occur at shallow depth in the zone of weathering near the contact of the soil with the bedrock. Known residual deposits are indicated by small, randomly distributed pits.

A vertical or steeply inclined fracture that has been widened by solution at a single bed or restricted set of strata is called an opening (fig. 3). Galena occurs (1) as crystals or small aggregates of crystals in clay-filled openings, (2) as coatings on walls of openings, and (3) as large discontinuous lenticular masses partly embedded in clay or sandy dolomite within openings. In contrast with the sheetlike gash veins, these openings occur at definite stratigraphic horizons. The long dimension of an opening is parallel to the strike of the joint and is generally several hundred feet long. Rock remaining in an opening may be leached to a porous, honeycomb appearance, or decomposed to dolomite sand, or partly removed to form a void.

Most of the lead ore in this area is produced from the third opening, which is near the base of the Noncherty unit (fig. 3). During recent years the only significant quantity of lead ore (62,000 pounds) produced from this area came from the third opening in the Blue Bird mine (sec. 8, T. 1 N., R. 1 W.). In the lower openings zinc minerals become economically important, and below the water table sphalerite is the dominant ore mineral.

Zinc ore bodies.—Zinc ore deposits, which contain some lead, are generally confined to the lower part of the Cherty unit of the Galena dolomite and to the Decorah formation. Sphalerite, the main ore mineral, occurs in inclined veins locally known as pitches, in bedding-plane veins referred to locally as flats, as disseminated crystals, particularly in shaly beds of the Guttenberg limestone member of the Decorah, in breccia zones as open space filling and locally called honeycomb or brangle ore, and in vugs and cavities.

Pitches are mineralized fractures that dip at angles of 45° to 60°, have negligible displacement, and are in the steep limbs or around the noses of narrow folds. Flats are mineralized fractures along bedding planes or are veins in horizontal open spaces made by solution. Brecciated and mineralized rock adjacent to the footwall side of a pitch is called core ground.

The Hazel Green mine in the NE¼ sec. 24, T. 1 N., R. 1 W., was developed on a typical east-trending linear ore body with well-developed north- and south-dipping pitches. In this mine, brangle zinc-lead ore was mined from the upper part of the Cherty unit. Vein and brangle zinc ore from the base of the Guttenberg to the lower part of the Cherty unit of the Galena and vein lead ore from the upper part of the Cherty unit have been produced at the Jefferson mine in the SE¼ sec. 13, T. 1 N., R. 1 W. This mine is in the northwest extension of the Kennedy syncline (Agnew et al., 1948). The Crawford mine, in sec. 25, T. 1 N., R. 1 W., is on a compound arcuate ore body in a local east-trending basin within a large northeast-trending syncline. From the discovery of the deposit in 1931 until 1936, half a million tons of zinc ore having an average grade of 3.9 percent zinc was produced from the Crawford mine. A negligible amount of galena was shipped as a byproduct of the zinc ore. Mines in secs. 23 and 24, T. 2 N., R. 1 W., produced zinc and lead ores from joint-controlled veins near the top of the Cherty unit.

GUIDES TO EXPLORATION

Most of the larger known pitch-and-flat zinc-lead deposits are in the Cherty unit, the Decorah limestone, and the Quimbys Mill member. Further exploration of these rocks may show the presence of new pitch-and-flat deposits. As the tightly folded and sheared rocks on the flanks of folds may contain zinc ore, these areas probably should be explored; however, not all folds and sheared rocks are ore-bearing. Parts of secs. 13, 33, and 34, T. 1 N., R. 1 W., and secs. 26 and 27, T. 2 N., R. 1 W., are areas of structure favorable for the possible occurrence of ore bodies. Mineralized fractures, such as those traced through secs. 13 and 24, T. 1 N., R. 1 W., and secs. 23 and 24, T. 2 N., R. 1 W., could be explored through the upper Platteville strata for pitch-and-flat deposits.

Gash-vein deposits are restricted to the Galena dolomite. The shale capping of the upland areas discouraged early prospectors; therefore exploration of projections of known mineralized fracture zones into such areas may be profitable. Water presented a formidable barrier to the early miners; consequently, exploration beneath the water table might be considered in areas of former intensive shallow mining, as ore may exist below the water table.

In heavily mineralized areas the possibility that the Quimbys Mill member contains ore should be tested by at least several drill holes, as zinc ore has been mined from this unit less than 5 miles to the east of the Sinsinawa River area.

The Prairie du Chien group of Early Ordovician age contains zinc and lead minerals in other parts of the mining district (Heyl et al., 1952, p. 5; Agnew et al., 1953, p. 10). Current exploration in the Sinsinawa River area is restricted to formations above the St. Peter sandstone, as known deposits in the Prairie du Chien group are small and sparse. Exploration at the depths necessary to reach these deposits in the Sinsinawa River area appears uneconomic at present.

In areas of closely spaced, parallel lead crevices, mineralized fractures can be exposed by trenching to bedrock. Shear zones in secs. 27 and 34, T. 1 N., R. 1 W., and sinkholes in the NE¼NE¼ sec. 12, T. 1 N., R. 1 W., indicate fractures that may have developed into pitches at depth. Mineral-bearing ground in the vicinity of Cuba City is soft, and the iron sulfides are almost completely oxidized. Ore found there will probably be partly oxidized or leached, and soft, caving ground may make mining difficult.

Near the Maquoketa-Galena contact the depth to the lowest productive zone is about 270 feet. In structurally high areas of secs. 25 and 36, T. 2 N., R. 1 W., and near the Sinsinawa River, drill-hole completion depth is 150 feet or less. An estimated depth to any horizon can be determined by using stratigraphic thicknesses (fig. 3), structure contours (geologic map), and topographic contours from the Ipswich SW quadrangle.

In addition to a structure contour map, an isopach map that shows variations in the thickness of the Guttenberg and Quimbys Mill members would aid in the appraisal of a locality. Rock in areas of thinning in the Decorah formation, notably in the Guttenberg, may contain appreciable amounts of zinc or lead minerals. Thinning as a guide to ore, however, should be used with caution, as not all rock in areas of thinning is ore-bearing; such areas of thinned rock are near the eastern border of the Sinsinawa River area. Elongate areas of thinned rock may indicate the direction to mineral-bearing strata.

The top of the Cherty unit of the Galena formation as a datum plane for structure contouring may not accurately reflect the structural features that would be indicated by contours on a lower datum plane, such as the base of the Quimbys Mill member of the Platteville; nevertheless, the top of the Cherty unit was selected as the datum for structure mapping in the Sinsinawa River area because it is easily recognized in exposures and in drill cuttings. Moreover, this horizon is near the midpoint of the vertical thickness of strata exposed in the area; extrapolations to the lowest and highest marker horizons may be made from the top of the Cherty unit. The accuracy of logging the depth to the top of the Cherty unit from drill cuttings properly taken at 5-foot intervals is within 2 feet.

The normal thickness of unleached rock from the top of the Cherty unit of the Galena to the top of the Spechts Ferry shale member of the Decorah, datum for many structure contour maps of the zinc-lead district, is 140 feet. The use of this conversion factor of 140 feet will permit comparison of contour maps drawn on these key beds.

METHODS OF EXPLORATION

As a study of drill cuttings generally provides adequate lithologic and mineralogic data to guide exploration, churn drilling is most commonly used for exploring pitch-and-flat ore-bearing zones. Rotary core drilling has been used with moderate success near Hazel Green. It has the disadvantages of poor core recovery in loose or soft ground and the loss of drilling fluids in open or vuggy ground. These disadvantages are partly offset by greater footage per shift, by more accurate sampling, and by its adaptability to underground exploration in mine stopes.

A power-driven auger has been used to drill to the contact of the Maquoketa shale with the Galena dolomite; however, the restricted areal extent of the shale and the possibility of getting erroneous information because of the extreme mobility and slumping of the shale limit the value of this tool. A system of drifts and crosscuts from a central shaft or inclined adit could be used to explore and develop ore in areas of closely spaced parallel fractures. In addition, horizontal adits permit inexpensive dewatering.

In localities of sparse vertical-control data, flexures can be determined in sufficient detail to guide exploration by a grid of drill holes on 1,320-foot centers, as is commonly used in this district. Mineralized ground, in an area considered favorable by structural and stratigraphic criteria, may be prospected by several cross sections of holes until the boundary of an ore body is delineated or the area has been otherwise sufficiently explored. The spacing of drill holes for cross sections is governed by the width of the expected ore bodies. A maximum drill-hole spacing of 100 feet for exploration of arcuate ore bodies such as those at the Jefferson and Crawford mines is desirable, because these ore bodies average 100 feet in width; whereas exploration of a linear structure such as that at the Hazel Green mine requires a maximum spacing of 50 feet, because ore bodies of this type average 50 feet in width.

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MINERAL INVESTIGATIONS
FIELD STUDIES MAP MF 40

ZINC AND LEAD DEPOSITS OF THE SINSINAWA RIVER AREA, GRANT COUNTY, WISCONSIN
By
John W. Allingham, Arthur E. Flint, and Allen F. Agnew
1955

~~Wisconsin~~ (Sinsinawa River area). ~~Lead and zinc.~~
~~cop.~~ 1.