REPORT OF INVESTIGATIONS

INVESTIGATION OF MELROSE ZINC-LEAD DISTRICT
OTTAWA COUNTY, OKLA., AND CHEROKEE COUNTY, KANS.

BY

CLINTON C. KNOX
REPORT OF INVESTIGATIONS

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

INVESTIGATION OF MELROSE ZINC-LEAD DISTRICT, OTTAWA COUNTY, OKLA., AND CHEROKEE COUNTY, KANS. 1/ 

By Clinton C. Knox 2/

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1/ The Bureau of Mines welcomes reprinting of this paper, providing the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Report of Investigations 4337."

2/ Mining engineer, Bureau of Mines, Joplin, Mo.
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SUMMARY

To demonstrate the feasibility of unwatering ore reserves previously indicated in the virgin Melrose zinc-lead field in Kansas and Oklahoma, the Bureau of Mines carried through a pumping project on the Park Walton farm in 1943. Due to success of the undertaking, attention was turned to exploration of other indicated ore deposits and promising areas within that part of the field benefited by the drainage project. By the middle of 1946, four private mining companies were active in the field, and a considerable output of lead and zinc concentrate had been obtained from the new Park Walton mine and mill.

The Park Walton ore deposit was unwatered by installing deep-well pumps in three holes previously drilled by the lessee. Pumping was continued by the Bureau of Mines at a rate of 2,500 to 5,000 g.p.m. for about 6 months; during this time the local static artesian water level, originally averaging 108 feet below the surface in the old drill holes, was lowered to the 316-foot level, which justified beginning the initial shaft sinking and mine developments. In all, about 750,000,000 gallons of water was pumped by the Bureau of Mines at an operating cost averaging $0.024 per 1,000 gallons.

Meanwhile, the records of previous drilling in the Melrose field were collected and correlated, together with the results of geophysical surveys and other pertinent data, and plans were laid for a Bureau of Mines exploratory program. The geology of the Melrose area was found to be similar to that of the great Picher mining field, where knowledge of stratigraphy and structure is essential in exploration. A long-range program of combined geophysical surveying and churn drilling was proposed by the Bureau of Mines, but only a small part had been achieved when the project was recessed in 1946.

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The Bureau of Mines drilling during the 2-year period totaled 90 holes, which added about 360,000 tons of ore to the previously estimated Melrose field reserves. This, with reserves based on prior and contemporary private drilling, brought the field's total reserve estimates on a dozen different properties to 1,800,000 tons of ore, of which nearly 500,000 with an average metallic content of 2.25 percent zinc and 1.20 percent lead are indicated; the remainder is inferred but virtually undelineated.

The general characteristics of the Melrose ore deposits, observed in churn-drill holes and in underground exposures, particularly in the Park Walton mine, assisted in directing the drilling program. Localization of the richer deposits was noted in the higher stratigraphic beds along the edges or flanks of structural highs.

INTRODUCTION

The initial Bureau of Mines investigation in the Melrose district was made in 1942. The examination was confined to the Park Walton property in Ottawa County, 3 miles southwest of Melrose, Kans., on which an ore deposit had been indicated by old churn drilling. The proposed drainage project was undertaken by the Bureau of Mines late in 1942.

Upon successful completion of the Park Walton drainage test in November 1943, a general program of churn drilling and experimental geophysical surveys by the Bureau of Mines in the virgin Melrose lead-zinc field appeared to be justified. Pertinent data had been collected from various sources by the project engineer in charge of the drainage test, including logs, sample analyses, maps, and other recorded information from about 500 old holes that various private concerns had churn-drilled at different times from 1923 to 1941 on some 35 of the farms in the 6-square-mile drainage area surrounding the Park Walton. About 150 holes that had been drilled from 1925 to 1934 by the Vinegar Hill (Century) Zinc Co. during extensive reconnaissance explorations were exceptionally logged, sampled, and located on maps. Most of the other drill holes were either too shallow or incompletely recorded to furnish concise information.

Individually, most of the inferred and indicated ore deposits on the numerous properties had appeared too small, marginal and isolated before the regional study was made of all the assembled data and before Melrose drainage had proved feasible. Thereafter it was recognized that immediate further churn drilling might increase the ore reserves of some of the best deposits enough to justify other mining developments besides the Park Walton. Such other developments appeared practical only while the Park Walton mine drainage, power, and central milling facilities were available. The proposed drilling program was also expected to clarify obscure geological features and to reveal the extent of the Park Walton drainage effect. War demand for lead and zinc, premium prices, future national needs, and the opportunity to conserve these low-grade ores by timely exploration, development, and production were also recognized in the proposal.

Later, as a second step, it was hoped that the long-range program could be expanded to include preliminary churn drilling of distantly spaced reconnaissance holes in virgin areas along extensions of geologically inferred
favorable structural trends. Such reconnaissance drilling was to be paralleled by appropriate geophysical research and geological studies. Adequate topographic mapping, which had never been done in the Melrose district, was a prerequisite for the program. With the anticipated success of the Park Walton and other early mining developments, private enterprise was expected to be sufficiently encouraged to complete churn-drill delineation of any ore reserves that could be reasonably inferred from results of the Bureau of Mines program.

Finally, with development of an effective combined geophysical and churn-drilling exploration method, the Melrose district investigation could be economically projected throughout the 30- to 60-square mile virgin area. Inferred ore-making structures could be explored, which were presumed to extend several miles southeast to some old mines near Miami, Okla., northeast to intersect several previously indicated ore reserves along the Bendelari "trough" northwesterly extension from Fischer, and northwest along the Park Walton inferred structural trend toward Chetopa, Kans.

The Melrose district project was started by the Bureau of Mines in late June 1944. The first six holes were drilled on the Park Walton property to check gravimetric anomalies previously indicated by the Kansas State Geological Survey. In addition to topographic and some preliminary gravimetric surveys made during the first 10 months, churn drilling on eight different Oklahoma and Kansas properties progressed with a few interruptions until April 13, 1946.

This report of investigations covers the limited progress on the Melrose development program that had been made up to the latter part of 1946, including the Park Walton drainage project and the Melrose drilling project of the Bureau of Mines and exploratory and mining developments by private capital.

ACKNOWLEDGMENTS

The Park Walton property was examined in July 1942 by W. D. McMillan, district engineer, accompanied by E. T. McKnight and H. S. Ladd of the Federal Geological Survey.

The Park Walton drainage project in 1942-43 and the Melrose project during 1944-45 were under the general supervision of W. D. McMillan and continued under C. H. Johnson, chief of the Rolla Branch, Mining Division, of the Bureau of Mines in the fiscal year 1946. The writer was the project engineer for both Bureau of Mines projects from November 1942 to July 1946.

The work of the Bureau of Mines in the Melrose district received the generous support of all the many Tri-State mining companies, consulting engineers, geologists, geophysicists, land-owners, churn drillers and others. Acknowledgment is hereby gratefully given to each for the splendid cooperation, assistance, advice, constructive criticisms and freely given access to all recorded data.

Figure 1. - Location map, Tri-State mining region.
Essential information was furnished from the files of A. G. Johnson, geologist, Vinegar Hill (Century) Zinc Co., K. L. Koelker, consulting mining engineer, Joplin, and D. G. Harrison, district manager, United Zinc Smelting Corp. Concepts of stratigraphic and structural geological control which governed planning of the Melrose drainage and churn-drilling programs by the Bureau of Mines were based largely on discussions with G. M. Fowler, consulting geologist of Joplin, and his assistants, J. P. Lyden and J. M. Thiel, and upon study of their numerous publications on the geology of the Tri-State mining region. Discussions with S. S. Clarke, general mine superintendent, Eagle Picher Mining & Smelting Co., and his experienced assistants, and visits to the numerous Picher field pumping plants helped in planning installation of the Park Walton plants.

The geophysical surveys were based largely on published results of investigations by the State Geological Survey of Kansas, and discussions with staff members of the Kansas Geological Survey, The American Zinc, Lead & Smelting Co., and C. H. Frost, consulting geophysicist of Tulsa, Okla., all of whom had done similar geophysical work in the Tri-State district. The geophysical work of the Division of Geophysical Exploration of the Bureau of Mines in the Melrose district consisted of gravimetric surveys, computations, and maps by W. E. Davis, associate geophysicist under the supervision of H. R. Joesting, regional geophysicist. The resulting geophysical data and maps were made available for use in this report of investigations.

In a visit to the Park Walton mine workings on September 6, 1945, A. E. Weissenborn and J. S. Cullison, geologists of the Federal Geological Survey, mapped the underground geology, but completion of comprehensive mapping for the geological guidance of the Melrose district program was not possible at the time.

LOCATION OF MELROSE DISTRICT

The Melrose mining district lies beyond the western outskirts of the highly productive Tri-State mining region. It includes a 30- to 60-square-mile area in northwestern Ottawa County, Okla., and southwestern Cherokee County, Kans. The area is roughly bounded by the Neosho River on the west and Fourmile Creek on the east and extends from Chetopa, Kans., southward about 15 miles to Miami, Okla. (fig. 1).

The village of Melrose, Kans., at the north edge of that district is on paved U. S. Highway 166, about 28 miles west of Joplin, Mo. It is 7 miles west and 3 miles north from Picher, Okla. The Park Walton mine and mill, centrally located and easily accessible in the Melrose district, are on the Oklahoma side of the State-line road, 2-1/4 miles south and 1-1/4 miles west of Melrose. A network of graveled farm-to-market roads and paved highways connects with Picher, Miami, Chetopa, Columbus, Baxter Springs, and other surrounding towns, where mining labor, supplies, and other necessities are ordinarily plentiful.

All other new mine developments, as well as all the properties on which the Bureau of Mines conducted churn drilling, are within a 3-mile radius to

\[\footnote{Work cited in footnote 3.}\]
the northwest, north, and southeast of the Park Walton. The new T. R. Smith mine and mill of the Fourmile Mining Co. are in Oklahoma on the west bank of Fourmile Creek, 3 miles south and 1 mile east of Melrose. The same company has made preparations to sink a shaft on the Alsbaugh property which joins the T. R. Smith on the south. The Mahuteka Mining Co. has started mine development on the Varatta property in Kansas, 2 miles south of Melrose and 3½ miles northeast of the Park Walton.

Nearest railroads to the Melrose district mines are the Missouri, Kansas & Texas and the Missouri Pacific through Chetopa, Kans., 7 miles west of Melrose, and the Northeast Oklahoma and Frisco Railroads serving the Picher mining field to the east.

PHYSICAL FEATURES AND CLIMATE

The entire Melrose district is devoted to farming and is relatively flat, open terrain, with some wooded tracts along the river and creeks. The surface drainage is to the southwest along several creeks and ravines flowing into the Neosho River. The gentle topographic relief slopes from the 890-foot elevation on the highest hill in the district 1-1/2 miles south of Melrose down to the 765-foot normal water level in the Neosho River 2-1/2 miles to the west (fig. 2).

Climate and precipitation are generally moderate, affording excellent year-around mine and mill operating conditions.

GENERAL GEOLOGY

The Tri-State mining district lies on the northwestern flank of the Ozark uplift 35 miles from the nearest outcropping igneous rocks. Sedimentary strata of shale, sandstone, limestone, chert and dolomite of several geological systems overlie the granitic basement rocks. Sedimentary thicknesses varying from 1,045 to 1,815 feet below the surface have been recorded in the few deep wells that have penetrated igneous rocks in the Tri-State mining region. Ordinarily, 16 often recognizable thin-bedded strata that have been designated as B to R beds,⁵/ comprise the Mississippian Boone formation, which, with occasionally the overlying Chester formation, are the host rocks of the ore deposits. Beds B, C, H, K, M, O, P, and R have been most productive. Alteration by solution action has more or less silicified and dolomitized the areas in the vicinity of the ore.⁶/ Sphalerite and galena are the ore minerals; chert, limestone, jasperoid, and dolomite, with minor quantities of calcite, dolomite, and marcasite crystals, are the principal gangue materials. Pockets of a rusty gray gouge (locally referred to as "selvage"), some muddy slimes, "earthy" limestone, tar "sand", and shale are commonly found filling crevices


⁶/ McKnight, E. T., and others. Map showing structural geology and dolomitized areas in part of the Picher zinc-lead field, Oklahoma and Kansas: Geol. Survey, Tri-State Zinc-Lead Investigations, Preliminary Map (6 sheets), 1940 (?)
Figure 2. - Topographic map of Melrose district.
Figure 3. - Ore deposits and general geology of the Tri-State region.
Figure 4. - Stratigraphic correlation, Tri-State mining fields.
Figure 5. - Contours on base of Cherokee shale.
Figure 6. - Contours on top of M bed.
Figure 7. - Contours on top of Grand Falls chert horizon.
in the deposits. Mineralization has been controversially ascribed to ascending hot solutions,\(^7\) artesian circulation,\(^8\) and descending ground water.\(^2\)

Regardless of the uncertainty of their origin, the ore deposits generally bear a more or less definite relationship to structural features,\(^{10}\) exemplified by the gentle folding, doming, slumpage, and their attendant fracturing stress relief in the Tri-State region. Major known features of the Picher mining field are the Miami "trough" or fault, an irregular system of deep structural basins which follows a northeasterly course, and an intersecting synclinal northwesterly-striking trough, known as the "Bendelari" (fig. 3). Other paralleling northeast and northwest structures are indicated, and some ore bodies trend along those respective fracture systems.

The Melrose field drilling has shown similar deformation through apparently milder results of solution action, and underground development in the Park Walton mine has revealed northwest and northeast fracturing associated with the ore body.

Melrose stratigraphy, with a few exceptions, is similar to that in the Picher field (fig. 4). Melrose is a little farther down on the slight northerwestern regional slope of the Ozark uplift. In the Mississippian system the Grand Falls chert horizon (\(N, 0, P, Q\) beds) has an average thickness of 60 feet; the overlying \(M\) bed is about 30 feet thick; often the top of \(M\) and nearly always the overlying \(K\) and \(L\) beds are absent owing to unconformities at the top of the Keokuk member of the Mississippian-Boone formation.

An average 100-foot thickness of the overlying Warsaw (\(B, C, D, E, F, G, H, J\) bed) member remains, with sharp erosional unconformities in the upper strata. The Warsaw is unconformably blanketed by the Chester limestone formation, which varies from 0 to 150 feet in thickness at Melrose but averages about 25 feet. A few sporadic ore deposits occur in the Chester at Melrose, as in the Picher field. The unconformity at the top of the Mississippian series, 120 to 300 feet below the surface at Melrose, is overlain by the impervious Pennsylvanian Cherokee shale. The shale, often with a few thin interbedded sandstone and coal strata, is generally covered by 10 to 60 feet of recent surface alluvium.

Figure 5 shows the "topography" of the top of the Chester limestone, or base of the Cherokee shale, as indicated by drilling in the Melrose field. In the course of this project an attempt was made similarly to contour the top of the Short Creek oolitic limestone, which is also the top of the \(M\) bed and is an excellent stratigraphic marker where present and recognizable (fig. 6), and the top of the Grand Falls chert, which is a generally recognizable deeper horizon (fig. 7).

\(^7\) Work cited in Footnote 3.
\(^{10}\) Fowler, George M., Tri-State Geology: Eng. and Min. Jour., vol. 144, No. 11, 1943, pp. 73-79.
Solution channels along permeable zones in the Mississippian strata occur throughout the Melrose district similar to those found in the Picher-Commerce field,\textsuperscript{11} where during the early explorations and mining developments heavy flows of sulfur (hydrogen sulfide-bearing) water were also encountered in the "open" subterranean solution channels. At Melrose, the similar artesian water pressure in "open" exploratory churn-drill holes was sufficient to force the water up from the subterranean channels encountered at depths of 230 to 425 feet, to static levels of 65 to 150 feet below the surface. Because of this pressure, together with occasional pockets of bitumen ("tar"), natural gas, and the relatively deeper Melrose ore deposits, many authorities had predicted an almost insurmountable mine drainage and development problem. Park Walton pumping, however, quickly funneled the static water level down to the 350-foot drainage level being developed and maintained just under the Park Walton ore deposit. The water level also has been lowered 100 to 170 feet wherever measurable in deep wells in the surrounding 6 square miles of the Melrose district (fig. 6). The Park Walton pump output was reported to average less than 2,000 gallons of water per minute during the first half of 1946, which satisfactorily maintained the mine drainage under the steadily diminishing inflow. The artesian sulfur water is normally alkaline but may become slightly acid and troublesome if allowed to rise into mine workings or natural openings where sulfides are in the process of oxidizing. Surface and shallow water flows have not affected mine drainage in the Melrose field because of the impervious Pennsylvanian shale overlying the Mississippian Boone formation.

HISTORY OF MELROSE DISTRICT

Exploration

Drilling by various concerns on numerous Melrose district farms from 1923 to 1938 totaled more than 800 holes, but this total includes many shallow holes drilled only to the base of the shale. The Park Walton deposit had received the most detailed exploratory drilling, but zinc and lead discoveries reported in the more scattered drill holes on a dozen nearby farms indicated additional ore reserves.

The feasibility of using geophysical methods to guide zinc and lead explorations in the Tri-State mining region was investigated during 1941 by the University of Kansas and the Kansas Geological Survey, with the financial assistance of the Tri-State Ore Producers Association. About 20 acres over the indicated Park Walton ore deposit was one of the small areas on eight widely separated Oklahoma, Kansas, and Missouri properties which were experimentally surveyed by five geophysical methods.\textsuperscript{12} The conclusion was that resistivity, magnetic, and gravimetric surveys, in that order, promised the most as guides for churn drilling explorations.

Other State geological surveys and some Tri-State mining companies also have conducted geophysical explorations in other parts of the Tri-State mining region, but as yet no acceptable interpretation of the geophysical anomalies is known to have been demonstrated.

\textsuperscript{11} Work cited in footnote 8.
\textsuperscript{12} Work cited in footnote 3.
Figure 8. - Static Artesian water levels, June 1946.
Mining Developments

After drilling 10 more holes on the Park Walton farm in 1941 to confirm and further explore that ore deposit, the United Zinc Smelting Corp. churn-drilled three holes of large diameter. 370 feet in depth, for anticipated installation of deep-well drainage pumps. In November 1942 the Bureau of Mines began work on the Park Walton drainage project, to be described later. Starting in July 1943 the United Zinc Smelting Corp. sank the first Park Walton shaft to the 310-foot level and drove 70 feet of crosscut toward the ore body. Favorable results of Bureau of Mines pumping, which had been begun in May 1943, also enabled the United Zinc Smelting Corp. to obtain adequate Defense Plant Corporation financing to complete mine development and drainage. All pumping equipment and operations were taken over by the United Zinc Smelting Corp., acting as agent for the Defense Plant Corporation, in the latter part of 1943.

Then the first shaft was deepened, and a second was sunk to the 350-foot level. Despite the inability of the Bureau of Mines deep-well pumps to maintain drainage below the 316-foot level, owing to the restricted water inflow into the relatively small pump holes, both shafts were sunk "dry" to a depth of 350 feet below the surface because they were located in "tight" limestone along the west wall of the deposit. The heavy water flow was first tapped in its natural subterranean channel which was over the back of the 350-level crosscut, 50 feet east from the bottom of the initial shaft. Almost complete drainage of the Park Walton ore reserves was soon maintainable on the 350-foot level after the operating company had driven a crosscut east from the bottom of each shaft to connect with deep-well pump holes.

Park Walton production started early in 1944, from crosscuts and drifts that were driven on the 310-foot level. An estimated half of the previously indicated ore reserves above that level had been developed and depleted by June 1946; little development or production had been accomplished on the 350 level.

Production was facilitated in February 1946, when the Park Walton mill, which was built by the United Zinc Smelting Corp. without Government financial assistance, was put into operation. All ore had previously been hauled 11 miles east to the United Zinc's Royal mill for treatment.

The Park Walton mill had a maximum capacity of 700 tons of ore per day and was of standard modern Tri-State design with ample storage bins, crushing plant, and concentration equipment, including rougher jigs, a ball mill, and flotation circuits for both lead and zinc concentration. The plant was adequately equipped for custom milling.

The Mehuta Mining Co. obtained a Reconstruction Finance Corporation development loan and started work in September 1946. A large pump hole was churn-drilled, a pumping plant was installed, and sinking of a 425-foot shaft on the Varatta property, 3/4 mile northeast of the Park Walton, was completed in February 1947.
Starting in 1944, the Fourmile Mining Co. sank a 234-foot shaft on the T. R. Smith property, 2-1/2 miles southeast of the Park Walton. An upper ore horizon 190 to 230 feet in depth, indicated on the Chester horizon by previous drilling, had been watered in 1943 through subterranean solution channels leading to the Park Walton pumps. The Fourmile Mining Co., having partly developed the shallow T. R. Smith mine and built a mill, was ready for production but had operated only during short, intermittent periods during 1946.

Preparatory work was also done early in 1946 by the Fourmile Mining Co., and sinking of an initial 315-foot shaft on the Alstaugh property 1/4 mile south of the T. R. Smith shaft was started where an ore reserve had been previously indicated.

WORK BY BUREAU OF MINES

Park Walton Drainage Project

The Bureau of Mines began preparatory work on the Park Walton drainage project in November 1942. The initial work included purchase of pumping and electrical equipment, topographic surveying, road building, excavation of drainage ditches and measuring-weir ponds, precautions to prevent soil erosion, and construction of three 30-foot pump derricks and buildings. Three miles of high-voltage power line was constructed by the power company from its main transmission line at Melrose, Kans., and a transformer station and power distribution lines were erected on the Park Walton property for the Bureau of Mines.

The pump holes were 15 inches in diameter through the upper 200-foot shale section, which was cased with 12-1/4-inch pipe. The lower sections of the holes through the Mississippian rocks were drilled 12-1/4 inches in diameter to completion and left uncased. The holes penetrated the "open" ground in the upper ore horizon about 270 to 315 feet under the surface, below which much less porosity had been indicated by the churn drilling in the relatively "tight" formations. Later, this tight horizon did seriously restrict the water inflow into the holes after the water table had been lowered below the 300-foot level, and when pumps were lowered to their permanent 350-foot level settings.

After a long recess due to delays in obtaining delivery of the high-priority pumping equipment, the three pumps arrived in May, June, and July, respectively; upon delivery, each was installed promptly and put into operation. Excepting a few necessary shut-downs, the pumps operated continuously and were taken over by the United Zinc Smelting Corp. on November 15, 1943.

The three units were identical standard Pomona, deep-well, water-lubricated, turbine pumps, each having a rated capacity of 1,200 gallons of water per minute against a 360-foot head when turning 1,760 r.p.m. Each pump assembly has 10 stages of 11-1/2-inch head when turning 1,760 r.p.m. Each pump assembly has 10 stages of 11-1/2-inch, porcelain-lined, cast-iron bowls with bronze impellers on a stainless steel shaft. The bowl assembly on each pump is at the bottom of the 350-foot, 9-inch discharge column extending down each of the 12-1/4-inch churn-drill holes. The drive shaft is supported in the center of
the discharge column by floating-type, water-lubricated, rubber bearings, which are held by bronze spiders between each 10-foot pipe length of the discharge column. The "unidrive" surface discharge head on each pump features a direct-connected, vertical-mounted, 2,300-volt, 60-cycle, 150-horsepower motor on top of which a large radial roller thrust bearing supports the weight of the long drive shaft and impellers. Installed in the building at each pumping plant were starting panels with surge switches, overload oil circuit breakers, lightning arrestors, and water-pressure switches to stop the pump automatically upon faltering of the water supply.

All possible provisions for continuous trouble-free operation during the anticipated long pumping period were emphasized, but the pump installations generally followed the common practice of operators in the neighboring Picher mining field.

During the 6-1/2 months of continuous pump operations by the Bureau of Mines, one man was employed watching the three pumping plants on each 8-hour shift. Records were kept of: (1) Hourly weir measurements for the output of each pump, (2) the exact time lost during shut-downs and the reason for the delays, (3) daily water-level measurements in various nearby "open" churn-drill holes, and (4) semimonthly measurements in all open outlying wells in the district (tables 1 and 2). The serious losses in operating time occurred during the disastrous May 1943 flood, when the main power switch at the Park Walton transformer was damaged and the power company plant threatened. Later, much time was lost while awaiting repairs after the rubber bearings in one of the pumps had been damaged by pumping "tar" when the water level had suddenly "funneled" down to the pump intake.

Inflow to the pumps was seriously restricted after September 1943, when the water had receded below the "open" 300-foot horizon and it became necessary to lower the pumps to the permanent 350-foot setting. Because of the tighter formation in the M-bed horizon of the 12-1/4-inch holes the pumps could not maintain drainage below the 316-foot level. Later attempts by the United Zinc Smelting Corp. to chamber a hole by heavy blasting also proved unsuccessful. It was therefore necessary during the last 2 months of pump operation by the Bureau of Mines to shut down a pump occasionally and to raise the impeller drive shaft adjustment on each pump sufficiently so that pump output would equal drill-hole inflow.
### TABLE 1. - Summary of pump operations, May - November 1943

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<td>Hr. operated</td>
<td>500</td>
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<td>675</td>
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<td>1,395</td>
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<td>980</td>
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<td>Hr. operated</td>
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<td>360</td>
<td>3,538</td>
<td></td>
</tr>
<tr>
<td>Average g.p.m.</td>
<td>1,510</td>
<td>1,390</td>
<td>1,200</td>
<td>1,120</td>
<td>1,055</td>
<td>1,040</td>
<td>1,235</td>
<td></td>
</tr>
<tr>
<td>No. 3 pump</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hr. operated</td>
<td>55</td>
<td>731</td>
<td>717</td>
<td>744</td>
<td>359</td>
<td>2,606</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average g.p.m.</td>
<td>1,300</td>
<td>1,145</td>
<td>1,220</td>
<td>1,210</td>
<td>1,200</td>
<td>1,195</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total output</td>
<td>47,100</td>
<td>115,100</td>
<td>128,000</td>
<td>146,580</td>
<td>115,140</td>
<td>127,080</td>
<td>60,180</td>
<td>1,741,180</td>
</tr>
<tr>
<td>Total power consumption, kw.-hr.</td>
<td>54,000</td>
<td>181,800</td>
<td>192,400</td>
<td>282,300</td>
<td>244,700</td>
<td>271,900</td>
<td>150,050</td>
<td>1,378,750</td>
</tr>
<tr>
<td>Kw.-hr. per 1,000 gal.</td>
<td>1.159</td>
<td>1.526</td>
<td>1.527</td>
<td>1.933</td>
<td>2.125</td>
<td>2.140</td>
<td>2.493</td>
<td>1.860</td>
</tr>
<tr>
<td>Power cost per 1,000 gal.</td>
<td>$0.0116</td>
<td>$0.0146</td>
<td>$0.0143</td>
<td>$0.0175</td>
<td>$0.0196</td>
<td>$0.0223</td>
<td>$0.0178</td>
<td>$0.01718</td>
</tr>
<tr>
<td>Other operating costs per 1,000 gal.</td>
<td>2/$0.0101</td>
<td>$0.0031</td>
<td>$0.0030</td>
<td>$0.0079</td>
<td>$0.0013</td>
<td>$0.0039</td>
<td>$0.0178</td>
<td>2/$0.00712</td>
</tr>
<tr>
<td>Average water level, ft. below surface</td>
<td>108 to 136</td>
<td>245</td>
<td>275</td>
<td>308</td>
<td>300</td>
<td>316</td>
<td>316</td>
<td></td>
</tr>
<tr>
<td>Rated capacity of each pump at that depth, g.p.m.</td>
<td>1,500</td>
<td>1,400</td>
<td>1,300</td>
<td>1,260</td>
<td>1,280</td>
<td>1,250</td>
<td>1,250</td>
<td></td>
</tr>
</tbody>
</table>

1/ In thousands of gallons of water.
2/ All other direct costs, not including amortization of capital investment for equipment.
TABLE 2. - Pump operating-time record  
(time in pump-hours)

<table>
<thead>
<tr>
<th>Pump</th>
<th>No. 1</th>
<th>No. 2</th>
<th>No. 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total operating time, hrc.</td>
<td>4,424</td>
<td>3,538</td>
<td>2,606</td>
<td>10,568</td>
</tr>
<tr>
<td>Analysis of lost time, hr.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power failures during storms, etc.</td>
<td>96</td>
<td>3</td>
<td>3</td>
<td>102</td>
</tr>
<tr>
<td>Repairing</td>
<td>6</td>
<td>-</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Connecting other equipment</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Pumping equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowering settings</td>
<td>19</td>
<td>6</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Insufficient water in holes</td>
<td>55</td>
<td>-</td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>Pulling and repairing</td>
<td>-</td>
<td>351</td>
<td></td>
<td>351</td>
</tr>
<tr>
<td>Adjusting impellers, etc.</td>
<td>11</td>
<td>1</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Total lost time, hr.</td>
<td>192</td>
<td>362</td>
<td>17</td>
<td>571</td>
</tr>
</tbody>
</table>

At the end of the 6-1/2-month period of the Park Walton test drainage project, the static artesian water level, originally about 108 feet below the surface, had been lowered to the 316-foot level in the "open" drill holes in the Park Walton ore deposit. Not only was a considerable part of the Park Walton ore reserve unwatered, thus demonstrating the feasibility of the operation, but significant drainage had been effected throughout a 6-square mile surrounding area.

**Melrose District Project**

As already stated, a long-range program of exploration and development for the Melrose district was proposed which would consist of three steps or phases. As a start, the Bureau drilled 90 holes, totaling 33,808 feet, and made a number of topographic and geophysical surveys.

In the first step, about 72 holes were drilled to cross-section the most promising of the previously inferred ore bodies. As already mentioned, private companies continued drilling, and mine development has been undertaken on three properties besides the Park Walton.

Of the second step in the proposed program, only the initial topographic mapping of the heart of the Melrose district, 6 holes drilled on the Park Walton property to check some previously recorded gravimetric anomalies, 12 distantly spaced holes on a regional reconnaissance basis, and detailed gravimetric surveys of two small areas have been accomplished.

Of the final, or third, stage of the proposed program, only a preliminary gravimetric survey covering 15 square miles in the heart of the Melrose district has been completed.

2462
Churn Drilling and Sampling

Parts of three areas - the Park Walton, the Vanatta, and the Fourmile Creek - were investigated in detail by the Bureau of Mines. Each included two or more prospects in the Melrose district.

The churn drilling by the Bureau of Mines was distributed as shown in table 3:

<table>
<thead>
<tr>
<th>Property</th>
<th>State</th>
<th>Area (acres)</th>
<th>No. of holes</th>
<th>Total footage</th>
<th>Date recessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park Walton</td>
<td>Okla.</td>
<td>240</td>
<td>6</td>
<td>2,176</td>
<td>9/15/44</td>
</tr>
<tr>
<td>Coffey</td>
<td>Kans.</td>
<td>150</td>
<td>2</td>
<td>763</td>
<td>10/12/44</td>
</tr>
<tr>
<td>T. R. Smith</td>
<td>Okla.</td>
<td>100</td>
<td>18</td>
<td>5,777</td>
<td>6/9/45</td>
</tr>
<tr>
<td>H. W. Smith</td>
<td>Kans.</td>
<td>115</td>
<td>15</td>
<td>5,638</td>
<td>4/20/45</td>
</tr>
<tr>
<td>Alsbaugh</td>
<td>Okla.</td>
<td>400</td>
<td>14</td>
<td>4,840</td>
<td>6/1/45</td>
</tr>
<tr>
<td>Mead</td>
<td>Kans.</td>
<td>38</td>
<td>4</td>
<td>1,656</td>
<td>9/28/45</td>
</tr>
<tr>
<td>Vanatta</td>
<td>do.</td>
<td>160</td>
<td>21</td>
<td>9,104</td>
<td>11/29/45</td>
</tr>
<tr>
<td>von Trebra</td>
<td>do.</td>
<td>140</td>
<td>10</td>
<td>4,054</td>
<td>4/13/46</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>90</td>
<td>53,803</td>
<td></td>
</tr>
</tbody>
</table>

Of the 90 holes drilled by the Bureau of Mines, 22 indicated minable ore; 10 of the 22 were relatively "high grade." Submarginal zinc and lead ore occurred in 26 of the other holes; "shine holes," as the latter are called, may be evidence of ore reserves in the Tri-State district, particularly where cavernous conditions and heavy subterranean artesian water flows cause unsatisfactory recovery of drill cuttings. Samples from 31 holes contained traces to 0.5 percent lead and zinc. The remaining 11 holes were blanks.

The Bureau of Mines was permitted to log and sample 34 privately drilled holes during the period of the project.

The Melrose district project was begun on June 24, 1944. One to four churn drills, each with a two-man crew, were employed under contract on a single-shift basis until the project was stopped on April 13, 1946 (excepting recesses from June 8 to July 30, 1945, and September 26 to October 29, 1945). During the entire time, 40 feet of hole per drill-shift was averaged. C. Shouse & Sons Drilling Co. of Baxter Springs, Kans., was the contractor.

Ten-inch holes were drilled and cased in surface alluvium, which occurred to a maximum of 60 feet in depth. Through the shale, ranging from 130 to 264 feet in depths below the surface, the diameter of the holes was reduced to 8 inches, and another smaller casing was set to the top of the Mississippian Chester limestone. Most holes were completed at depths ranging from 307 to 445 feet, with 5-1/8-inch bits. In some holes loose, cavernous ground, often encountered near the ore horizon, threatened accuracy of sampling. Under such conditions, 6-inch casing was driven as deep as possible while the holes were being completed to the required depths with 4-7/8-inch bits.
Cuttings were bailed from the holes at 5-foot intervals and examined for mineralization and stratigraphic correlation. Small portions of each sample were penned, and the sampling interval was reduced to 2-1/2 feet upon the appearance of lead or zinc minerals or when a favorable bed was approached. All cuttings and slimes obtained in samples containing significant lead and zinc mineralization were settled in tube to allow the clear water to be siphoned off. The entire bulk of each sample was normally reduced by pouring through a large sample splitter (Jones sampler) enough times to obtain a 4- to 6-pound sample when dried. Recovery of samples was calculated for each 2-1/2-foot hole section. Lead and zinc analyses were made by a commercial laboratory. Recovery of samples during the drilling was often unsatisfactory due to loose, cavernous conditions in the holes and the usual accompanying heavy sulfur-water flow. Occasional samples were very small or entirely lost upon the holes encountering crevices or caves. Few of the calculated sample recoveries exceeded 100 percent, which indicated that it had not been possible to drive the casing rapidly enough to prevent caving or running in of loose materials.

Effort was made to record all pertinent data from the drilling of each hole. All holes were logged independently by the driller, by the Bureau of Mines sampling forman, and by the project engineer. Under the supervision of the project engineer, the sampling was done by the trained sampling foreman and a part-time assistant.

On each of the completed drill-hole logs were recorded the measured depths to the top and bottom of the ore horizons, the sample analyses, stratigraphic lithology, mapped coordinates locations, and the curb elevations of the holes. Also noted were the relative hardiness of each bed, the intensity and kind of alteration, the associated gangue materials, the panning estimate of the lead and zinc content, the horizons of crevices, caverns, and loose materials, the percentage of sample recovery, the point at which water inflows were encountered (particularly the deep artesian sulfur water), the static water level upon completion of the holes, and any pockets of natural gas, "tar" or crude oil that were encountered. The methods were described whenever holes were blasted to straighten them or to obtain a rough recheck on poor recovery of samples.

Churn-drill-hole sampling, although the most practical method yet devised for testing Tri-State ore deposits, only compromises with accuracy, but the balance of errors has generally proved to be on the conservative side. Much of the ore found in hard flint formations associated with heavy water flow is lost in crevices. The boulders and muddy slimes in water and loosely filled caverns often contaminate the samples to some extent in spite of closely driven casing. Large crystalline pieces of galena and sphalerite are often associated with the stiff, pasty, selvage, and mud in some parts of the deposits that exclude water. In such soft horizons, the large pieces of ore are only chipped by the churn-drill bit while being pushed into the soft walls or bottom of the hole.

Upon comparing the actual Park Walton mine production with the initial indicated ore-reserve estimates by the Bureau of Mines, based on the recorded old churn-drill data for the exact areas that had been mined out by June 1946,
it was found that the mined tonnage was 25 percent greater than the original calculated tonnage; zinc concentrate production was 50 percent higher and lead concentrate production had more than doubled the early estimate.

**Topographic Surveys**

Beginning in July 1944, about 45 miles of taped base-line traverses and bench levels were surveyed along the section line roads in 15 square miles of the Melrose district by a three-man survey crew and the project engineer. Eighth-mile stations with close elevation data along these lines and the more detailed grids laid out on parts of five properties were used for gravimetric survey stations. The coordinate system initiated by the Century Zinc Co. in mapping the Park Walton property during 1929 churn-drilling explorations was extended throughout the district mapping by the Bureau of Mines. All surveys and elevations were adjusted and tied closely to the new Federal Geological Survey traverse monuments and elevation bench marks which were brought into the Chetopa area in 1939 - revised notes of which were made available by C. L. Sadler from the Federal Geological Survey office of the Topographic Branch, Rolla, Mo. Locations and curb elevations of all churn-drill holes and the more detailed topography of the investigated areas usually were mapped by stadia surveys. Supplementing the base surveys, elevations or gravity survey stations, drill holes, and other concisely located points in the Melrose district, and aerial photographs of the area (obtained from the United States Department of Agriculture) were used to sketch the intervening relief and drainage pattern details on the topographic map.

When the topographic map and aerial photographs are viewed from a regional standpoint, sporadic slight surface expressions of the structural pattern are apparent. In the absence of more tangible basic data these served as guides to the preliminary reconnaissance churn drilling.

**Geophysical Surveys**

From August 1944 to May 1945, a regional gravimetric survey was conducted by the Bureau of Mines. About 15 square miles in the center of the Melrose district was covered by 1/8-mile station intervals along each section line road (fig. 9). More detailed gravimetric work was done on parts of five properties in the Park Walton and the Fourmile areas.

The anomalous features indicated in the gravimetric maps of the detailed areas appeared similar in many general respects to the structural pattern inferred from topography, but since only a few test holes have been drilled, no definite conclusions were reached.

A regional gravimetric survey as well as some of the old churn-drill-hole data suggested a structural "dome", 3/4 mile southeast of the Park Walton but insufficient drilling has been done for confirmation. Although gravimetric surveying has been successful in exploring for large oil field structures, the miniature structures in the Tri-State mining region are expected to be indicated by anomalies so small as to nearly approach the instrumental and reading errors.
Figure 9. - Residual gravity map of Melrose district.
Figure 10. - Initial gravimetric survey, Park Walton area.
Figure II. - Bureau of Mines gravimetric survey, Park Walton area.
Figure 12. - Gravimetric survey, Fournile Creek area.
Figure 13. – Drilling in Park Walton area.
Figure 15. - Drilling in Fourmile Creek area.
As previously stated, the first 6 Bureau of Mines holes on the Park Walton were drilled to test previously-indicated gravity anomalies\(^{13}\) (fig. 10).

Hole BM-1 was located on a gravimetric "high" and showed the recognizable Mississippian beds to be stratigraphically high, predominantly limestone, unaltered and unmineralized throughout the entire depth. The hole was drilled 345 feet in depth, 10 feet into the hard Grand Falls chert (N-bed); no openings or artesian sulfur water was found.

Hole BM-2 was near the maximum gravity "low" area, which happened to be 100 feet east of the first hole. A large cavern, loosely filled with boulders and altered material, was encountered from 264 to 330 feet in depth. The sulfur water level stood at 324 feet in depth to which it had then been lowered by Park Walton pumping and traces of galena and sphalerite were found on the floor of the cavern at 330 feet, under which the hard Grand Falls chert horizon was encountered.

Hole BM-3 was a short distance from the south end and on the flank of a long narrow irregular gravimetric "low". A 20-foot thickness of fair lead ore was encountered at 305 feet. The ore had nearly been waterned by the mine pumps but the typical sulfur water was encountered before reaching the top of the Grand Falls chert horizon at 341 feet.

Holes BM-4 and -5 were drilled on flanks of a rather broad gravity "low" in the northeast corner of the area. The recognizable predominantly limestone beds were stratigraphically low in both holes. Sulfur water and a little zinc and lead were encountered in a crevice at the top of the Grand Falls chert horizon, 370 feet in depth.

Hole BM-6 was about midway between holes 3 and 5, near the north end of the previously mentioned long, narrow, irregular, gravimetric "low" area, but results were similar to those for hole 5.

On the assumption that since most of the Park Walton ore deposit and surrounding interrelated subterranean voids had been waterned and that the gravimetric "low" contour differentials therefor might be exaggerated, the Bureau of Mines resurveyed the Park Walton area in detail with the newly purched gravimeter late in 1944 (fig. 11). In the spring of 1945, the detail gravimetric survey was extended northwestward onto the W. W. Smith and Mead properties shortly before the Bureau of Mines drilling on those properties was discontinued. Another area surveyed in detail was the Fourmile Creek area (fig. 12).

FACTUAL CHURN-DRILL DATA

The locations of the 90 holes churn-drilled by the Bureau of Mines in the Meboose district are shown in figures 13, 14, and 15. The condensed logs and stratigraphic correlations are given in Table 4; the detailed logs are presented in an appendix to this report.

\(^{13}\) Work cited in footnote 3.
TABLE 4. - Pertinent data from Bureau of Mines churn-drill-hole logs

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Collar elev., f.a.s.</th>
<th>Completed, total</th>
<th>Base of shale</th>
<th>Base of Chester</th>
<th>Top of M bed</th>
<th>Top of N bed</th>
<th>Ore horizon From-</th>
<th>Ore horizon To-</th>
<th>Average metal content, percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM-1</td>
<td>813</td>
<td>345</td>
<td>187</td>
<td>220</td>
<td>303</td>
<td>335</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BM-2</td>
<td>813</td>
<td>350</td>
<td>187</td>
<td>230</td>
<td>303</td>
<td>338?</td>
<td>325</td>
<td>330</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-3</td>
<td>815</td>
<td>360</td>
<td>198</td>
<td>235</td>
<td>325</td>
<td>341</td>
<td>302-1/2</td>
<td>325</td>
<td>0.43 1.34</td>
</tr>
<tr>
<td>BM-4</td>
<td>818</td>
<td>380</td>
<td>212</td>
<td>240</td>
<td>338</td>
<td>373</td>
<td>360</td>
<td>370</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-5</td>
<td>817</td>
<td>371</td>
<td>213</td>
<td>240</td>
<td>330</td>
<td>368</td>
<td>360</td>
<td>368</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-6</td>
<td>817</td>
<td>370</td>
<td>208</td>
<td>240</td>
<td>320</td>
<td>357</td>
<td>360</td>
<td>365</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-7</td>
<td>808</td>
<td>373</td>
<td>218</td>
<td>255</td>
<td>335</td>
<td>368</td>
<td>360</td>
<td>367-1/2</td>
<td>0.36 0.19</td>
</tr>
<tr>
<td>BM-8</td>
<td>796</td>
<td>320</td>
<td>142</td>
<td>170</td>
<td>279</td>
<td>310</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BM-9</td>
<td>807</td>
<td>390</td>
<td>218</td>
<td>245</td>
<td>345</td>
<td>382</td>
<td>350</td>
<td>357-1/2</td>
<td>1.8 0.34</td>
</tr>
<tr>
<td>BM-10</td>
<td>793</td>
<td>312</td>
<td>138</td>
<td>170</td>
<td>235</td>
<td>297</td>
<td>290</td>
<td>295</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-11</td>
<td>810</td>
<td>382</td>
<td>220</td>
<td>225</td>
<td>334</td>
<td>367</td>
<td>360</td>
<td>365</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-12</td>
<td>792</td>
<td>318</td>
<td>142</td>
<td>170</td>
<td>287</td>
<td>302</td>
<td>295</td>
<td>300</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-13</td>
<td>810</td>
<td>383</td>
<td>213</td>
<td>245</td>
<td>330</td>
<td>367</td>
<td>360</td>
<td>367-1/2</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-14</td>
<td>793</td>
<td>330</td>
<td>146</td>
<td>185</td>
<td>303</td>
<td>310</td>
<td>300</td>
<td>305</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-15</td>
<td>812</td>
<td>376</td>
<td>201</td>
<td>225</td>
<td>334</td>
<td>367</td>
<td>355</td>
<td>367-1/2</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-16</td>
<td>796</td>
<td>355</td>
<td>130</td>
<td>280</td>
<td>345?</td>
<td>Shallow None</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BM-17</td>
<td>811</td>
<td>395</td>
<td>198</td>
<td>230</td>
<td>323</td>
<td>360</td>
<td>357-1/2</td>
<td>362-1/2</td>
<td>0.84 0.09</td>
</tr>
<tr>
<td>BM-18</td>
<td>794</td>
<td>322</td>
<td>160</td>
<td>180</td>
<td>290</td>
<td>310?</td>
<td>200</td>
<td>225</td>
<td>0.6 1.12</td>
</tr>
<tr>
<td>BM-19</td>
<td>811</td>
<td>390</td>
<td>196</td>
<td>220</td>
<td>321</td>
<td>369</td>
<td>360</td>
<td>362-1/2</td>
<td>0.6 0.03</td>
</tr>
<tr>
<td>BM-20</td>
<td>803</td>
<td>386</td>
<td>184</td>
<td>210?</td>
<td>335?</td>
<td>345?</td>
<td>360</td>
<td>375</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-21</td>
<td>808</td>
<td>363</td>
<td>199</td>
<td>230</td>
<td>320</td>
<td>360</td>
<td>355</td>
<td>360</td>
<td>Trace Trace</td>
</tr>
<tr>
<td>BM-22</td>
<td>800</td>
<td>310</td>
<td>167</td>
<td>185</td>
<td>290?</td>
<td>300?</td>
<td>215</td>
<td>235</td>
<td>.65 0.49</td>
</tr>
<tr>
<td>BM-23</td>
<td>799</td>
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TABLE 4 - Pertinent data from Bureau of Mines churn-drill-hole logs (Continued)

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Figure 16. - Park Walton mine development.
During the Bureau's Melrose program, an unusually large quantity of data was assembled for study. Besides the results of topographic mapping, geophysical surveys, the Park Walton drainage project, and churn drilling by the Bureau of Mines, the data from private concerns that drilled 34 holes and developed underground mines during the same period were assembled, together with the many records of previously drilled prospect holes in the district. A study of the Melrose data and much comparable information from other Tri-State fields has furnished useful criteria for future zinc-lead ore developments.

Before World War II, the possibilities for mining the indicated Melrose-district ore deposits had been difficult to visualize from the existing drill records. Sporadic drilling had indicated a few favorable but relatively deep, isolated-appearing ore deposits. Initial estimates by the Bureau of Mines, while investigating only the Park Walton property in 1942, were necessarily based on certain geological assumptions in addition to merely evaluating the factual drill data. Underground developments at the Park Walton have shown that there, at least, the assumptions were substantially correct. Continued ore discoveries and other new mining developments, in general along the favorable trends inferred from drill records, now can be more confidently predicated on the accumulating evidence from new drilling and from initial underground mining developments. Ultimate results may still remain difficult for the casual observer to visualize unless he is familiar with detailed and regional features of the local geology. Guidance of Bureau of Mines work pivoted, to a large degree, on frequent underground observations in the Park Walton mine.

Park Walton Mine

Two 350-foot, single-compartment shafts were sunk by the United Zinc Smelting Corp. in 1943 to develop the Park Walton ore reserves. The two shafts, 360 feet apart, were sunk "dry" in the relatively unaltered sedimentary formations along the west edge or "wall" of the most promising indicated ore deposit on the Park Walton property. Crosscuts on both the 310- and 350-foot levels were driven eastward from each shaft through the deposit. Details of subsequent underground development and mining are illustrated in figure 16.

Relatively high-grade lead ore with some zinc was found in C and H beds, largely above the 310-foot level and by June 1946 had been stoped 400 feet in length, averaging 65 feet in width and 25 feet in height. In this "lead" stope, the usual Tri-State open breast-stopping method was used. Only three small pillars were left temporarily for roof support; a long narrow strip of ore was left for support along the east wall.

This ore body apparently is bounded along the east wall by a large, steep, mud- and boulder-filled fissure which strikes about N. 37° W. and with a slight eastward dip, as shown in a single, 310-level, crosscut exposure, 165 feet east of the No. 1 shaft. Southeastward extension of the fissure was indicated by a few of the churn-drill holes. The exposed west wall in hard, relatively unaltered strata follows a minor fracture which strikes N. 37° W. with a 70°
dip to the westward, except near the southwest corner of the stope, where the wall swings due south and the dip reverses. This indicated secondary modification in strike and dip of the wall near the south end of the "lead" stope is roughly paralleled by an irregular, loosely boulder-filled cavern farther into the west wall. The cavern had been encountered earlier near the No. 2 shaft while the 310 level crosscut was being driven eastward. Timbering of the cavern to a vertical height of 20 feet was necessary along 30 feet of the crosscut.

The roof of the "lead" stope was correlated as F bed; it is a firm, limey, white siliceous and porous rock, locally termed "cotton rock." The roof is 25 feet above the 310 level over most of the lead stope, but rolls down to the level at the north end of the stope and is "dragged" sharply upward to a maximum height of 35 feet in an intensely cross-fractured area near the south end of the stope. Although disorderly and partly obliterated by alteration and ore deposition, the cross-fracture pattern in the roof, which also was noted in the underlying ore body during stoping, suggested compression fracturing. Directly below, along the 350-level crosscut, a narrow, brecciated zone is discernible, which strikes about N. 45° E. with a steep northward dip; this was sufficiently broken to require timbering of the crosscut.

Occasional sheets of sphalerite were exposed in the thin bedding planes of the F bed wherever slabs of the roof were blasted or subsequently caved in the lead stope. Drill records indicated that ore rose to within 260 feet of the surface in the cross-fractured roof area toward the south end of the stope.

The bottom of that lead ore body is indicated to lie in the intensely disturbed J bed, normally a few feet below the 310-level. The J bed, which rests on the Warsaw-Keokuk unconformity, is erratic in thickness and distorted locally by slumpage into underlying solution channels. Records of three widely spaced drill holes which straddled the ore body indicate narrower zones of zinc-predominating ore continuing in depths to the 350-foot level in the diverging downward extensions of the parallel wall fractures which bound the stope. These two parallel fracture zones contained significant but submarginal zinc mineralization where cut by the 350-level crosscuts (fig. 16) at about 60 and 180 feet, respectively, northeast from each shaft. The only heavy sulfur-water flows encountered during mine development entered the 350-level crosscuts from open crevices in these zones. Development drifting from the 350-level crosscuts had not been attempted before June 1946, except for one short exploratory drift that was driven about normal to the east end of the No. 2 shaft crosscut. Lead with some zinc ore occurred in that short drift from which a significant stope production was begun. None of the 350-level development work before June 1946, however, had reached any of the drill holes that had previously indicated minable ore to 350 feet in depth.

Beyond the previously mentioned cross-fractured roof area, in the south end of the 310-level Park Walton "lead" stope, the strata tightened in a downward "rolling" structure, the intensity of fracturing and lead-zinc mineralization diminished, and the gently dipping bedding planes became more orderly. A downward-inclined development drift was continued southward to intercept the gently sloping J bed; there lead-zinc mineralization was continuous, but only
sporadic small bodies of minable ore were encountered. Upon reaching the 322-foot level, the strata again became horizontal and somewhat fractured where a small block of J-bed ore was being stoped in June 1946, 160 feet south of the lead stope. Horizontal continuation of the development drift southward was in progress during June 1946. Records of drill holes farther to the south indicate a gentle upward slope of the top of the ore beds for an additional 200 feet southward, where the next most attractive Park Walton ore deposit is indicated by numerous drill holes, located on the peninsula between arms of the Walton lake. The drilling also indicates that this second attractive ore deposit ranges from 285 to 350 feet in depth and is stratigraphically and structurally high; there is evidence that it also is localized with respect to intersecting fracture systems.

Near the north end of the lead stope, the ore has been stoped downward to about 25 feet below the 310-level roof (fig. 16). The lead and zinc content in the north stope face in June 1946 was diminishing, and observations showed that the north end of the stope was entering another low structural area. Underneath that north part of the stope, appreciable zinc mineralization is exposed where the two previously mentioned parallel fracture zones were cut by the 350-level crosscut from the No. 1 shaft. Zinc ore is reported in one drill hole under the west wall, near the north end of the lead stope. Significant "openings" and zinc-lead mineralization were reported in three more distantly-spaced drill holes to the northward, and ore was found farther to the north in three holes 400 feet from the stope; four other old holes in ore are 300 feet to the west. These two latter groups of ore holes, both lying partly in Kansas, were surrounded by old drill holes which showed loose, cavernous conditions but in which only submarginal zinc and lead mineralization had been recovered during the sampling.

The floors of both the 350-level crosscuts and the bottoms of the ore bodies indicated by drilling generally lie on the top of the more competent Grand Falls chert strata. Between the two parallel fracture zones, along each of the 350-level crosscuts, the hard Grand Falls chert is overlain by disorderly, misplaced blocks of slumped overlying strata and boulders of limestone and chert, largely reconsolidated with mud, selvage, marcasite and some disseminated zinc and lead mineralization. That "core" has been reconsolidated to such an extent that little water flows through those residual "cave" materials.

Records of some more distant drill holes in the relatively undisturbed and unaltered walls of the Park Walton deposit indicate little vertical displacement locally, across the northwesterly trending Park Walton fracture system (section Y-Y', fig. 16). Horizontal movement is suggested by horizontal striations along fracture planes in the ore near the fissure which bounds the east wall of the lead stope. Stylolite partings were observed on the fractured and somewhat disorderly bedding planes, which averaged about 15° in eastward dip within the lead ore body; the bedding flattened and became more regular toward the stope-roof stratum, which dips only slightly eastward. The attitudes of the strata observed within the deposit suggested that the successive dissolution collapse or slumps were hinge only on the fracture bounding the west wall of the deposit.
In relation to regional geological setting, the Park Walton ore deposit has been inferred - from the little drilling and geophysical work that has been done - to be related to a gentle, northwesterly pitching anticlinal structure, which is believed to be a branching arm of the previously mentioned, central Melrose structural "dome".

H. W. Smith and Other Properties in Park Walton Area

The H. W. Smith and other adjacent properties included in the Park Walton area (fig. 13) lie along the Kansas side of the State line, adjoining the Park Walton only 300 feet north of the mine working. Three isolated-appearing ore deposits have been indicated by preliminary drilling on the H. W. Smith property; two of these were mentioned in describing the Park Walton deposit. The third was discovered 500 feet north of the state line by Bureau of Mines drilling early in 1945. Locations of the Bureau holes, as well as results of the subsequent detailed gravimetric survey, are shown in figure 11.

In all three H. W. Smith deposits, the ore found in the churn-drill holes occurred in the M bed, 315 to 360 feet in depth. The indicated deposits were surrounded by holes in which cavernous, loose, broken conditions were found and only submarginal zinc and lead mineralization was indicated. Sample recovery in the delimiting old holes was reported to have been difficult and unsatisfactory. The static artesian-water level is 50 to 80 feet higher than in the nearby Park Walton mine. About 300 feet west of the third H. W. Smith deposit, a structurally higher area was inferred from three old drill-hole records and the detailed gravimetric survey by the Bureau of Mines. Funds were insufficient for drilling to confirm that inference after results of the gravimetric survey were obtained.

The Mead property adjoins the H. W. Smith farm on the west. Four holes were drilled there by the Bureau of Mines following the detailed gravimetric survey, but without marked success. The four holes cross-sectioned the flanks of two indicated gravimetric lows. They were also located with reference to the structural implications from some old drilling in the same general area and six newer holes that had been put down by a private concern just preceding the Bureau drilling by a few months, with similar results. The ore found was stratigraphically and structurally low with respect to the Park Walton and other of the more promising deposits of the district (fig. 7). The Mead ore reserves range in depth from 350 to 420 feet below the surface, chiefly in the O-P beds of the Grand Falls chert. The static artesian water level averaged 100 feet higher than in the Park Walton mine (fig. 8).

Drilling by the Bureau of Mines east of the H. W. Smith property included 2 holes on the Coffey tract (fig. 13) and 10 on the Von Trebra (fig. 14). Results were similar to those on the Mead tract. Except for some sporadic occurrences in the M bed similar to the 3 previously mentioned H. W. Smith ore bodies, most of the ore that has been indicated by the relatively few holes on the Mead, Coffey, and Von Trebra properties generally occurred both stratigraphically and structurally low, in the O and P beds of the Grand Falls chert horizon (see table 4). The static artesian water level in the Von Trebra drill holes was found to be only 60 feet higher than in the Park Walton mine, 1/2 mile to the southwest (fig. 8).
Figure 18. - Cross sections, Vanatta deposit.
Figure 19. - Cross sections, Vanatta deposit.
Figure 20. Cross sections, Vanatta deposit.
Figure 21. - Cross sections, Vanatta deposit.
Vanatta Ore Deposit

The Vanatta ore deposit is 3/4 mile northeast of the Park Walton, to which it is similar in many respects. The Vanatta area (fig. 14) lies on the north flank of the inferred central Melrose district structural dome (figs. 7 and 9). It has the following similarities to the Park Walton deposit: (1) The average proportion of lead to zinc is about the same. (2) Lead predominates in the upper ore horizon, as in many Tri-State mines. (3) The richer ore and greatest water inflows were found in drill holes near the indicated walls of the deposit. (4) Drilling indicated that cross-troughs or structurally low areas interrupt (or offset?) the ore continuity along the major northwesterly trend (fig. 17). (5) Residual materials, forming a "core" of mud, boulders, some marcasite, and disseminated lead and zinc mineralization, were indicated in the drill holes along the center line zone of the deposit where strong water inflows were seldom encountered.

The Vanatta deposit is deeper than the Park Walton, lying 385 to 425 feet below the surface. This is largely due to the topographic relief, averaging 50 feet higher than the Park Walton, because the ore deposit averages only about 50 feet deeper from a structural standpoint. Stratigraphically, the Vanatta ore is not lower than much of the Park Walton reserves. Although slight H-bed lead mineralization was found in a few drill holes, the minable ore horizon was generally indicated in the J bed.

The easily recognizable Short Creek "oolite" horizon at the top of the M bed was found in many of the Vanatta drill holes (fig. 6), often contained ore and showed a comparatively uniform slumping throughout the Vanatta deposit, apparently due to dissolution of the lower section of M bed. The collapsed upper M-bed overlying strata were found in most of the drill holes in the deposit to be separated from the top of the N-bed chert by only a few feet of residual M-bed flints and accumulated cave materials under which artesian sulfur water often flowed heavily. The loose condition of those residual materials, together with the heavy water flow, generally prevented satisfactory recovery of samples in that solution zone under the indicated ore horizon. Drill holes indicated a major fracture zone striking about N. 37° W. along the center line of the Vanatta deposit, roughly paralleled by two secondary hinge fractures, one on each side and as far as 100 feet away from the indicated center line (figs. 18-21). In drill holes along the center line of the deposit slight lead mineralization was found extending up into the H bed, strong artesian sulfur-water flows were not often encountered (owing presumably to the water-impervious "muddy" centerline core), and the top of the N bed was found to be shattered or not positively recognizable until unusual depths were reached, suggesting the course of the original fracture or "fault" zone.

The walls of the deposit were indicated by drill-hole cross sections which showed: (1) Abrupt thinning, dissolution, or collapse in the M bed at the edges of the deposit, with corresponding level strata on either side; (2) unusually high-grade zinc ore in a thick horizon, with lead predominating at the top and bottom; and (3) an abundant artesian sulfur water flow that was encountered shallower than usual. Throughout the deposit, a thin bed of rich lead ore was found in many drill holes upon reaching the floor of the ore.
No geophysical work was done in the Vanatta area.

Pumping at the Park Walton mine had lowered the static artesian water level an average of 150 feet; in June 1946 the average water level stood 305 feet below the surface in the Vanatta holes which had penetrated "open" subterranean channels (fig. 8).

Estimates of the Vanatta ore reserves were based on 39 previously drilled holes, 21 holes drilled by the Bureau of Mines during 1945, and 23 holes that had been completed by the Mahutska Mining Co. in August 1946. Practically all the holes were drilled in a small area 1/4 mile long by 600 feet in width.

The Mahutska Mining Co. obtained a Reconstruction Finance Corporation development loan and started initial Vanatta mine-development work in September 1946. A large pump hole was drilled, a pumping plant was installed, and sinking of a 425-foot shaft was completed in February 1947, after which time some production was soon started.

Development of the deposit and completion of drainage by the combined Park Walton and Vanatta pumping are not expected to be unusually difficult. The powerline brought into the district by the Bureau of Mines in 1942 and the Park Walton mill are available nearby.

T. R. Smith Mine

The T. R. Smith mine is in the Fourmile area, which is 3/4 mile south and 2 miles east of the Park Walton mine (fig. 15). From a regional geological standpoint, the Fourmile area appears to be the eastern flank of the central Melrose structural "dome".

Near the T. R. Smith mine, drilling had revealed the most clearly defined example of the few sink-hole structures that have been discovered in the Melrose district. In a 200- by 300-foot oval area on the T. R. Smith and extending into the adjoining T. H. Hill tract on the west, the base of the Cherokee shale sinks from its normal 145-foot depth around the rim to an extreme depth of 250 feet below the surface in the center (fig. 5). The data from several of the deeper holes showed the sink-hole structure to be a slumped core of cave materials in which there was little lead and zinc mineralization. The open and loose cavernous conditions found in the Reeds Spring horizon (R bed) by the deeper holes indicated that the sink-hole slumpage resulted from collapse after intense solution action in the Reeds Spring strata. The overlying Kookuk-Warraw and Chester strata were nearly normal in thickness, but a sharp 40-foot vertical offset was indicated by a cross-section drawn through drill holes near the east rim of the sink hole (fig. 7). The general northeasterly course of Fourmile Creek is offset sharply about 3/4 mile to the northwest, significantly near the "sink hole" on the T. R. Smith farm (fig. 2).

Most of the 50 old holes that had been churn-drilled on the T. R. Smith farm from 1923 to 1938 during intermittent explorations by various concerns were confined to a shallow deposit where zinc ore was reported to have been found 180 to 235 feet in depth in the Chester formation in a small area bordering on the northeast rim of the sink hole.
The Bureau of Mines drilled 18 holes in cross sections along an inferred ore trend connecting the T. R. Smith with the Alsbach deposit, 1/4 mile to the south. Mina ble zinc-lead ore was found in 4 of the Bureau of Mines holes, which extended the indicated deposit 300 feet southward under Fourmile Creek; this indicated extension of the ore deposit slopes downward through the various Warsaw strata to the H, J and M beds. The ore was found 275 to 295 feet in depth in the drill holes at the south end. At that point, stratigraphic, structural and other significant features were similar to those found in the Alsbach, Vanatta, and Park Walton drill holes. This ore reserve has not been delimited; minor zinc and lead mineralization and loose, cavernous conditions were found on the same horizon in other Bureau of Mines holes farther south. Ore indications were reported in some old drill holes 500 feet northeast of the sink hole but were not investigated by Bureau of Mines drilling.

Following the Bureau of Mines churn drilling on the T. R. Smith farm, part of the tract was included in the detailed gravimetric survey of the Fourmile area (fig. 12).

The water level in the "open" drill holes on the T. R. Smith tract had stood at about 235 feet below the surface since 1943, when it was lowered 170 feet during the Park Walton drainage project. Although the pumping had quickly lowered the T. R. Smith water level from the original 65 to 235 feet below the surface, which indicated "open" channels in the upper Mississippian strata, the negligible effect since 1943, while Park Walton pumping has been continued to maintain that mine drainage, indicates discontinuity of the deeper subterranean channels or that the steep water-level gradient is being held by dams of mud and the other residual cave materials choking the natural channels.

In 1944, while the Bureau of Mines drilling was in progress on the T. R. Smith farm, the Fourmile Mining Co. having churn-drilled two check holes into the previously indicated "Chester" deposit, started sinking a shaft near the northeast rim of the "sink hole". After the shaft was completed to 234 feet in depth, some underground drifting was accomplished and a standard Tri-State head frame, hoisting plant, ore bin, crushing plant, and Joplin-type jig mill were constructed by the Fourmile Mining Co. on the T. R. Smith tract. The mine and mill were operated intermittently during 1946.

In underground observations by the Bureau of Mines during the progress of T. R. Smith mine development, little new information was gained. The shaft, being near the northeast rim of the sink hole, penetrated shale and was timbered from the surface to the top of the Chester limestone, about 170 feet in depth. Below the shale a hard, thick slab of unaltered limestone, dipping about 45° toward the center of the sink hole, was penetrated by the shaft and formed the roof of the zinc mineralization in the underlying Chester deposit. Below the roof slab the zinc mineralization increased steadily while the shaft was being sunk from 190 to 225 feet and decreased from there to completion at 234 feet in depth, where the static water level was revealed in "open" crevices in the bottom of the shaft. In the prospect drifts being driven from the shaft on the 225 foot level, disseminated zinc ore occurred with a gangue of residual Warsaw chert rubble reconsolidated by very soft altered and unstratified coarse-grained Chester limestone, cotton rock, selvage, and occasional shale seams in
which the numerous crevices were coated with dolomite crystals. The ore is free-milling and consists of coarse, granular, crystalline sphalerite. Although the recovery of zinc concentrate while milling the material mined during the driving of development drifts and the sinking of the lower 45 feet of the shaft is believed to equal that indicated by the old churn drilling in that particular area, enough underground drifting has not been done to prove that the entire indicated Chester ore deposit will be minable. Churn-drilling samples often are unavoidably "salted" in such soft, granular deposits. The deeper reserves indicated by the Bureau of Mines drilling remain under water and are insufficient to justify mining. Development of the inferred extensions by further churn drilling has not been undertaken.

Albaugh Property

The Albaugh property in the Fourmile area (fig. 15) adjoins the T. R. Smith tract on the south. About 47 holes had been drilled on it during intermittent explorations by various concerns from 1923 to 1938. Most of the drill holes were closely grouped in a small 200- by 400-foot area, 1/4 mile south of the T. R. Smith mine. The drill records indicated a minable ore deposit ranging from 285 to 315 feet below the surface in the J and M beds. Early in 1944 three check holes were drilled in the same area by another private concern, with favorable results.

During the first half of 1945, the Bureau of Mines drilled 14 holes on the Albaugh property and included a small part of that tract in the detailed gravimetric survey of the Fourmile Creek area (fig. 12). The preliminary drilling by the Bureau of Mines was spread over greater potential areas of the Albaugh tract. The hole locations were based largely on structure inferred from the few scattered old holes and those just previously drilled on the T. R. Smith tract and to a minor extent on some preliminary data which became available from the gravimetric survey in progress during the same period. Besides demonstrating extensions of the previously indicated Albaugh ore reserve by ore found in two of the holes, marginal ore was found in four of the other Bureau of Mines holes in a small area 600 feet to the northeast. These two deposits, like that on the T. R. Smith property, have not been delimited by churn drilling. Zinc mineralization and other conditions in the few intervening drill holes suggest that favorable structures connect all three indicated deposits. The J and M bed conditions in Albaugh drill holes were similar to those found in the Vanatta, T. R. Smith, and Park Walton drill holes.

Park Walton pumping has lowered the water level in the "open" Albaugh drill holes evenly with that previously reported in the T. R. Smith (fig. 8), or to a level about 90 feet higher than in the Park Walton mine.

A small head frame was erected by the Fourmile Mining Co. in preparation for sinking the initial 320-foot shaft, and sinking to the most favorable indicated Albaugh ore deposit was begun early in 1947.
CONTROL OF DRILLING IN MELORE DISTRICT

The present knowledge of the nature of Melrose ore deposits is far from complete but is of considerable value as a guide to drilling. Due allowance must be made for conditions that are erratic, unpredictable, or misleading and thus lessen the chances for success in preliminary drilling. Nevertheless, a program planned in the light of observed general facts is likely to be more successful and less costly than either "playing hunches" or arbitrarily spacing holes at fixed intervals throughout large areas.

General Observation

Nearly all the known ore bodies in the Melrose field of such size and richness as to be minable under recent wartime prices and demand are in the upper strata, specifically the E, G, H, J, and M beds, of the Mississippian Boone section. Furthermore, the ore bodies in these higher beds have been found only along the shoulders and flanks of structurally high areas.

Some Bureau holes and many previous holes in the district penetrated deposits that were stratigraphically and structurally low. These "sheet-ground" deposits, the local term being descriptive of their thin-sheeted mineralization and great breadth, occur usually in the O, P, and Q beds of the Grand Falls chert; some extend deeper in fractured and silicified areas in the Reeds Spring, or R bed. Such deposits have rarely been known to underlie important shallower ore bodies in the Tri-State region. Although the sheet-ground contributes an important and growing proportion of the Tri-State output, such deep deposits found in the Melrose district appear too thin-bedded or too low-grade to be of interest. Structurally, they appear to favor broad synclinal or low areas.

Another observed major feature of Melrose deposits is their association with fracturing. Underground and drill-hole observations confirm the existence here, as elsewhere in the Tri-State, of northwesterly and northeasterly basic systems, intersecting to form diamond-shaped echelon patterns or long, irregularly periodically interrupted and offsetting runs with various secondary modifications.

A few other generalized observations appeared significant in our study of controls. The better deposits were found where: (1) The Chester limestone had an average thickness on the order of 20 feet; abnormal thicknesses up to 150 feet, or complete absence of this formation, came to be regarded as unfavorable. (2) The thickness of Cherokee shale was about average for the particular localities, although slight configurations denoted the differential solution peculiarly found over such ore deposits as the Park Walton. (3) A high percentage of chert occurred in place, particularly in the E, G, and H beds. (4) First sulfur-water flow was encountered slightly above the J bed, rather than deeper. (5) The firm but thin-bedded dolomitized limestone and chert strata had been "opened" by abundant small vertical fractures or stylo-lite partings along the bedding in which dolomite crystallization has also been deposited. The ore usually is at some distance, however, from large, loosely filled caverns, often lined with large calcite crystals.
Unfavorable appearing at Melrose, the sheet-ground deposits were indicated in broad structurally and stratigraphically low areas where there were found (1) greater than average depths of shale, (2) relative lack of chertification or other alteration in the strata above the Grand Falls, and (3) the first sulfur-water flow, not higher than the top of the Grand Falls.

Methods of Controlling Drilling

Contour mapping was the principal basis for planning the preliminary phases of the Bureau drill program, following the method described by Fowler. All available drill logs were utilized to draw contours on recognizable horizons, from which regional structure and fracture patterns were inferred with more or less certainty.

The Short Creek oolitic limestone which normally forms the top 5 feet of the M bed is the best marker in the Melrose field, as elsewhere in the Tri-State district. It is absent, however, in many places owing to the Warsaw-Kecskemétn discontinuity, and often elsewhere may not be identified because of alteration. In some holes slumping appears to have dropped Short Creek into openings in lower beds as deep as the bottom of the Grand Falls.

The next most easily distinguished horizon on which to base structure contours is the Grand Falls chert. The top of the 10- to 20-foot N bed is almost always recognizable by its hard, white, dull porcelain chert cuttings, within limits of 5 to 10 feet even in fractured zones. In underground workings the N bed chert nodules, about a foot thick and 6 to 15 feet in diameter, often embedded in limestone or cotton rock, are readily recognized.

The regional gravimetric maps showed some features corresponding roughly with structures indicated by previous drilling, but the correlation was tested by too few holes to reach definite conclusions. As previously stated, topographic maps and aerial photographs were used to infer structure, particularly fracture patterns, from the surface drainage pattern and relief. Lack of more reliable evidence, such guides supplemented the simple projection of known ore trends or structures when preliminary holes were located in virgin areas.

If one or more preliminary holes gave encouraging indications, the next step in the Bureau of Mines procedure was to drill closely spaced holes on a line across the prevailing N. 37° W. trend of fracturing and ore deposition. This was the practice successfully followed formerly by the Century (Vinegar Hill) Zinc Co. Each cross section was extended far enough and holes spaced closely enough to determine the approximate position of the unaltered walls, the profile of roof and floor, the ore limits, the character of the core, and local structure, including slumping, folding, and fracturing. In the past, some of the typically narrow Melrose deposits have been straddled in cross sectioning by too widely spaced holes.

Wherever a cross section of holes justified further drilling, the practice was to drill more distantly spaced holes along the presumed northwest and southeast trend. If the trend appeared to be interrupted or offset, or if, on the other hand, a very promising locality was indicated, another closely spaced section was drilled, either to pick up the lost ore or to explore the favorable area.

14/ Work cited in footnote 10.
Complete delimiting of the deposits by drilling was not attempted. It is believed, after reasonably indicating deposits of the Melrose type at such depths, that development can be risked more economically and satisfactorily by initial shaft sinking, underground drifting, followed by some drilling shortly ahead of mining when underground inspection permits more accurate guidance. Horizontal "long-hole" drilling or even diamond drilling in the wall rocks of Melrose ore deposits probably would be effective in discovering parallel fracture zones or other conditions which could then be tested by precisely located churn drilling.

ORE RESERVES

For purposes of estimation, ore reserves are divided by the Bureau into three categories - measured, indicated, and inferred.

Measured ore reserves include only those that have been blocked out or exposed and sampled on three sides by mine workings. Of these there is a relatively negligible tonnage in the Tri-State region, where underground development rarely precedes exploitation. Most of the ore exposed in Tri-State mine workings is considered as indicated reserves. "Channel" sampling of underground ore exposures is not practical in the Tri-State region mines, but the grade is visually estimated satisfactorily or is known from mill returns.

Indicated ore reserves in the Melrose district were based on the few exposures in mine workings and on definitely located and authentically recorded drill holes, spaced less than 100 feet apart, in which were found minimum minable ore thicknesses of 7 feet when calculated on a cut-off basis of 1.50 percent metallic lead and zinc content. The indicated-ore-reserve estimates were calculated by weighting the lead and zinc content in accordance with each sampling interval throughout the ore horizons, then in accordance with areas or polygons of influence around each drill hole and the total finally weighted with respect to the calculated volumes and metallic contents of the indicated ore around each hole. The arbitrary polygon method of outlining areas of influence around each "ore" hole, was modified to conform with the indicated geological characteristics of each individual deposit. Most Tri-State operators give weight to favorable "open" structural conditions found in many of the exploratory churn-drill holes, but in making the Bureau of Mines indicated-ore-reserve estimations this was not done.

Inferred ore reserves were roughly estimated on the basis of: (1) geologically reasonable extensions of indicated ore reserves, (2) holes where ore was reported but for which exact locations, analyses or other data were incomplete or open to question, (3) widely scattered drill holes in which ore, or sub-marginal mineralization were found, with other favorable conditions, and (4) to some extent on previous Tri-State experience with respect to "open" holes in which sample recovery was difficult or impossible.

15/ Jackson, Chas. F., and Hedges, J. H., Metal Mining Practice: Bureau of Mines Bull. 419, 1939, p. 68.
R.I. 4337

Of the 90 holes drilled by the Bureau of Mines on the 8 different Kansas and Oklahoma properties in the Melrose district, 22 holes indicated 90,000 tons of ore reserves containing 1.99 percent metallic zinc and 0.70 percent metallic lead; additional reserves of 290,000 tons were inferred.

During the same period four private concerns drilled 34 holes on 4 of the same properties and developed underground mines on three of those properties, thus further indicating about 53,000 tons of ore with an average content of 2.58 percent zinc and 0.15 percent lead, and inferring an additional 245,000-ton reserve.

When the calculations were based on all available data including previous drilling, total Melrose district ore reserves estimated in June 1946, amounted to 1,800,000 tons, of which 1,895,000 tons was indicated with an average 2.25 percent zinc and 1.20 percent lead content and the remainder is reasonably inferred but virtually unexplored (fig. 22). The average grade of the indicated ore reserve compares favorably with that remaining and that mined in other Tri-State fields\(^{16}\) during World War II.

Figure 22. - Ore reserves, Melrose district.
CHURN-DRILL HOLE LOGS

Hole BM-2

Coordinates: 10,040 N - 10,150 E

Started: 7/11/44
Completed: 7/25/44
Elevation of collar: 813
Park Walton Tract (Kan.)
Water encountered at
Water standing at 340 ft.
Size of hole: 35 ft., 10 in.; 155 feet, 8 inch; 155 feet, 6 inch

Depth, Feet
From - To -

0.0 33.0 Soil, clay and gravel
33.0 105.0 Black shale
105.0 165.0 Shale with some thin interbedded sandstone, coal and fireclay seams
165.0 170.0 Shale and some sandstone
170.0 187.0 Black shale
187.0 220.0 Coarse gray brown and white limestone
220.0 255.0 White limestone, some grey chert
255.0 240.0 White limestone, blue and white chert
240.0 245.0 Light gray limestone, some white chert, and a seam of bright green shale
245.0 260.0 Gray limestone, some white chert
260.0 273.0 Light brown limestone
273.0 300.0 Brown to dark gray limestone, a little gray, blue and white chert
300.0 305.0 Some greenish gray speckled limestone, followed by brown oolithic limestone
305.0 315.0 Tan and white limestone, a little gray to white chert, trace of pyrite
315.0 325.0 Tan and white limestone, thin black shale seams and some pyrite
325.0 355.0 Coarse tan limestone and black shale seams
355.0 360.0 Faintly tan spotted white and gray cherty
360.0 365.0 Gray, brown and grayish chert, a very little black jasperoid

No samples taken

2462

- 33 -
Hole BK-3
Coordinates: 10,400 N - 10,300 E

Started: 7/25/44  Completed: 8/7/44
Elevation of collar: 800  Park Walton Tract (Kan.)
Water encountered at 522.5 feet  Water stands at 522.5 feet
Size of hole: 35 feet, 10 inch; 200 feet, 8 inch

Depth, Feet
From- To-
0.0  18.0 Soil and clay
18.0  22.0 Red mud and sand
22.0  35.0 Gravel and sand
35.0  65.0 Shale
65.0  75.0 Shale and gray sand
75.0  150.0 Shale
150.0  170.0 Sandstone and some shale
170.0  189.0 Shale
189.0  235.0 Brown and white Chester limestone; bands of tar and some white chert
235.0  245.0 White limestone
245.0  260.0 White limestone; light blue and white chert
260.0  270.0 Gray limestone; white chert
270.0  275.0 Gray and white limestone; some light gray chert and black shale seams
275.0  280.0 Gray and white limestone
280.0  285.0 Gray and white limestone and white cotton rock
285.0  290.0 Gray limestone and chert, trace of lead and pyrite in mud seams
290.0  297.5 Loose light and dark gray chert, thin trace of lead
297.5  300.0 Light and dark gray chert, gray limestone and Pb shines
300.0  302.5 Hard light gray and brown chert, Pb shines
302.5  305.0 Tan and white chert, Pb and Zn shines
305.0  307.5 Gray limestone, white, gray and blue chert, fair Pb and Zn
307.5  310.0 Gray limestone, some gray chert, fair Pb and Zn
310.0  312.5 Gray limestone, some gray chert, fair Pb and Zn
312.5  315.0 Gray and tan chert, brown limestone and Pb shines
315.0  317.5 Gray and tan chert, brown limestone and Pb shines
317.5  320.0 Gray, tan and white chert, black limestone, Pb and Zn shines
320.0  322.5 Black limestone and chert, some gray and blue chert, Pb and Zn shines
322.5  325.0 Loose black, gray and blue chert, some calcite, good Pb and Zn shines
325.0  327.5 Loose black, gray and blue chert, some loose oolitic limestone, calcite and Pb shines
327.5  332.5 Brown, black and white chert, some brown and some oolitic limestone, calcite and trace Pb (falling?)
332.5  335.0 Gray, brown, black and white chert, very much marcasite and trace Pb (falling?)

15 samples taken

Analysis, Percent

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<th>Depth, Feet</th>
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<tr>
<td>From- To-</td>
<td>Zinc</td>
<td>From- To-</td>
<td>Zinc</td>
</tr>
<tr>
<td>297.5  300.0</td>
<td>0.20</td>
<td>All</td>
<td>315.0  317.5</td>
</tr>
<tr>
<td>300.0  302.5</td>
<td>0.32</td>
<td>All</td>
<td>320.0  322.5</td>
</tr>
<tr>
<td>302.5  305.0</td>
<td>0.29</td>
<td>2/3</td>
<td>325.0  327.5</td>
</tr>
<tr>
<td>305.0  307.5</td>
<td>0.60</td>
<td>2/3</td>
<td>330.0  332.5</td>
</tr>
<tr>
<td>307.5  310.0</td>
<td>0.58</td>
<td>2/3</td>
<td>332.5  335.0</td>
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<tr>
<td>310.0  312.5</td>
<td>0.42</td>
<td>2/3</td>
<td>335.0  337.5</td>
</tr>
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<td>312.5  315.0</td>
<td>0.56</td>
<td>2/3</td>
<td>337.5  340.0</td>
</tr>
<tr>
<td>315.0  317.5</td>
<td>0.58</td>
<td>2/3</td>
<td>340.0  342.5</td>
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</tbody>
</table>

Hole BK-3 (continued)
<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From</th>
<th>To</th>
</tr>
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<tbody>
<tr>
<td>0.0</td>
<td>20.0</td>
<td>Soil and clay</td>
</tr>
<tr>
<td>20.0</td>
<td>35.0</td>
<td>Clay and gravel</td>
</tr>
<tr>
<td>35.0</td>
<td>165.0</td>
<td>Shale</td>
</tr>
<tr>
<td>165.0</td>
<td>180.0</td>
<td>Gray sandstone</td>
</tr>
<tr>
<td>180.0</td>
<td>212.0</td>
<td>Shale</td>
</tr>
<tr>
<td>212.0</td>
<td>240.0</td>
<td>Gray, brown and white Chester limestone, a little white chert</td>
</tr>
<tr>
<td>240.0</td>
<td>250.0</td>
<td>White limestone</td>
</tr>
<tr>
<td>250.0</td>
<td>255.0</td>
<td>White limestone, a little white chert</td>
</tr>
<tr>
<td>255.0</td>
<td>260.0</td>
<td>White limestone and white and little gray chert</td>
</tr>
<tr>
<td>260.0</td>
<td>270.0</td>
<td>Tan and a little dark gray limestone and some white chert</td>
</tr>
<tr>
<td>270.0</td>
<td>280.0</td>
<td>Coarse tan limestone, some blue and white chert</td>
</tr>
<tr>
<td>280.0</td>
<td>290.0</td>
<td>Tan limestone, a little white chert and speckled cotton rock</td>
</tr>
<tr>
<td>290.0</td>
<td>295.0</td>
<td>Dark and light gray limestone, a little gray chert</td>
</tr>
<tr>
<td>295.0</td>
<td>300.0</td>
<td>Light and dark gray chert, a very little gray limestone</td>
</tr>
<tr>
<td>300.0</td>
<td>315.0</td>
<td>Light and dark gray limestone and some gray and white chert</td>
</tr>
<tr>
<td>315.0</td>
<td>330.0</td>
<td>Light tan and gray shaly limestone, white and a little gray chert</td>
</tr>
<tr>
<td>330.0</td>
<td>335.0</td>
<td>Tan, brown and black limestone, black and white chert, a little fine pyrite</td>
</tr>
<tr>
<td>335.0</td>
<td>340.0</td>
<td>Some black limestone, brown calcitic limestone and some black flint</td>
</tr>
<tr>
<td>340.0</td>
<td>350.0</td>
<td>Brown and tan calcitic limestone, some light blue speckled silicified calrite</td>
</tr>
<tr>
<td>350.0</td>
<td>355.0</td>
<td>Brown and tan limestone, some light gray flint, a little calrite falling</td>
</tr>
<tr>
<td>355.0</td>
<td>360.0</td>
<td>Brown and tan coarse crystalline limestone, a very little blue chert</td>
</tr>
<tr>
<td>360.0</td>
<td>365.0</td>
<td>Gray, white and a very little black and blue chert, very little limestone, trace Zn</td>
</tr>
<tr>
<td>365.0</td>
<td>367.5</td>
<td>Gray, white chert, very little limestone, small opening with pink dolomite crystals, thin trace Zn</td>
</tr>
<tr>
<td>367.5</td>
<td>370.0</td>
<td>Dark and light gray and white chert, trace Zn</td>
</tr>
<tr>
<td>370.0</td>
<td>375.0</td>
<td>Light and dark gray chert, some tan and white spotted Grand Falls chert, dolomite crystals and trace Zn</td>
</tr>
<tr>
<td>375.0</td>
<td>380.0</td>
<td>Dull white and translucent white, light blue, gray and brown chert</td>
</tr>
</tbody>
</table>

Bottom

No samples taken.

2462
Hole BM-6
Coordinates: 10,812 N - 10,271 E

Started: 9/4/44  Completed: 9/14/44
Elevation of collar: 617 feet  Park Walton Tract (Kan.)
Water encountered at 290 feet  Water stands at 350 feet
Size of hole: 57 feet, 10 inch; 175 feet, 8 inch; 160 feet, 6-1/4 inch

Depth, Feet
From- To-
0.0  34.0 Soil, clay and sand
34.0  37.0 Sand and gravel
37.0  165.0 Shale
165.0  180.0 Gray sandstone and some shale
180.0  206.0 Shale
206.0  240.0 Brown, gray and white limestone, a little chert
240.0  250.0 White limestone
250.0  265.0 White and some light gray limestone and light blue chert
265.0  280.0 Tan limestone and white chert
280.0  285.0 Tan limestone
285.0  305.0 Gray chert and brown limestone
305.0  315.0 Brown limestone and gray and white chert
315.0  320.0 Shaly black limestone
320.0  325.0 Dark brown to light gray oolitic limestone, some dark brown chert
325.0  350.0 Pinkish gray and blue oolitic limestone, a very little black chert
350.0  360.0 Pinkish gray and blue oolitic limestone, a little light blue chert
360.0  375.0 Brown limestone, a very little brown oolitic limestone, some white limestone and gray chert
375.0  377.5 Gray, light blue and brown chert, a little brown limestone
377.5  380.0 Light gray, brown and white translucent chert, some dull white chert
380.0  382.5 Light gray, white and tan, faintly spotted translucent chert, some dull white and black chert, a mud seam, thin Pb siliceous and water
382.5  385.0 Dull white chert, some translucent chert, mud and trace Pb
385.0  370.0 Light blue, tan and white translucent chert, some dull white chert and trace Pb

Bottom
No samples taken.

2462
- 36 -

Hole BM-7
Coordinates: 12,560 N - 10,062 E

Started: 9/15/44  Completed: 9/26/44
Elevation of collar: 808 feet  Coffey Tract (Kan.)
Water encountered at 556 feet  Water stands at 220 feet
Size of hole: 52 feet, 10 inch; 192 feet, 8 inch; 139 feet, 6-1/4 inch

Depth, Feet
From- To-
0.0  16.0 Clay
16.0  24.0 Clay and gravel
24.0  218.0 Shale
218.0  235.0 Brown, gray, white Chester limestone
235.0  255.0 Gray and white Chester limestone
255.0  270.0 White limestone and blue and white chert
270.0  280.0 White chert and white limestone
280.0  300.0 Light gray limestone, some white chert and cotton rock
300.0  305.0 Gray limestone, some blue and white chert
305.0  320.0 Gray and some white chert, some gray limestone
320.0  330.0 Gray limestone, some gray chert
330.0  335.0 Gray shaly limestone, a very little gray chert
335.0  340.0 Black shaly oolitic limestone, and some gray and brown speckled oolitic limestone
340.0  345.0 Gray and brown oolitic limestone
345.0  350.0 Gray, brown and white chert (some silicified oolite) a little limestone, a very faint trace of Zn and Pb, much marcasite
350.0  355.0 Black and white chert, a little limestone, jasperoid and silicified chert, some Pb, some very much marcasite
355.0  377.5 Gray translucent chert, some silicified oolite, few calcite crystals, a thin black shale seam and much marcasite
377.5  360.0 White chert, some gray translucent chert, a little silicified oolite and black jasperoid, some marcasite
360.0  365.0 Gray, tan and white translucent chert, some shale seams and thin seams of calcite, dolomite and marcasite in the chert, zinc and lead shanes, some calcite and marcasite
365.0  367.5 Brown, tan, gray and white translucent chert, a trace of zinc and lead, some calcite and marcasite
367.5  370.0 Dull white and tan chert, a thin trace lead, some marcasite
370.0  372.0 Hard dull white and tan chert, a thin trace lead and marcasite
Bottom
Two samples taken.

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Zinc</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>To</td>
<td>565.0</td>
</tr>
<tr>
<td>360.0</td>
<td>365.0</td>
<td>0.40</td>
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</table>
Hole BM-8
Coordinates: 6,604 N - 23,026 E

Started: 9/28/44
Completed: 10/10/44
Elevation of collar: 800 feet
Water encountered at 507 feet
Water stands at 232 feet
Size of hole: 13 feet, 10 inch; 154 feet, 8 inch; 175 feet, 6-1/4 inch

Depth, Feet
From - To -

0.0 5.0 Soil and clay
5.0 12.0 Sandy gravel and water
12.0 60.0 Sandy shale
60.0 142.0 Shale
142.0 150.0 Gray limestone, a little gray chert and marcasite
150.0 185.0 Gray limestone
185.0 197.0 Gray, brown and white limestone, a green shaly seam and a little gray chert
175.0 180.0 Gray and light blue chert and gray limestone
180.0 190.0 White and brown limestone, white and blue chert
190.0 195.0 Tan and white limestone, a little white and light blue chert
195.0 205.0 Hard white limestone, a very little blue chert
205.0 210.0 Soft white limestone, some gray and blue chert
210.0 215.0 White and blue brecciated chert, some gray limestone
215.0 225.0 White and light gray translucent chert, some soft brown limestone seams
225.0 230.0 Tan, gray and white translucent chert
230.0 240.0 White, blue and gray translucent chert, brown limestone, some selavage seams
240.0 250.0 Course shaley gray and light brown limestone, dark gray and white chert
250.0 260.0 Light brown limestone, blue and gray chert
255.0 275.0 Brown limestone, blue and dark gray chert
275.0 280.0 Black limestone, a little brown oolitic limestone, a very little gray and white chert and marcasite
280.0 285.0 Light brown limestone, some oolitic limestone, light blue, gray and white chert
285.0 290.0 Light brown limestone, a little oolitic limestone, and a very little white chert
290.0 295.0 Hard tan limestone, some white chert
295.0 300.0 White chert, tan, blue and white translucent chert, a little tan limestone
300.0 510.0 Dull gray, blue and brown chert, some calcite and pink dolomite crystals (Water at 307 ft.)
310.0 520.0 Dull gray and white chert

No samples taken.

Hole BM-9
Coordinates: 10,600 N - 10,050 E

Started: 9/27/44
Completed: 10/12/44
Elevation of collar: 807 feet
Water encountered at 252 feet
Water stands at 226 feet
Size of hole: 26 feet, 10 inch; 194 feet, 6 inch; 170 feet, 6-1/4 inch

Depth, Feet
From - To -

0.0 14.5 Soil and clay
14.5 25.5 Greek gravel and clay
25.5 216.5 Shale
216.5 245.0 Gray Chester limestone, some gray chert, selycage and marcasite
245.0 255.0 Light gray chert, gray limestone
255.0 270.0 Light blue chert, dark gray limestone
270.0 280.0 Brown and gray limestone, light blue chert
280.0 285.0 White limestone, gray and blue chert
285.0 290.0 Gray and brown limestone, gray chert
290.0 295.0 Gray and brown limestone, blue chert
295.0 300.0 Light gray limestone, gray and white chert
300.0 305.0 White and gray limestone, some white chert
305.0 310.0 Gray and white limestone, gray and blue chert
310.0 320.0 Gray shelly limestone, hard gray chert, trace marcasite
320.0 325.0 Gray and white chert, tan limestone
325.0 335.0 White limestone, gray and white chert
335.0 340.0 Shelly gray limestone, a very little gray chert, trace marcasite
340.0 345.0 Black and dark brown limestone, trace marcasite
345.0 350.0 Gray and brown limestone, silicified oolite
350.0 355.0 Blue gray and brown flint, some oolitic limestone, fair Zn shales
355.0 358.0 Blue gray and brown flint
355.0 375.5 Blue gray and brown flint, calcite and pink dolomite crystals, trace of Pb and Zn shales
357.5 360.0 Blue, brown and gray chert, thin shales of Pb and Zn
360.0 362.5 Blue, brown and gray chert. Zn and Pb shales
362.5 365.0 Blue, brown and gray chert, some black jasperoid, trace of Zn and Pb
365.0 370.0 White translucent chert
370.0 375.0 White translucent chert, little light blue chert
375.0 380.0 Soft white and some light blue chert, Pb and Zn shales
380.0 382.0 Soft gray and white chert, trace Pb
382.5 385.0 Dull white and gray chert, thin trace of Pb
385.0 397.5 Dull white and gray chert, thin trace Pb, some calcite
397.5 399.0 Dull white and gray chert, some tan spotted chert

Bottom

Seven samples taken.

Analysis, Percent

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<tr>
<th>Depth, Feet</th>
<th>Zn%</th>
<th>Pb%</th>
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<td></td>
</tr>
<tr>
<td>355.0</td>
<td>0.82</td>
<td>0.56</td>
</tr>
<tr>
<td>357.5</td>
<td>0.72</td>
<td>0.62</td>
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<td>367.5</td>
<td>0.44</td>
<td>0.04</td>
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</tbody>
</table>

- 37 -
### Hole BM-10

**Coordinates:** 6,602 N - 22,430 W

- **Started:** 10/12/44  
- **Completed:** 10/21/44

**Elevation of collar:** 795 feet  
**T. R. Smith Tract (Okla.)**

- **Water encountered at:** 235 feet  
- **Water stands at:** 250 feet

**Size of hole:** 15 feet, 10 inch; 128 feet, 8 inch; 171 feet, 6-1/4 inch

**Depth, Feet**

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
</table>
| 0.0  | 5.0 | Soil and clay
| 5.0  | 10.0| Sand and creek gravel
| 10.0 | 185.0| Shale
| 185.0| 195.0| Gray Chester limestone
| 195.0| 220.0| Gray Chester limestone and some gray chert
| 220.0| 250.0| Gray Chester limestone, blue chert and some gray chert
| 250.0| 275.0| Fan limestone and blue chert
| 275.0| 305.0| White and gray chert, some limestone, and a little marcasite
| 305.0| 320.0| White and gray chert, dark gray limestone and a selvage seam
| 320.0| 325.0| White and gray chert, brown limestone
| 325.0| 330.0| White and gray chert, brown limestone
| 330.0| 335.0| Blue gray chert, brown limestone, and a selvage seam
| 335.0| 350.0| Blue gray chert, brown limestone, and some speckled glauconitic limestone, very little chert
| 350.0| 355.0| Blue gray chert, some translucent chert and glauconitic limestone, a few small zinc crystals
| 355.0| 360.0| Blue white chert, a little gray and tan translucent chert, a few specks of zinc
| 360.0| 365.0| Blue white chert and a little translucent chert
| 365.0| 372.0| Blue white chert and a little spotted tan and white chert

**Bottom**

- No samples taken.

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### Hole BM-11

**Coordinates:** 12,375 N - 9,835 E

- **Started:** 10/14/44  
- **Completed:** 10/23/44

**Elevation of collar:** 630 feet  
**H. W. Smith Tract (Kan.)**

- **Water encountered at:** 280 feet  
- **Water stands at:** 250 feet

**Size of hole:** 28 feet, 10 inch; 195 feet, 8 inch; 159 feet, 6-1/4 inch

**Depth, Feet**

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
</table>
| 0.0  | 30.0| Soil, clay and gravel
| 30.0 | 50.0| Muddy gray shale
| 50.0 | 100.0| Black shale
| 100.0| 115.0| Sandy gray shale
| 115.0| 135.0| Gray shale
| 135.0| 145.0| Sandy black shale
| 145.0| 150.0| Black shale
| 150.0| 170.0| Black shale and some pyrite
| 170.0| 220.0| Dark gray Chester limestone and a very little dark gray chert
| 220.0| 225.0| Gray and white chert, gray and white Chester limestone
| 225.0| 230.0| Gray and white Chester limestone and a little white chert
| 230.0| 240.0| White limestone, blue and white chert
| 240.0| 270.0| White limestone, light gray chert
| 270.0| 275.0| White limestone, light gray chert
| 275.0| 280.0| Grayish white limestone, white and blue chert, a little selvage
| 280.0| 285.0| Gray limestone and white chert
| 285.0| 295.0| Light gray limestone and a little white chert
| 295.0| 300.0| Speckled tan and white cotton rock and white chert
| 300.0| 305.0| Gray and white chert, some gray limestone, a little marcasite
| 305.0| 310.0| Gray limestone, gray and white chert
| 310.0| 320.0| Light gray limestone, gray and white chert
| 320.0| 325.0| Gray limestone and white chert
| 325.0| 330.0| Gray limestone and a little gray and white chert
| 330.0| 335.0| Some black limestone, some gray speckled glauconitic limestone, a little oolitic limestone slightly silicified
| 335.0| 340.0| Gray limestone, mottled gray and white chert
| 340.0| 345.0| Gray white speckled chert, oolitic limestone, and a little marcasite
| 345.0| 350.0| Oolitic limestone, a very little chert
| 350.0| 355.0| Gray and white chert, a little oolitic limestone and tan limestone
| 355.0| 360.0| Gray and white limestone, some silicified oolite
| 360.0| 365.0| Gray, white and brown chert, a very little limestone, a thin black shale seam and a faint trace of an
| 365.0| 367.5| Gray, white and tan translucent chert, a few specks of ZnS
| 367.5| 370.0| Soft dull grayish white chert, a few specks of ZnS
| 370.0| 382.0| Soft dull grayish white chert

**Bottom**

- No samples taken.
Hole BM-12
Coordinates: 6,679 N 22,662 E

Started: 10/25/44  Completed: 10/30/44
Elevation of collar: 796 feet  T. R. Smith Tract (Okla.)
Water encountered at 290 feet  Water stands at 230 feet
Size of hole: 14 feet, 10 inch; 135 feet, 8 inch; 171 feet, 6-1/4 inch

Depth, Feet
From  To

0.0  7.0 Soil and clay
7.0  12.0 Sand and gravel
12.0  30.0 Shale
30.0  42.0 Sandy shale
42.0  142.0 Shale
142.0  165.0 Gray Chester limestone
165.0  175.0 Gray limestone, some gray chert and a little salvage
175.0  180.0 Gray and white chert; some limestone
180.0  185.0 Gray and tan limestone; a very little chert
185.0  200.0 White limestone; a very little chert
200.0  205.0 Light gray and white chert, tan limestone
205.0  210.0 Gray, blue and white chert, tan limestone
210.0  215.0 Gray and white and tan and white chert, some gray limestone
215.0  225.0 Blue and white chert, tan limestone and a little salvage
225.0  235.0 Dull tan and white spackled cotton rock and chert; some brown limestone
235.0  245.0 Gray and white chert; brown and tan limestone, thin salvage seams
245.0  250.0 Gray and white chert; brown and some tan limestone
250.0  260.0 Gray and white chert; brown limestone
260.0  270.0 Gray and white chert; light brown limestone
270.0  275.0 Dark gray and white chert; brown and tan limestone
275.0  280.0 Shaly gray and tan limestone; some dark gray chert
280.0  285.0 Shaly gray limestone; a little black limestone, a little tan limestone; some dark gray chert
285.0  290.0 Brown limestone, a little black limestone, some oolitic limestone; a very little dark gray chert
290.0  295.0 Dull white, gray and tan chert; a very little tan translucent chert
295.0  300.0 Hard gray, white, and tan spotted chert showing brecciation and leaching, some dark brown chert. Trace Zn and Pb
300.0  305.0 Dull white and tan and white spotted chert; a little brown and white translucent chert; some soft dark gray pieces of oolitic limestone differing in texture from that noted above
305.0  318.0 Dull white and tan and white chert

Bottom

No samples taken.

Hole BM-15
Coordinates: 12,365 N 9,725 E

Started: 10/24/44  Completed: 11/4/44
Elevation of collar: 810 feet  H. W. Smith Tract (Kan.)
Water encountered at 362 feet  Water stands at 280 feet
Size of hole: 26 feet, 10 inch; 199 feet, 8 inch; 171 feet, 6-1/4 inch

Depth, Feet
From  To

0.0  15.0 Soil and clay
15.0  24.0 Clay and creek gravel
24.0  215.0 Shale
215.0  220.0 Gray Chester limestone
220.0  225.0 Gray Chester limestone, some gray chert
225.0  245.0 Gray limestone
245.0  255.0 Gray limestone and white chert
255.0  260.0 Gray limestone and gray chert
260.0  270.0 Dark gray limestone, light gray blue chert
270.0  280.0 Brown limestone and gray fliint
280.0  290.0 Gray chert and gray limestone
290.0  294.0 Gray chert, some blue chert
294.0  295.0 Shale and marcasite
295.0  300.0 Gray and blue chert, gray limestone, some marcasite
300.0  310.0 Gray and blue chert, gray limestone, thin shale seams
310.0  320.0 Brown limestone and blue chert
320.0  325.0 Brown limestone and gray chert
325.0  330.0 Dark brown and speckled glauconitic limestone, very little chert
330.0  340.0 Gray oolitic limestone, gray chert and some marcasite
340.0  345.0 Gray and light blue chert, some gray limestone
345.0  355.0 Gray and brown chert, a very little blue chert and some thin shale seams with marcasite
355.0  360.0 Gray and blue chert
360.0  365.0 Gray and brown chert, some blue chert, shale seams, thin trace of Zn
367.5  370.0 Gray and white chert
370.0  372.5 Dull gray and translucent gray and white chert
372.5  380.0 Gray chert, some translucent white chert
380.0  385.0 Dull gray and white chert

Bottom

No samples taken.
R.I. 4337

Hole BM-14
Coordinates: 6,614 N - 23,124 E

Started: 11/2/44  
Completed: 11/2/44
Elevation of collar: 793 feet  
T. R. Smith Tract (Kila.)
Water encountered at 295 feet  
Water stands at 230 feet
Size of hole: 12 feet, 10 inch; 150 feet, 8 inch; 188 feet, 6-1/4 inch

Depth, Feet
From  To  Description
0.0  8.0  Soil, clay, gravel and water
8.0  45.0  Sandy shale
45.0  145.0  Shale
145.0  170.0  Gray Chester limestone
170.0  175.0  Gray Chester limestone, a little chert
175.0  185.0  Light gray limestone
185.0  190.0  Gray limestone and gray chert
190.0  195.0  White limestone and some thin green shale seams
195.0  200.0  White limestone, blue chert and a thin green shale seam
200.0  215.0  Gray and brown limestone, gray chert and some pyrite
215.0  225.0  White limestone and some green shale (probably falling)
225.0  230.0  White limestone, dark gray and white chert
230.0  240.0  White limestone, light blue chert, and a little marcasite
240.0  250.0  Gray and light blue breciated chert remented with selvage
250.0  255.0  Gray, light blue and tan chert
255.0  265.0  Light and dark gray and tan chert, some cotton rock and selvage
265.0  270.0  Light and dark gray and a little white chert, a little marcasite
270.0  275.0  Light and dark gray and some white chert, some calcite crystals
275.0  285.0  Light and dark gray and tan chert, some black and green shale seams
285.0  290.0  Light and dark gray and brown chert, some pink dolomite crystals, 
sealage and marcasite
290.0  295.0  Loose light gray chert, black, dark brown and gray limestone and some pink dolomite
295.0  300.0  Loose light gray chert and dull white chert, black and gray lime-
stone, some dolomite
300.0  305.0  Gray chert, some oolithic limestone and dolomite crystals, a small 
opening and a trace of Zn
305.0  307.5  Gray, white and light blue chert, some silicified oolite
307.5  310.0  Gray, white and tan chert, a little brown spotted translucent chert
310.0  315.0  Dull white and brown speckled translucent chert
315.0  320.0  Dull white chert, white and tan translucent chert, and some 
silicified oolite
320.0  325.0  White and tan chert, a little dull white chert
325.0  330.0  Gray, white and tan chert, some dull white chert
Bottom

No samples taken.

- 40 -
Hole BM-16
Coordinates: 6,578 N - 25,657 E

Started: 11/10/44                   Completed: 11/21/44
Elevation of collar: 796 feet        T. R. Smith Tract (Okla.)
Water encountered at 230 feet         Water stands at 235 feet
Size of hole: 12 feet, 10 inch; 125 feet, 8 inch; 225 feet, 6-1/4 inch

Depth, Feet
From — To

0.0  8.0  Soil and gravel
8.0  55.0  Hard sandy shale
55.0  150.0  Shale
150.0  165.0  Gray, white and brown Chester limestone, some yellow limestone fossils, and a very little water at 140 feet
165.0  180.0  Gray Chester limestone and loose green shale seams
180.0  185.0  Loose dark brown and white Chester limestone, a little tar and shale
185.0  170.0  Gray sandy Chester limestone, much selvage, green shale, tan sandstone and marcasite
170.0  175.0  Brown and greenish gray Chester limestone, some selvage, green shale and marcasite (probably fallen)
175.0  190.0  Brown, gray and white limestone (possible Chester)
190.0  205.0  Tan and white limestone
205.0  210.0  Tan, greenish gray and white limestone, some selavage, green shale (falling)
210.0  225.0  Light brown and some white limestone
225.0  240.0  Light brown and white spotted limestone
240.0  245.0  Gray, tan and white limestone
245.0  255.0  Light brown, white and gray limestone
255.0  265.0  Light brown limestone and a little gray chert
265.0  285.0  Tan limestone and a very little white chert
285.0  290.0  Light tan limestone recementing some brecciated light blue, gray and white chert
290.0  300.0  Light, blue, gray and white chert, tan and white limestone
300.0  305.0  Tan limestone, white and blue chert, some white translucent chert
305.0  310.0  Tan and white limestone, some light blue and white chert
310.0  315.0  White limestone, some white cotton rock, light blue and white chert
315.0  320.0  Tan and gray limestone, light blue and white chert
320.0  325.0  Hard tan limestone, some light blue and white chert
325.0  335.0  Light gray, white and light blue chert and tan limestone
335.0  340.0  Hard and light gray chert, a little gray and brown spotted translucent chert, some tan limestone and marcasite
340.0  345.0  Tan and brown spotted limestone, gray and white translucent chert, some selvage seams and much marcasite
345.0  350.0  Brown and white spotted limestone, dull white chert and gray and white translucent chert, much selvage and marcasite
350.0  355.0  Hard dark brown and white spotted limestone (fossils) and dull white chert

Bottom
No samples taken.

2462

Hole BM-17
Coordinates: 11,466 N - 9,419 E

Started: 11/11/44                   Completed: 11/24/44
Elevation of collar: 613 feet        H. W. Smith Tract (Kan.)
Water encountered at 355 feet         Water stands at 270 feet
Size of hole: 30 feet, 10 inch; 170 feet, 8 inch; 195 feet, 6-1/4 inch

Depth, Feet
From — To

0.0  25.0  Soil and clay
25.0  30.0  Gravel and clay
30.0  190.0  Shale; natural gas pocket at 40 ft., tar flow and gas at 100 ft.
190.0  230.0  Gray Chester limestone
230.0  235.0  Gray and white limestone, little gray chert
235.0  240.0  White limestone and little gray chert
240.0  245.0  Gray and blue chert and gray limestone
245.0  250.0  Blue and gray chert and gray limestone
250.0  255.0  Blue and gray chert, some gray limestone, a little selavage
255.0  265.0  Blue chert and dark gray limestone
265.0  270.0  Light blue and gray chert, a little gray limestone
270.0  275.0  Gray chert and gray limestone
275.0  290.0  Dark gray limestone, gray, brown and blue chert, a little cotton rock
290.0  300.0  Brown and gray chert, some gray limestone
300.0  305.0  Brown, gray and white chert, gray limestone
305.0  310.0  Brown and white chert, gray limestone
310.0  315.0  Brown, white and some blue chert
315.0  320.0  Dark brown and black limestone, some gray glauconitic limestone, a very little gray chert
320.0  325.0  Gray, brown and blue chert, a little brown limestone and a little gray chert and chert silicified
325.0  345.0  Dark gray chert limestone, a little gray chert and chert silicified
345.0  350.0  Gray, brown and blue chert, a little gray limestone, thin trace Pb
350.0  355.0  Gray and brown chert, a trace Pb
355.0  360.0  Gray, brown and some blue chert, a little marcasite
360.0  365.0  Gray, blue and some brown chert, trace Pb and Zn
365.0  370.0  Gray, blue and some chert, good Zn and Pb shingles
370.0  375.0  Hard translucent gray and brown chert, thin Zn and Pb shingles
375.0  380.0  Gray, brown and black translucent chert
380.0  385.0  Gray, brown and light blue chert, a little black chert
385.0  390.0  Translucent gray and brown chert
390.0  395.0  Gray and blue chert, some white chert
395.0  400.0  Gray, brown and some white and black chert
400.0  405.0  Gray and brown chert, some brown limestone, a trace Pb
405.0  410.0  Gray and brown chert, some brown limestone, a trace Pb

- 41 -
Hole BI-17 (continued)

Depth, Feet
From - To -
385.0 387.5 Brown and dark gray chert, calcite, some translucent chert, a very little black chert, Pb shines
387.5 390.0 Translucent brown and tan chert, light gray chert, a very little white chert, trace Pb
390.0 395.0 Dull gray to light gray chert, a little light blue chert

Bottom

Five samples taken.

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<thead>
<tr>
<th>Depth, Feet</th>
<th>Zinc</th>
<th>Percent</th>
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<tr>
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<td>390.0</td>
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<td>392.5</td>
<td>395.0</td>
<td>0.08</td>
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Hole BI-18
Coordinates: 7,196 N - 22,570 E

Started: 11/22/44     Completed: 12/4/44
Elevation of collar: 794 feet    T.R. Smith Tract (Okla.)
Water encountered at 230 feet    Water stands at 230 feet
Size of hole: 12 feet, 10 inch; 156 feet, 6 inch; 154 feet, 6-1/4 inch

Depth, Feet
From - To -
0.0 9.0 Soil, clay and gravel
9.0 50.0 Shale
50.0 64.0 Sandy shale
64.0 160.0 Shale
160.0 170.0 Gray Chester limestone
170.0 185.0 Gray Chester limestone and some gray and light blue chert
185.0 190.0 Gray Chester limestone and a very little gray chert
190.0 200.0 Loose gray Chester limestone, selvage and mud filling
200.0 205.0 Loose gray Chester limestone, selvage and mud, trace Zn
205.0 210.0 Loose gray limestone, gray and blue chert, selvage and mud
trace Zn
210.0 215.0 Loose gray and blue chert, some gray limestone, selvage and thin trace Zn shines
215.0 220.0 Loose gray and blue chert, some gray limestone, selvage and thin trace Zn shines, a little marcasite
220.0 222.5 Loose gray and blue chert, some gray limestone, selvage, a little marcasite, a trace Zn
222.5 225.0 Loose light blue and gray chert, some gray limestone, selvage, some marcasite and calcite crystals and a strong trace Zn
225.0 230.0 Limestone coated, light blue and gray chert, selvage, some marcasite and calcite, trace Zn, strong sulphur water at 230 ft.
230.0 240.0 Brown, tan, blue, gray and a little white chert, a very little limestone, some calcite
240.0 245.0 Tan, dark and light gray chert, calcite and trace Zn
245.0 250.0 Gray, brown and blue chert, some tan limestone, calcite and a trace Zn
250.0 270.0 Gray, blue and a little brown chert, gray limestone and some pink dolomite crystals
270.0 285.0 Gray, blue, brown and tan chert, some dolomite crystals
285.0 290.0 Dark brown and gray chert, some dolomite crystals
290.0 295.0 Blue gray and brown chert, some marcasite and dolomite crystals, a little brecciated (partially silicified) oolitic limestone
295.0 305.0 Gray, brown and blue chert, some dolomite crystals
305.0 310.0 Gray, brown and some white chert, some black jasperoid
310.0 315.0 White and some gray and tan translucent chert, a little black jasperoid

2462
R.I. 4337

Hole EM-18 (continued)

Depth, Feet
From- To-
315.0 317.0 Gray, brown and white translucent chert, some dull white chert
317.0 322.0 White and some tan spotted translucent chert

Bottom

Six samples taken.

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Sample</th>
<th>Depth, Feet</th>
<th>Sample</th>
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</thead>
<tbody>
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<td>From- To-Zn</td>
<td>Lead</td>
<td>From- To-Zn</td>
<td>Lead</td>
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<tr>
<td>200.0 205.0 0.20 None</td>
<td>5/4</td>
<td>215.0 220.0 0.60 None</td>
<td>5/6</td>
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<tr>
<td>205.0 210.0 0.32 None</td>
<td>5/6</td>
<td>220.0 222.5 0.32 None</td>
<td>5/4</td>
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<tr>
<td>210.0 215.0 0.54 None</td>
<td>2/3</td>
<td>222.5 225.0 0.38 None</td>
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</table>

Hole EM-19

Coordinates: 11,508 N - 9,361 E

Started: 11/28/44  Completed: 12/3/44
Elevation of collar: 321 feet  H. W. Smith Tract (Kan.)
Water encountered at 555 feet  Water stands at 280 feet
Size of hole: 30 feet, 10 inch; 170 feet, 8 inch; 190 feet, 6-1/4 inch

Depth, Feet
From- To-

0.0 20.0 Soil and clay
20.0 30.0 Clay and gravel
30.0 196.0 Shale, small gas flow at 180 ft.
196.0 200.0 Gray Chester limestone
200.0 222.0 Gray Chester limestone, some gray chert
220.0 225.0 Gray limestone, some white chert
225.0 245.0 Gray and blue chert, some gray limestone
245.0 250.0 Blue and gray chert, gray limestone and some selvage
250.0 265.0 Blue and gray and a very little brown chert, brown limestone
265.0 275.0 Gray and blue chert, to white cotton rock, light gray limestone
275.0 315.0 Gray and blue chert and gray and brown limestone
315.0 321.0 Dark brown to black limestone, a little brown chert, some marcasite
321.0 324.0 Blue, brown and gray chert, little gray limestone
324.0 330.0 Dark gray ooilitic limestone, a little blue silicified colite and chert
330.0 545.0 Dark gray to brown ooilitic limestone, some gray chert
345.0 555.0 Gray, some light blue, and a little brown chert, some gray limestone
355.0 560.0 Gray and light tan translucent chert, some marcasite, a thin trace of Pb
360.0 362.5 Gray, brown chert, some jasperoid, a trace of Zn and Pb
362.5 365.0 Gray translucent chert, a thin trace Zn
365.0 367.5 Gray and brown translucent chert
367.5 370.0 Gray, tan and light blue chert, some dull white and tan chert
370.0 375.0 Dull gray, white and brown chert
375.0 380.0 Gray secondary limestone seams in cotton rock, a trace Pb
380.0 382.5 Gray, brown, light blue and some black chert, a thin trace Pb
382.5 387.5 Gray, brown and light blue chert, some calcite, a thin trace Zn and Pb
387.5 390.0 Dull gray and brown chert

Bottom

Four samples taken.

Analysis, Percent

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<tr>
<th>Depth, Feet</th>
<th>From- To-Zn</th>
<th>Lead</th>
<th>Depth, Feet</th>
<th>From- To-Zn</th>
<th>Lead</th>
</tr>
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<tbody>
<tr>
<td>360.0 362.5</td>
<td>0.60 0.05</td>
<td>375.0 380.0</td>
<td>- 0.08</td>
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</table>
Hole BM-20  Coordinates: 7,311 N - 22,523 W

Started: 12/5/44  Completed: 12/18/44
Elevation of collar: 803 feet  T. R. Smith Tract (Okla.)
Water encountered at 240 feet  Water stands at 240 feet
Size of hole: 14 feet, 10 inch; 176 feet, 8 inch; 190 feet, 6-1/4 inch

Depth, Feet  From-
-  To-

0.0  16.0  Soil, clay and gravel
16.0  184.0  Shale
184.0  195.0  Gray Chester limestone, much marcasite
195.0  200.0  Gray Chester limestone
200.0  215.0  Gray Chester limestone, gray to dark gray chert
215.0  225.0  Gray limestone, gray chert and selvage
225.0  240.0  Soft dirty white decomposed limestone and some white chert
240.0  245.0  Loose gray limestone, gray and light blue chert
245.0  250.0  Gray and blue and light tan chert, selvage and gray limestone
250.0  260.0  Gray and blue chert, brown limestone
260.0  280.0  Loose gray and blue light blue chert
280.0  290.0  Gray, blue, and blue shaly chert
290.0  295.0  Blue, gray, tan and white chert, some gray limestone and selvage
295.0  305.0  Gray, light tan and some blue chert, some gray limestone and selvage seams
305.0  310.0  Loose gray, white and brown speckled chert
310.0  315.0  Loose dull gray, white and a very little blue-tan chert
315.0  320.0  Loose dull gray, white and a little brown chert, calcite, a little gray limestone and thin shale seam
320.0  325.0  Gray and white chert, some light blue and tan translucent chert, small crevices, struck strong sulphur water at 325 ft.
325.0  335.0  No cuttings, opening, strong sulphur water
335.0  345.0  Loose dark brown to light gray speckled chert, some tan and white spotted translucent chert, dolomite crystals and a little silicified oolite and black chert, probably fallen from above, crevices
345.0  360.0  Translucent dull light to dark gray chert, a little dolomite and white chert
360.0  375.0  Hard gray, white and tan translucent chert, a very thin trace Zn
375.0  380.0  Gray and brown mottled chert, a little dark gray-blue chert and limestone
380.0  386.0  Dull dark blue-gray chert and a little limestone with a little white chert in small crevices

Bottom

No samples taken.

Hole BM-21  Coordinates: 11,612 N - 8,999 E

Started: 12/11/44  Completed: 12/22/44
Elevation of collar: 808 feet  H. W. Smith Tract (Kan.)
Water encountered at 255 feet  Water stands at 255 feet
Size of hole: 30 feet, 10 inch; 172 feet, 8 inch; 123 feet, 6-1/4 inch; 36 feet, 5 inch

Depth, Feet  From-
-  To-

0.0  27.0  Soil and clay
27.0  30.0  Gravel
30.0  199.0  Shale
199.0  210.0  Gray Chester limestone, some gray chert
210.0  225.0  Gray Chester limestone
225.0  225.0  Open (no cuttings)
225.0  240.0  Loose gray chert, a little gray limestone
240.0  245.0  Loose light blue and gray chert
245.0  250.0  Loose light blue and gray chert, gray limestone, some marcasite
250.0  260.0  Loose blue and gray chert, a few pink dolomite crystals
260.0  275.0  Loose blue and gray chert, very soft and open
275.0  280.0  Loose white and a little blue chert, very soft and open
280.0  290.0  Blue and gray chert, some marcasite, very soft and caving
290.0  310.0  Loose gray, blue and tan chert, much white cotton rock
310.0  315.0  Grayish green shaly limestone
315.0  320.0  Loose dark brown and black speckled glauconite limestone and selvage, some black and white chert, marcasite, a few specks of Pb
320.0  325.0  Loose gray and green silicified oolite, some white chert and glauconitic limestone
325.0  355.0  Dull tan silicified oolite, a little limestone
335.0  345.0  Hard white chert and tan limestone, trace marcasite
345.0  350.0  Hard white and tan chert, a little tan limestone, a thin trace Pb, some marcasite
350.0  355.0  Hard dull gray chert, a little tan limestone, some marcasite
355.0  360.0  Hard tan and a little white chert, a little jasperoid and brown sand spar. A trace Pb
360.0  365.0  Hard dull tan and some tan and white spotted chert, a trace Pb

Bottom

No samples taken.
Hole BM-22

Coordinates: 7,150 N - 22,655 W

Started: 12/12/44
Completed: 12/22/44
Elevation of collar: 800 feet
T. R. Smith Tract (Okla.)
Water encountered at 233 feet
Water stands at 233 feet
Size of hole: 15 feet, 10 inch; 150 feet, 6 inch; 160 feet, 6-1/4 inch

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<tbody>
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Note: Nine samples taken.

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<td>217.5</td>
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<td>220.0</td>
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<td>227.5</td>
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<td>230.0</td>
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</table>
DEPT, FEET

0.0 - 16.0 Soil, clay and gravel
16.0 - 148.0 Shale
148.0 - 155.0 Gray and white Chester limestone, green and black shale seams
155.0 - 160.0 Gray and white Chester limestone, some green shale seams
160.0 - 185.0 Gray and white Chester limestone, some green shale (falling)
185.0 - 190.0 Gray shelly limestone, some gray chert
190.0 - 195.0 Gray chert, and gray limestone
195.0 - 220.0 Gray chert, gray limestone, selvage, a little cotton rock
220.0 - 220.0 Gray shelly limestone, very little chert, some green shale (falling)
220.0 - 225.0 Light blue-gray chert, a little gray limestone and cotton rock
225.0 - 245.0 Gray limestone, some light blue-gray chert
245.0 - 255.0 Light blue-gray chert, some tan and gray limestone
255.0 - 260.0 Blue-gray and a little white chert, tan limestone
265.0 - 265.0 Gray and some light blue chert, tan limestone
265.0 - 265.0 Tan limestone, light blue-gray chert
265.0 - 290.0 Light brown to a dark brown limestone, brown and gray chert
290.0 - 295.0 Black to dark brown limestone, a little gray chert and selvage
295.0 - 300.0 Black to dark brown limestone, trace Zn
300.0 - 302.5 Loose brown and black-green speckled glauconitic blue chert; Zn shines, trace Pb
302.5 - 305.0 Loose brown and black-green speckled glauconitic limestone, blue chert; Zn shines, trace Pb
305.0 - 307.5 Opening - no cuttings
307.5 - 310.0 Loose gray to dark brown chert; Zn ore
310.0 - 312.5 Loose light and dark gray and some white chert, trace Zn
312.5 - 315.0 Loose gray, light tan and some black and white chert; Zn shines
315.0 - 317.5 Gray light tan and some white chert and selvage
317.5 - 320.0 Gray and tan, some spotted translucent chert and a little dull white chert
320.0 - 325.0 Hard blue and brown chert, brown and white spotted translucent chert and some dull white chert

BOTTOM

Six samples taken.

<table>
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<th>Depth, Feet</th>
<th>Analysis, Percent</th>
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<tbody>
<tr>
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<td>302.5 305.0</td>
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<td>312.5 315.0</td>
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Three samples taken.

Analysis, Percent

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<td>287.5 290.0</td>
<td>0.34 0.10</td>
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</table>

- 46 -
R.I. 4337

Hole BM-25

Coordinates: 11°6'82 N - 8°38 E

Started: 12/23/44  
Completed: 1/4/45

Elevation of collar: 801 feet  
H. W. Smith Tract (Kan.)

Water encountered at 275 feet  
Water stands at 275 feet

Size of hole: 25 feet, 10 inch; 167 feet, 8 inch; 123 feet, 6-1/4 inch; 31 feet, 4-7/8 inch

Depth, Feet
From   To

0.0  17.0 Soil and clay
17.0  22.0 Creek gravel and clay
22.0  187.0 Shale
187.0 220.0 Gray Chester limestone and some gray chert
220.0 225.0 Gray chert
225.0 250.0 Gray chert and a little blue chert
250.0 255.0 Gray and blue chert, gray limestone
255.0 260.0 Dark gray limestone, light blue chert
260.0 265.0 Brown gray-blue chert, some cotton rock
265.0 265.0 Gray-blue chert, little gray limestone
265.0 270.0 Gray chert, tan limestone
270.0 280.0 Gray-blue chert, secondary limestone, some selvage
280.0 290.0 Open and loose gray-blue chert, mud and selvage
290.0 305.0 Open and caving blue-gray chert
305.0 315.0 Blue-gray chert, green-black glauconitic limestone, some black limestone
315.0 318.0 Opening - no cuttings
318.0 320.0 Loose blue, gray and brown chert, dolomite crystals in oolitic limestone, Pb shines
320.0 322.5 Firm blue, black and some white chert, trace Zn and Pb (probably falling)
322.5 325.0 Firm blue, black and some white chert, trace Zn and Pb
325.0 328.5 Firm gray, brown and some white chert, thin trace Zn and Pb
328.5 331.0 Loose dull white, gray and tan chert, white translucent chert and black jasperoid, fair Zn ore
331.0 333.5 Loose dull speckled tan and white chert, some white translucent chert, much black jasperoid, good Zn ore, trace Pb
333.5 335.0 Loose dull white and tan chert, gray oolitic and tan limestone, dolomite crystals, much black jasperoid, chatty Zn ore, trace Pb
335.0 336.5 Very loose dull tan and white chert, black jasperoid, chatty Zn shines, trace Pb
336.5 341.0 Loose dull tan and white chert, dolomite crystals, some black jasperoid, trace Zn
341.0 343.5 Firm gray and light blue translucent chert, thin trace Zn and Pb
343.5 346.0 Hard gray, brown and blue translucent chert, trace Zn
346.0 360.0 Hard gray brown translucent chert, a thin trace Zn and Pb (probably falling)
360.0 362.5 Loose dull gray and white chert, selvage seams in crevices, Zn shines, trace Pb

Depth, Feet
From   To

362.5 365.0 Firm dull gray and white chert, selvage, a thin trace Zn
Bottom

Eight samples taken.

Analysis, Percent

Depth, Feet
From   To

318.0 320.0 0.16 1.35 1/4 535.5 336.0 3.78 0.14 1/8
322.5 325.0 0.18 0.04 5/4 536.0 336.5 0.66 0.04 1/20
328.5 331.0 0.36 0.01 1/3 536.5 341.0 0.20 0.02 1/4
331.0 335.0 5.40 0.27 1/8 560.0 362.5 0.58 0.05 All
R.I. 4337

Hole BM-26
Coordinates: 6,915 N - 22,615 E

Started: 1/3/45
Completed: 1/12/45

Elevation of collar: 724 feet
T. R. Smith Tract (Okla.)

Water encountered at 255 feet
Water stands at 222 feet

Size of hole: 15 feet, 10 inch; 137 feet, 8 inch; 164 feet, 6 inch

Depth, Feet

From- To-

0.0 12.0 Soil and clay
12.0 146.0 Shale
146.0 160.0 Gray Chester limestone
160.0 175.0 Gray limestone and gray chert
175.0 180.0 Gray chert and gray limestone
180.0 185.0 Gray limestone, gray and some blue and white speckled chert, some selvage at 180 ft.
185.0 220.0 Gray to light blue chert, tan to brown limestone
220.0 250.0 Gray and some light blue chert, gray limestone, cotton rock and selvage
230.0 240.0 Gray, some light blue and spotted chert, tan-gray limestone, black shale seams and selvage
240.0 250.0 Gray and blue chert, tan limestone
250.0 265.0 Blue, gray and some brown chert, tan limestone
265.0 267.5 Hard blue gray and some light blue chert, gray limestone
267.5 268.5 Hard gray chert and some light blue chert, gray limestone
268.5 270.0 Very loose dull gray, blue and some tan chert
270.0 272.5 Loose brown, blue, gray and some tan and speckled chert and cotton rock
272.5 275.0 Loose brown and some gray mottled chert, crevices, calcite, trace Pb
275.0 277.5 Loose brown and some gray mottled chert, crevices, calcite, trace Pb, selvage and openings
277.5 280.0 Opening - no cuttings recovered
280.0 282.5 Loose brown, gray and some light blue chert, calcite, trace Pb
282.5 285.0 Loose mottled brown and gray chert, calcite, trace Zn and Pb
285.0 287.5 Loose coarse dull dark brown and a little light gray translucent chert, calcite crystals, Zn shives in black and partially silicified green-black speckled glauconitic limestone
287.5 290.0 Loose gray, blue and brown chert, black and glauconitic speckled green-black limestone with fair Zn ore
290.0 292.5 Loose gray blue and brown chert, black limestone with fair Zn ore
292.5 295.0 Loose black limestone, some gray and brown chert with good Zn shives
295.0 297.5 Loose gray, brown and some blue chert, some rounded pieces of partially silicified brown oolithic limestone, thin Zn shives
297.5 300.0 Brecciated dull gray and brown chert in selvage

Hole BM-26 (continued)

Depth, Feet
From- To-

300.0 302.5 Brown limestone, leached gray and white chert
302.5 305.0 Gray, brown and light blue translucent chert
305.0 314.0 White and gray translucent chert
Bottom

Nine samples taken.

Note: Upon completion, the hole was blasted from 222 to 230 feet, but large slabs and boulders caved up to 275 feet. After cleaning out down to 285 feet, it was necessary to abandon the blasted sample.
R.I. 4337

Hole RM-27
Coordinates: 6,180 N - 23,294 E

Started: 12/30/44   Completed: 1/6/45
Elevation of collar: 799 feet   Albaugh Tract (Okla.)
Water encountered at 330 feet   Water stands at 240 feet
Size of hole: 18 feet, 10 inch; 155 feet, 8 inch; 184 feet, 6-1/4 inch

Depth, Feet
From- To- Depth, Feet

0,0 16,0 Soil and clay
16,0 152,0 Shale
152,0 175,0 Light gray Chester limestone
175,0 190,0 Light gray limestone, a very little white chert
190,0 205,0 Gray limestone, some light blue to gray chert
205,0 210,0 Gray translucent chert in small crevices, some gray limestone
210,0 215,0 Gray and tan chert, some gray limestone and black shale seams
215,0 220,0 Soft gray shaly limestone, black shale seams, gray and a little white chert
220,0 225,0 Soft gray shaly limestone
225,0 240,0 Soft gray shaly limestone, some gray chert and salvages
240,0 250,0 Gray and some light blue chert, tan and some gray limestone and black shale
250,0 270,0 Gray limestone, gray and some light blue chert in salvages
270,0 275,0 Gray chert, gray limestone, specks of green shale
275,0 285,0 Very soft pasty salvages and gray limestone, some brecciated light blue chert
285,0 290,0 Soft shaly gray secondary limestone, some brecciated gray chert and narsacite
290,0 300,0 Loose gray, light blue and some white chert in some gray limestone and marcasite, dolomite crystals and zinc shives
300,0 302.5 Loose gray and blue chert, some white translucent chert in some soft white secondary limestone, good trace Zn
302.5 305.0 Loose gray, tan, light blue and some white chert partially leached to cotton rock, dolomite and calcite crystals, trace Zn
305.0 307.5 Loose blue, gray and some tan chert in cotton rock and white limestone, trace maracite, thin Zn shives
307.5 310.0 Loose blue, gray and white chert in some cotton rock and limestone, dolomite crystals and good Zn shives
310.0 312.5 Loose blue, gray, brown and white chert, some coarse grained brown limestone, good trace Zn
312.5 325.0 Loose blue, gray, brown and white chert, some brown coarse grained limestone, calcite crystals and salvages
325.0 330.0 Loose blue, gray, white, tan and black chert, tan secondary limestone in a dark brown mud-filled opening, trace Zn
330.0 335.0 Loose dull gray speckled chert, some light and dark brown translucent chert, some loose brown limestone in salvages, thin trace Zn
335.0 359.0 Hard gray translucent chert, some dull gray chert

Six samples taken.

2462
R.I. 4337

Hole BM-28
Coordinates: 6,904 N - 22,675 E

Started: 1/15/45  Completed: 1/20/45
Elevation of collar: 794 feet T. R. Smith Tract (Okl.)
Water encountered at 245 feet Water stands at 235 feet
Size of hole: 15 feet, 10 inch; 137 feet, 8 inch; 137 feet, 6-1/4 inch; 25 feet, 4-7/8 inch

Depth, Feet
From—To—

0.0 8.0 Soil, clay, gravel and surface water
8.0 145.0 Shale
145.0 155.0 Gray Chester limestone
155.0 160.0 Gray Chester limestone, a little gray and blue chert
160.0 175.0 Gray limestone and gray chert
175.0 180.0 Gray limestone, gray-blue chert, some cotton rock
180.0 190.0 White chert, cotton rock, some gray limestone
190.0 200.0 Gray and white chert, gray limestone
200.0 220.0 Gray and blue chert, brown and tan limestone
220.0 230.0 Gray blue, and some white chert, tan limestone
230.0 250.0 Blue, gray and tan chert, some tan limestone
235.0 250.0 Blue and gray chert, brown limestone, struck sulfur water at 245 ft
250.0 255.0 Gray and blue chert, brown limestone with cherty (dissolved) trace Pb
255.0 260.0 Blue and brown chert, brown limestone with cherty (dissolved) trace Pb
260.0 265.0 Loose brown, some gray blue chert, tan limestone, trace Zn and Pb
265.0 275.0 Loose brown and gray chert, trace Zn
275.0 277.5 Loose gray and brown mottled chert, trace Zn
277.5 282.5 Loose and soft silt, gray and brown mottled and some blue chert, trace Zn
272.5 275.0 Loose brown and gray chert in an open water course, calcite crystals and trace Zn and lead disseminated in rock
275.0 280.0 Loose brown and gray chert, trace Zn and Pb
280.0 282.5 Loose coarse brown chert in water course, trace Zn and Pb
282.5 285.0 Opening, no cuttings
285.0 287.5 Open and loose coarse brown and some gray chert, a little jasperoid (?)
287.5 290.0 Open and loose coarse brown and some gray chert, thin Zn shins, trace Pb
290.0 292.5 Loose gray and dark brown chert, some brecciated and recemented with jasperoid (?) and green silicified glauconitic limestone with disseminated Zn shins and trace Pb
292.5 295.0 Loose light and gray mottled chert, some black flint, selvage, brown silicified oolitic limestone (probably fallen?), thin Zn shins and trace Pb
295.0 297.5 Loose, light translucent and dark gray mottled chert, some black flint, selvage, trace Zn and Pb

Final Report

Hole BM-28 (continued)

Depth, Feet
From—To—

297.5 300.0 Loose light gray, translucent and a little gray and brown spotted chert, black flint, selvage and mud, trace Zn and Pb
300.0 302.5 Gray and brown spotted translucent chert, selvage, mud, trace Zn and Pb (probably falling)
302.5 305.0 Hard gray, brown and some white chert
305.0 310.0 Hard dull gray, white and a very little translucent brown spotted chert

Bottom

Fourteen samples taken.

Analysis, Percent

<table>
<thead>
<tr>
<th>Sample Depth, Feet</th>
<th>Zno  Lead</th>
<th>Sample Depth, Feet</th>
<th>Zno  Lead</th>
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<td>297.5 300.0</td>
<td>0.24 0.07</td>
<td>1/4 290.0 292.5</td>
<td>0.20 0.07</td>
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<tr>
<td>295.0 297.5</td>
<td>0.20 0.05</td>
<td>1/5 287.5 290.0</td>
<td>0.36 0.05</td>
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<tr>
<td>292.5 295.0</td>
<td>0.18 0.02</td>
<td>1/5 290.0 292.5</td>
<td>0.56 0.06</td>
</tr>
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<td>290.0 292.5</td>
<td>0.24 0.02</td>
<td>1/4 292.5 295.0</td>
<td>0.34 0.05</td>
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<tr>
<td>287.5 290.0</td>
<td>0.14 0.06</td>
<td>1/5 295.0 297.5</td>
<td>0.26 0.07</td>
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<tr>
<td>285.0 287.5</td>
<td>0.02 0.04</td>
<td>1/5 297.5 300.0</td>
<td>0.24 0.05</td>
</tr>
<tr>
<td>282.5 285.0</td>
<td>0.23 0.07</td>
<td>1/4 300.0 302.5</td>
<td>0.23 0.07</td>
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</table>
Hole BM-29
Coordinates: 11,729 N - 8,918 E

Started: 1/5/45
Completed: 1/17/45
Elevation of collar: 803 feet
H. W. Smith Tract (Kan.)
Water encountered at 245 feet
Water stands at 275 feet
Size of hole: 19 feet, 10 inch; 101 feet, 8 inch; 127 feet, 6-1/4 inch;
23 feet, 4-7/8 inch

Depth, Feet

From – To

0.0 15.0 Soil and clay
15.0 17.0 Clay and creek gravel
17.0 186.0 Chalk
186.0 220.0 Gray Chester limestone, a little gray chert
220.0 230.0 Gray limestone, some selavage
230.0 235.0 Gray blue chert
235.0 240.0 Gray blue chert, opening, strong gas flow
240.0 250.0 Gray and blue chert, gray limestone
250.0 260.0 Blue chert and gray limestone
260.0 270.0 Gray-blue chert, brown limestone
270.0 275.0 Gray and some blue chert, a little gray limestone
275.0 280.0 Blue, brown and gray chert, a little gray limestone
280.0 285.0 Blue, brown and blue chert
285.0 290.0 Brown, blue and gray chert, brown limestone
290.0 300.0 Gray and brown limestone and blue chert
300.0 305.0 Blue, brown and gray chert, gray and brown limestone
305.0 310.0 Gray and brown glauconitic and black limestone, a little gray and
     blue chert
310.0 315.0 Gray and some black chert, some gray limestone, struck strong
    sulphur water at 315 ft.
315.0 320.0 Gray, brown and blue chert, some black chert
320.0 325.0 Opening, no cuttings
325.0 327.5 Loose blue and gray and some white chert, green colitic limestone
    (falling?) trace Pb
327.5 330.0 Loose gray, light brown and white chert, some calcite, tan
    limestone, trace Pb
330.0 332.5 Loose gray, tan, some dark brown and white chert, calcite, trace
    Pb and Zn
332.5 335.0 Light gray and tan chert, calcite, tan colitic limestone (falling?)
    thin Zn shines
335.0 337.5 Gray translucent chert, tan, dark brown and some black chert, Zn
    shines
337.5 340.0 Hard gray translucent and brown and gray chert, calcite, Zn shines
340.0 342.5 Tan, white translucent and some black chert, calcite, trace chatty
    Zn
342.5 345.0 Tan and white spotted chert, some brown, trace Pb and Zn and
    marnselite
345.0 347.5 Hard tan and white translucent spotted chert, trace Zn

Analysis, Percent

Depth, Feet

From – To

Sample

Depth, Feet

Sample

Zinc

Sample

Lead

Rec.

Zinc

Sample

Lead

Rec.

532.5 535.0 0.48 0.02 1/10
355.0 357.5 0.94 0.01 1/10
R.I. 4337

Hole BM-80
Coordinates: 13,025 N - 14,874 E

Started: 1/9/45
Completed: 1/20/45
Elevation of collar: 864 feet
Surface water encountered at 30 feet
Deep water encountered at 424 feet
Size of hole: 276 feet, 8 inch; 160 feet, 6-1/4 inch

Depth, Feet
From To

0.0 4.0 Soil, clay and sand
4.0 20.0 Sand and sandstone
20.0 263.0 Shale
263.0 267.0 Gray Chester limestone and selvage
267.0 290.0 Gray Chester limestone, some brown and dark gray limestone
290.0 305.0 Light and dark gray limestone, some blue chert
305.0 325.0 Gray limestone, a very little gray chert
325.0 360.0 Gray and brown limestone, some blue chert
360.0 370.0 Brown limestone, blue and gray chert
370.0 390.0 Brown and gray limestone, blue and gray chert, some shale seams with marcasite
390.0 395.0 Gray and light blue chert, tan limestone, some-shale seams with marcasite
395.0 400.0 Gray chert, tan limestone, some shale seams
400.0 410.0 Greenish-gray-brown limestone, gray chert, some shale seams with marcasite in selvage
410.0 420.0 Black and brown limestone, some marcasite in selvage and shale seams
420.0 425.0 Black limestone, calcite crystals, dark selvage, mud leached cotton rock, shale, trace Zn. Struck opening at 424 ft., lost all but a handful of cuttings when the upper water dropped to the 291 foot level.
425.0 427.5 Black limestone, chert and calcite, gray-black mottled chert, some sandy glauconitic limestone, thin trace Zn
427.5 430.0 Tan, white, blue and gray chert, calcite, dolomite crystals, trace Zn
450.0 432.5 Gray, light gray and some white translucent chert, dull gray and black chert, brown brecciated chert recemented with a little jasperoid, trace Zn and Pb
432.5 436.0 Dull gray spotted chert, some black chert (falling?)
Bottom

No samples taken.

2462 - 52 -
**Hole SW-32**

- Coordinates: 6,857 N - 22,656 E
- Started: 1/25/45
- Completed: 2/5/45
- Elevation of collar: 794 feet
- Water encountered at 255 feet
- Size of hole: 13 feet, 10 inch; 130 feet, 8 inch; 140 feet, 16-1/4 inch; 37 feet, 4-7/8 inch

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From- To-</th>
<th>Lead</th>
<th>Zinc</th>
</tr>
</thead>
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<td>141.0</td>
<td>Shale</td>
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<td>141.0 - 155.0</td>
<td>Gray Chester limestone</td>
<td>155.0</td>
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<tr>
<td>155.0 - 205.0</td>
<td>Gray limestone, some gray chert</td>
<td>205.0</td>
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<tr>
<td>205.0 - 220.0</td>
<td>Cotton rock and some gray chert</td>
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<td>220.0 - 225.0</td>
<td>Gray and blue chert, brown limestone</td>
<td>225.0</td>
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<td>225.0 - 250.0</td>
<td>Gray chert and tan limestone</td>
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</tr>
<tr>
<td>250.0 - 260.0</td>
<td>Tan limestone, gray and some blue chert</td>
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<td>260.0 - 285.0</td>
<td>Brown limestone, gray and blue chert</td>
<td>285.0</td>
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<td>285.0 - 295.0</td>
<td>Loose brown limestone, gray and blue chert, some marcasite</td>
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<tr>
<td>295.0 - 297.5</td>
<td>Loose gray, tan and light blue chert, a little tan limestone, trace Zn and Pb</td>
<td>297.5</td>
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<td>297.5 - 299.0</td>
<td>Loose gray, brown and light blue chert, trace Pb</td>
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<td>299.0 - 300.0</td>
<td>Loose gray, brown and some blue chert, trace Pb</td>
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<tr>
<td>300.0 - 325.0</td>
<td>Loose gray, brown and some blue chert, trace Pb</td>
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<tr>
<td>325.0 - 327.5</td>
<td>Loose gray motiled chert, some brown and blue chert, some gianoclastic limestone, trace Pb</td>
<td>327.5</td>
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<td>327.5 - 330.0</td>
<td>Loose brown, gray and blue chert, some gianoclastic limestone, trace of Zn and Pb</td>
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<td>330.0 - 340.0</td>
<td>Loose brown, gray and blue chert, green gianoclastic limestone, trace Zn</td>
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<td>340.0 - 350.0</td>
<td>Loose black and green gianoclastic limestone, some gray chert, trace Zn and Pb</td>
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<td>350.0 - 352.5</td>
<td>Loose brown and gray chert, trace Zn and Pb</td>
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<td>352.5 - 355.0</td>
<td>Gray, brown and white chert, brown limestone, trace Zn</td>
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<td>355.0 - 360.0</td>
<td>Gray, blue and brown chert, black limestone, trace Zn</td>
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<td>360.0 - 365.0</td>
<td>Black limestone, some gray chert, good Zn and Pb shines</td>
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<td>365.0 - 370.5</td>
<td>Opening, few cuttings - gray spotted translucent chert, some tan and white chert, trace Pb</td>
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<td>370.5 - 377.5</td>
<td>Dull tan and gray motiled chert, some dark gray sandy chert and jasperoid</td>
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<td>377.5 - 380.0</td>
<td>Dull gray and translucent chert</td>
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<td>380.0 - 385.0</td>
<td>Coarse pieces of dull white chert</td>
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<tr>
<td>385.0 - 390.0</td>
<td>Dull gray and translucent chert</td>
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<tr>
<td>390.0 - 395.0</td>
<td>Coarse pieces of dull white chert</td>
<td>395.0</td>
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**Analysis, Percent**

<table>
<thead>
<tr>
<th>Depth, Feet</th>
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<th>Lead</th>
<th>Zinc</th>
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<td>277.5 - 280.0</td>
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<td>280.0 - 282.5</td>
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<td>285.0 - 287.5</td>
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<table>
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<th>Depth, Feet</th>
<th>From- To-</th>
<th>Lead</th>
<th>Zinc</th>
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<tbody>
<tr>
<td>287.5 - 290.0</td>
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<td>290.0 - 292.5</td>
<td>0.28</td>
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<td>292.5 - 295.0</td>
<td>1.16</td>
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**Hole SW-33**

- Coordinates: 11,638 N - 8,808 E
- Started: 1/18/45
- Completed: 1/27/45
- Elevation of collar: 806 feet
- Water encountered at 270 feet
- Water stands at 270 feet
- Size of hole: 28 feet, 10 inch; 169 feet, 8 inch; 129 feet, 6-1/4 inch; 18 feet, 4-7/8 inch

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From- To-</th>
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</thead>
<tbody>
<tr>
<td>0.0 - 15.0</td>
<td>Soil and clay</td>
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<tr>
<td>15.0 - 18.0</td>
<td>Clay and gravel</td>
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<tr>
<td>18.0 - 190.0</td>
<td>Shale</td>
</tr>
<tr>
<td>190.0 - 220.0</td>
<td>Gray Chester limestone, a little gray chert</td>
</tr>
<tr>
<td>220.0 - 225.0</td>
<td>Gray chert and gray limestone</td>
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<tr>
<td>225.0 - 240.0</td>
<td>Gray and blue chert</td>
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<tr>
<td>240.0 - 250.0</td>
<td>Gray and blue chert, some gray limestone, a little selavage and marcasite</td>
</tr>
<tr>
<td>250.0 - 260.0</td>
<td>Blue and gray chert, dark gray limestone</td>
</tr>
<tr>
<td>260.0 - 275.0</td>
<td>Gray and a little blue chert, some gray limestone, strong sulphur water at 270 ft.</td>
</tr>
<tr>
<td>275.0 - 285.0</td>
<td>Dark gray limestone, blue and some brown chert, a little calcite</td>
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<tr>
<td>285.0 - 290.0</td>
<td>Loose and open gray, blue and some black chert, mud, some selavage and calcite</td>
</tr>
<tr>
<td>290.0 - 300.0</td>
<td>Loose and open gray and blue chert, some mud and calcite</td>
</tr>
<tr>
<td>300.0 - 310.0</td>
<td>Loose gray, blue and brown chert, some marcasite and calcite</td>
</tr>
<tr>
<td>310.0 - 315.0</td>
<td>Loose and open gray, blue and some coarse pieces of glassy brown and black chert, mud, selavage and calcite</td>
</tr>
<tr>
<td>315.0 - 320.0</td>
<td>Loose blue chert, a little gray limestone and calcite</td>
</tr>
<tr>
<td>320.0 - 322.5</td>
<td>Loose and open gray, brown and blue chert, a trace Pb</td>
</tr>
<tr>
<td>322.5 - 327.5</td>
<td>Loose gray blue and brown chert, some brown sandy limestone</td>
</tr>
<tr>
<td>327.5 - 330.0</td>
<td>Loose gray mottled and some blue chert, some calcite and marcasite</td>
</tr>
<tr>
<td>330.0 - 335.0</td>
<td>Dull gray, blue and brown chert and some dark mud</td>
</tr>
<tr>
<td>335.0 - 380.0</td>
<td>Loose open, few cuttings, blue, gray and brown chert and some dark mud</td>
</tr>
<tr>
<td>380.0 - 385.0</td>
<td>Loose open, few cuttings, gray, brown and blue chert partially leached to white cotton rock</td>
</tr>
<tr>
<td>385.0 - 390.0</td>
<td>Dull gray translucent chert, some spotted gray and white translucent chert</td>
</tr>
</tbody>
</table>

**Bottom**

No samples taken.
R.I. 4337

Hole BM-34
Coordinates: 13,018 N = 14,937 E

Started: 1/20/45  Completions: 1/21/45
Elevation of collar: 862 feet  Vanatta Tract (Kan.)
Surface water encountered at 50 feet
Heavy water flow encountered Water stands at 230 feet
Size of hole: 276 feet, 8 inch; 164 feet, 6-1/4 inch

Depth, Feet
From  To  
0.0  20.0 Soil, clay, sand and sandstone
20.0  282.0 Shale
282.0  390.0 Gray Chester limestone
390.0  500.0 Gray limestone, tan limestone, some blue chert
500.0  505.0 Gray and a little white limestone, blue chert, opening at 505 ft.
Gas and water flow
305.0  350.0 Gray and a little white limestone, blue chert
350.0  385.0 Blue chert and brown limestone
385.0  430.0 Blue chert, tan limestone, some white cotton rock
430.0  485.0 Blue chert and brown limestone
485.0  530.0 Gray chert, brown, tan and some gray limestone
530.0  590.0 Gray and some white chert, gray and tan limestone
590.0  625.0 Gray and blue chert, tan and gray limestone
625.0  650.0 Gray and some blue chert, greenish-gray glaucomitic limestone
650.0  657.5 Dark brown conglomerate limestone, some gray chert
657.5  710.0 Dark brown conglomerate limestone, blue, brown and a little white chert,
trace Zn and Pb
710.0  737.5 Dark brown conglomerate limestone, blue and brown chert, trace Zn and Pb
737.5  850.0 Loose dark brown conglomerate limestone, blue and brown chert,
trace Zn and Pb
850.0  902.5 Loose blue, brown and white mottled chert, some gray limestone,
calcite, dolomite crystals in an opening, some sulphur water,
Zn shines
902.5  940.0 Hard gray and white spotted translucent chert

Four samples taken.

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Zinc</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>From  To</td>
<td></td>
<td></td>
</tr>
<tr>
<td>420.0</td>
<td>0.30</td>
<td>0.28</td>
</tr>
<tr>
<td>425.0</td>
<td>0.16</td>
<td>0.36</td>
</tr>
<tr>
<td>2462</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hole BM-35
Coordinates: 6,240 N = 23,388 E

Started: 1/22/45  Completions: 1/20/45
Elevation of collar: 800 feet  Alsbaugh Tract (Okl.)
Water encountered at 275 feet  Water stands at 247 feet
Size of hole: 16 feet, 10 inch; 140 feet, 8 inch; 175 feet, 6-1/4 inch

Depth, Feet
From  To  
0.0  16.0 Clay and gravel
16.0  354.0 Shale
354.0  375.0 Gray Chester limestone
375.0  379.0 Gray limestone
379.0  410.0 Gray limestone, a little light blue chert
410.0  415.0 Gray, light blue chert, some gray limestone
415.0  420.0 Gray limestone, a little light blue chert
420.0  425.0 Gray limestone
425.0  450.0 Gray limestone and blue chert
450.0  455.0 Gray and light blue chert, some gray limestone
455.0  465.0 Gray and brown chert, some gray limestone
465.0  467.5 Blue chert and gray limestone
467.5  470.0 Gray and blue chert and gray limestone
470.0  472.5 Blue chert, brown and tan limestone
472.5  482.5 Blue and gray spotted chert, brown limestone, a little black chert,
trace Zn
482.5  272.5 Gray, brown and some white and blue chert, a little black chert,
trace Zn
272.5  295.0 Brown, black and gray limestone, some light blue and white chert,
Zn ore
295.0  297.5 Brown and some black limestone, gray chert, dolomite crystals,
Zn ore
297.5  300.0 Brown and black limestone, gray chert, dolomite crystals, selavage,
trace Pb
300.0  302.5 Black limestone, very little gray chert, some dolomite crystals,
Zn ore
302.5  305.0 Black shaly limestone, black mud and selavage, some gray, light
and blue chert, Zn shines trace Pb
305.0  307.5 Black shaly limestone, some gray chert, much dolomite crystals,
selavage, marcasite, good Zn shines, trace Pb
307.5  310.0 Black shaly limestone, gray chert, dolomite crystals in opening,
Zn shines
310.0  312.5 Black shaly limestone, gray and some blue chert, dolomite crystals,
good Zn shines
312.5  315.0 Gray and blue chert, black limestone, Zn shines
315.0  317.5 Gray and blue chert, black limestone, dolomite crystals and
marcasite in opening, Zn shines
R.I. 4337

Hole MD-35 (continued)

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>317.5</td>
<td>320.0</td>
<td></td>
</tr>
<tr>
<td>320.0</td>
<td>322.5</td>
<td></td>
</tr>
<tr>
<td>322.5</td>
<td>325.0</td>
<td></td>
</tr>
<tr>
<td>325.0</td>
<td>331.0</td>
<td></td>
</tr>
</tbody>
</table>

Loose gray and blue chert, Zn and Pb shales
Loose gray spotted translucent chert, a little olitic limestone (fallen), dolomite crystals, good Zn shales, trace Pb
Hard gray and translucent chert, dolomite crystals in seams, good Zn shales, trace Pb
Hard dull gray translucent chert

Bottom

Fifteen samples taken.

Note: Soft with numerous seams and crevices from 290 to 307.5 feet, quite loose and open, losing much of the cuttings from 307.5 to 320 feet.

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Sample</th>
<th>Depth, Feet</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>285.0</td>
<td>290.0</td>
<td>307.5</td>
<td>310.0</td>
</tr>
<tr>
<td>290.0</td>
<td>292.5</td>
<td>310.0</td>
<td>312.5</td>
</tr>
<tr>
<td>292.5</td>
<td>295.0</td>
<td>312.5</td>
<td>315.0</td>
</tr>
<tr>
<td>295.0</td>
<td>297.5</td>
<td>315.0</td>
<td>317.5</td>
</tr>
<tr>
<td>297.5</td>
<td>300.0</td>
<td>317.5</td>
<td>320.0</td>
</tr>
<tr>
<td>300.0</td>
<td>302.5</td>
<td>320.0</td>
<td>322.5</td>
</tr>
<tr>
<td>302.5</td>
<td>305.0</td>
<td>322.5</td>
<td>325.0</td>
</tr>
<tr>
<td>305.0</td>
<td>307.5</td>
<td>325.0</td>
<td>328.0</td>
</tr>
</tbody>
</table>

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Zinc</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>285.0</td>
<td>0.16</td>
<td>0.01</td>
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<tr>
<td>290.0</td>
<td>0.70</td>
<td>0.02</td>
</tr>
<tr>
<td>292.5</td>
<td>1.50</td>
<td>0.01</td>
</tr>
<tr>
<td>295.0</td>
<td>2.50</td>
<td>0.01</td>
</tr>
<tr>
<td>297.5</td>
<td>2.20</td>
<td>0.02</td>
</tr>
<tr>
<td>300.0</td>
<td>1.98</td>
<td>0.05</td>
</tr>
<tr>
<td>302.5</td>
<td>1.72</td>
<td>0.04</td>
</tr>
<tr>
<td>305.0</td>
<td>1.20</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Hole MD-36

Coordinates: 13,045 N = 14,981 E

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>18.0</td>
</tr>
<tr>
<td>18.0</td>
<td>284.0</td>
</tr>
<tr>
<td>284.0</td>
<td>280.0</td>
</tr>
<tr>
<td>280.0</td>
<td>300.0</td>
</tr>
<tr>
<td>300.0</td>
<td>350.0</td>
</tr>
<tr>
<td>350.0</td>
<td>345.0</td>
</tr>
<tr>
<td>345.0</td>
<td>560.0</td>
</tr>
<tr>
<td>560.0</td>
<td>400.0</td>
</tr>
<tr>
<td>400.0</td>
<td>410.0</td>
</tr>
<tr>
<td>410.0</td>
<td>415.0</td>
</tr>
<tr>
<td>415.0</td>
<td>420.0</td>
</tr>
<tr>
<td>420.0</td>
<td>425.0</td>
</tr>
<tr>
<td>425.0</td>
<td>427.5</td>
</tr>
<tr>
<td>427.5</td>
<td>452.5</td>
</tr>
<tr>
<td>452.5</td>
<td>455.0</td>
</tr>
<tr>
<td>455.0</td>
<td>460.0</td>
</tr>
</tbody>
</table>

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Zinc</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>285.0</td>
<td>0.20</td>
<td>0.01</td>
</tr>
<tr>
<td>290.0</td>
<td>0.72</td>
<td>0.02</td>
</tr>
<tr>
<td>292.5</td>
<td>0.26</td>
<td>0.04</td>
</tr>
</tbody>
</table>

- 55 -
Hole BI-37
Coordinates: 11, 913 N - 8, 912 E

Started: 1/29/45  Completed: 2/14/45
Elevation of collar: 502 feet  H. W. Smith Tract (fan)
Water encountered at 275 feet  Water stand at 275 feet
Size of hole: 26 feet, 10 inch; 168 feet, 8 inch; 152 feet, 6-1/4 inch; 135 feet, 4-7/8 inch

Depth, Feet
From: — To —

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Analysis, Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>17.0 Soil and clay</td>
</tr>
<tr>
<td>17.0</td>
<td>28.0 Gravel, sand, clay and water</td>
</tr>
<tr>
<td>23.0</td>
<td>155.0 Shale</td>
</tr>
<tr>
<td>193.0</td>
<td>220.0 Gray Chester limestone, a very little gray chert</td>
</tr>
<tr>
<td>220.0</td>
<td>235.0 Gray limestone, some light blue and gray chert</td>
</tr>
<tr>
<td>225.0</td>
<td>250.0 Loose blue and gray chert</td>
</tr>
<tr>
<td>230.0</td>
<td>260.0 Brown limestone, some blue chert</td>
</tr>
<tr>
<td>260.0</td>
<td>265.0 Blue and gray chert, gray limestone</td>
</tr>
<tr>
<td>265.0</td>
<td>275.0 Gray and blue chert, gray limestone</td>
</tr>
<tr>
<td>275.0</td>
<td>290.0 Gray, blue and brown chert, brown limestone</td>
</tr>
<tr>
<td>290.0</td>
<td>285.0 Gray limestone, some blue chert</td>
</tr>
<tr>
<td>285.0</td>
<td>295.0 Brown, gray, and blue chert, a little gray limestone</td>
</tr>
<tr>
<td>295.0</td>
<td>305.0 Light brown limestone, blue and gray chert</td>
</tr>
<tr>
<td>305.0</td>
<td>310.0 Gray limestone, gray, tan and a very little blue chert</td>
</tr>
<tr>
<td>310.0</td>
<td>315.0 Black, gray and white chert, greenish brown glauconitic limestone</td>
</tr>
<tr>
<td>315.0</td>
<td>320.0 Black, gray and white chert, greenish brown glauconitic limestone, trace Zn and Pb</td>
</tr>
<tr>
<td>320.0</td>
<td>325.0 Loose gray and blue chert, some leached green glauconitic limestone, trace Zn and Pb</td>
</tr>
<tr>
<td>325.0</td>
<td>325.0 Loose gray, tan, black and white chert, some glauconitic limestone, good Pb shales, trace Zn</td>
</tr>
<tr>
<td>325.0</td>
<td>327.5 Loose gray, tan and some blue chert, green glauconitic and brown limestone, good Pb shales, trace Zn</td>
</tr>
<tr>
<td>327.5</td>
<td>330.0 Loose gray, tan, black and some white chert, Pb shales, trace Zn</td>
</tr>
<tr>
<td>330.0</td>
<td>332.5 Loose dull gray speckled, dark gray, tan and some black chert, trace Zn and Pb</td>
</tr>
<tr>
<td>332.5</td>
<td>335.0 Loose dull gray speckled, dark gray and some tan chert, trace Zn and Pb</td>
</tr>
<tr>
<td>335.0</td>
<td>337.5 Loose gray speckled and some tan and white chert, a few calcite crystals, good Zn shives disseminated in black chert and jasperoid, trace Pb</td>
</tr>
<tr>
<td>337.5</td>
<td>340.0 Loose gray, white, tan and some black chert, jasperoid and/or black chert disseminated with trace Zn</td>
</tr>
<tr>
<td>340.0</td>
<td>342.5 Gray, white and some tan chert, dolomite crystals, fair Zn shives and trace Pb</td>
</tr>
<tr>
<td>342.5</td>
<td>345.0 Gray, brown and white chert, trace Zn</td>
</tr>
</tbody>
</table>

2462

Hole BI-37 (continued)

Depth, Feet
From: — To —

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Analysis, Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>345.0</td>
<td>347.5 Gray and brown translucent chert, some marcasite crystals</td>
</tr>
<tr>
<td>347.5</td>
<td>350.0 Gray and brown translucent chert, some jasperoid</td>
</tr>
<tr>
<td>350.0</td>
<td>357.5 Gray and brown translucent and some dull white chert, jasperoid</td>
</tr>
<tr>
<td>357.5</td>
<td>360.0 Gray, brown and black chert, a little jasperoid, trace Zn</td>
</tr>
<tr>
<td>360.0</td>
<td>362.5 Gray, brown, black and tan chert, trace Zn and Pb</td>
</tr>
<tr>
<td>362.5</td>
<td>365.0 Hard dull gray chert</td>
</tr>
<tr>
<td>365.0</td>
<td>370.0 Hard dull gray and brown chert</td>
</tr>
<tr>
<td>370.0</td>
<td>380.0 Hard dull gray chert, some marcasite, trace Zn</td>
</tr>
<tr>
<td>380.0</td>
<td>390.0 Gray, brown and blue chert, some marcasite, trace Zn</td>
</tr>
<tr>
<td>390.0</td>
<td>400.0 Dull gray, white and blue chert, some tan limestone</td>
</tr>
<tr>
<td>400.0</td>
<td>410.0 Dull gray, white and blue chert, gray and tan limestone, trace Zn</td>
</tr>
<tr>
<td>410.0</td>
<td>415.0 Fractured iron-stained gray and blue chert, tan limestone</td>
</tr>
<tr>
<td>415.0</td>
<td>420.0 Light blue and gray chert, gray limestone</td>
</tr>
<tr>
<td>420.0</td>
<td>425.0 Light blue and gray chert</td>
</tr>
<tr>
<td>425.0</td>
<td>450.0 Dark blue and a little gray translucent chert, gray limestone</td>
</tr>
</tbody>
</table>

Below samples taken.

Analysis, Percent

Depth, Feet
From: — To —

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Analysis, Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>315.0</td>
<td>320.0 0.14 0.13</td>
</tr>
<tr>
<td>320.0</td>
<td>320.5 0.50 0.48</td>
</tr>
<tr>
<td>322.5</td>
<td>325.0 0.20 1.14</td>
</tr>
<tr>
<td>325.0</td>
<td>327.5 0.14 1.18</td>
</tr>
<tr>
<td>327.5</td>
<td>330.0 0.12 0.85</td>
</tr>
<tr>
<td>330.0</td>
<td>332.5 0.13 0.20</td>
</tr>
<tr>
<td>332.5</td>
<td>335.0 0.20 0.42</td>
</tr>
<tr>
<td>335.0</td>
<td>337.5 0.24 0.40</td>
</tr>
<tr>
<td>337.5</td>
<td>340.0 1.84 0.02</td>
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<tr>
<td>340.0</td>
<td>342.5 0.32 0.10</td>
</tr>
<tr>
<td>342.5</td>
<td>345.0 0.40 0.01</td>
</tr>
</tbody>
</table>
Hole BM-38  
Coordinates: 6,879 N - 23,609 E  

Started: 2/6/45  
Completed: 2/16/45  
Elevation of collar: 734 feet  
T. K. Smith Tract (Okla.)  
Water encountered at 255 feet  
Water stands at 253 feet  
Size of hole: 12 feet, 10 inch; 144 feet, 6 inch; 108 feet, 6 inch; 47 feet, 5 inch  

Depth, Feet  
From—To—

<table>
<thead>
<tr>
<th>Depth Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0—10.0</td>
<td>Soil, sand and gravel</td>
</tr>
<tr>
<td>10.0—145.0</td>
<td>Shale</td>
</tr>
<tr>
<td>145.0—165.0</td>
<td>Gray Chester limestone</td>
</tr>
<tr>
<td>165.0—170.0</td>
<td>Gray limestone, some gray chert</td>
</tr>
<tr>
<td>170.0—185.0</td>
<td>Gray chert and gray limestone</td>
</tr>
<tr>
<td>185.0—195.0</td>
<td>Cotton rock, gray and some white chert</td>
</tr>
<tr>
<td>195.0—220.0</td>
<td>Gray chert and gray limestone</td>
</tr>
<tr>
<td>220.0—220.0</td>
<td>Gray and blue chert, tan limestone</td>
</tr>
<tr>
<td>220.0—220.0</td>
<td>Gray chert and tan to brown limestone</td>
</tr>
<tr>
<td>230.0—240.0</td>
<td>Gray and blue spotted chert, brown limestone</td>
</tr>
<tr>
<td>240.0—245.0</td>
<td>Associated and lime coated chert, soft pasty white limestone, calcite crystals</td>
</tr>
<tr>
<td>245.0—255.0</td>
<td>Brecciated gray, blue and brown limestone coated chert, gray limestone</td>
</tr>
<tr>
<td>255.0—260.0</td>
<td>Blue, brown and some gray chert, gray limestone</td>
</tr>
<tr>
<td>260.0—262.5</td>
<td>Brown, blue and some gray chert</td>
</tr>
<tr>
<td>262.5—265.0</td>
<td>Brown and blue chert, trace Pb</td>
</tr>
<tr>
<td>265.0—277.5</td>
<td>Brown and gray chert, trace Pb</td>
</tr>
<tr>
<td>277.5—270.0</td>
<td>Loose blue, brown and some gray chert, trace Pb</td>
</tr>
<tr>
<td>270.0—272.5</td>
<td>Loose brown, light blue and gray chert</td>
</tr>
<tr>
<td>272.5—282.5</td>
<td>Loose brown, blue and gray chert</td>
</tr>
<tr>
<td>282.5—288.5</td>
<td>Open, few cuttings, gray and brown chert, black limestone, trace Zn</td>
</tr>
<tr>
<td>288.5—287.5</td>
<td>Loose gray and brown chert, little limestone, trace Zn</td>
</tr>
<tr>
<td>287.5—290.0</td>
<td>Loose brown and gray chert, dark brown limestone, thin Zn shives, trace Pb</td>
</tr>
<tr>
<td>290.0—292.5</td>
<td>Loose dark brown limestone, gray and light blue chert, thin Zn shives, trace Pb</td>
</tr>
<tr>
<td>292.5—295.0</td>
<td>Loose black limestone, gray and white and some black chert, Zn shives</td>
</tr>
<tr>
<td>295.0—297.5</td>
<td>Loose gray and tan and some white and brown chert, trace Zn</td>
</tr>
<tr>
<td>297.5—302.5</td>
<td>Loose gray and brown chert, trace Zn (probably caving?)</td>
</tr>
<tr>
<td>302.5—307.5</td>
<td>Gray and white translucent chert, trace Zn (probably caving?)</td>
</tr>
<tr>
<td>307.5—311.0</td>
<td>Full gray chert</td>
</tr>
</tbody>
</table>

Bottom

Six samples taken.

**Analysis, Percent**

<table>
<thead>
<tr>
<th>Depth, Feet From—To—</th>
<th>Sample Depth, Feet From—To—</th>
<th>Zinc</th>
<th>Lead</th>
<th>Rec.</th>
<th>Zinc</th>
<th>Lead</th>
<th>Rec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>282.5—285.0</td>
<td>0.42 0.01</td>
<td>1/32</td>
<td>290.0 292.5</td>
<td>0.40 0.03</td>
<td>1/2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>285.0—287.5</td>
<td>0.16 0.01</td>
<td>1/2</td>
<td>292.5 295.0</td>
<td>0.70 0.01</td>
<td>1/2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>287.5—290.0</td>
<td>0.44 0.02</td>
<td>1/3</td>
<td>295.0 297.5</td>
<td>0.30 0.01</td>
<td>1/2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2462 - 37 -
Hole BM-40
Coordinates: 15,030 N - 14,475 E

Started: 2/9/45  
Completed: 2/16/45
Elevation of collar: 855 feet  
Vanatta Tract (Man.)
Water encountered at 410 feet  
Water stands at 285 feet
Size of hole: 25 feet, 6 inch; 165 feet, 6 inch

Depth, Feet
From - To -

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Soil, clay and sandstone</td>
</tr>
<tr>
<td>16.0</td>
<td>Soil</td>
</tr>
<tr>
<td>26.0</td>
<td>Shale</td>
</tr>
<tr>
<td>262.0</td>
<td>Gray Chester limestone</td>
</tr>
<tr>
<td>280.0</td>
<td>Gray limestone and gray chert</td>
</tr>
<tr>
<td>285.0</td>
<td>Gray limestone, gray and some light blue chert</td>
</tr>
<tr>
<td>286.0</td>
<td>Gray limestone, gray speckled and light blue chert</td>
</tr>
<tr>
<td>300.0</td>
<td>Gray chert and gray limestone</td>
</tr>
<tr>
<td>310.0</td>
<td>Gray limestone, gray and some light blue chert</td>
</tr>
<tr>
<td>315.0</td>
<td>Gray chert and gray limestone</td>
</tr>
<tr>
<td>320.0</td>
<td>Gray and light blue chert, tan limestone</td>
</tr>
<tr>
<td>335.0</td>
<td>Cotton rock, gray chert and some gray limestone</td>
</tr>
<tr>
<td>345.0</td>
<td>Tan limestone, gray and some light blue chert</td>
</tr>
<tr>
<td>355.0</td>
<td>Gray and blue chert, tan and brown limestone</td>
</tr>
<tr>
<td>365.0</td>
<td>Brown limestone and gray chert</td>
</tr>
<tr>
<td>385.0</td>
<td>Shale</td>
</tr>
<tr>
<td>395.0</td>
<td>Shaly gray limestone and some gray chert</td>
</tr>
<tr>
<td>400.0</td>
<td>Black and some brown limestone, trace Pb</td>
</tr>
<tr>
<td>406.0</td>
<td>Black and green glauconitic limestone, very good Zn ore</td>
</tr>
<tr>
<td>405.0</td>
<td>Black and green glauconitic limestone, calcite, some white chert,</td>
</tr>
<tr>
<td>407.5</td>
<td>very good Zn ore</td>
</tr>
<tr>
<td>410.0</td>
<td>Black and green glauconitic limestone, calcite, some white chert,</td>
</tr>
<tr>
<td>412.5</td>
<td>good Zn ore</td>
</tr>
<tr>
<td>415.0</td>
<td>Gray and some tan chert, fair Zn ore</td>
</tr>
<tr>
<td>415.0</td>
<td>Black and tan chert, Zn shines</td>
</tr>
<tr>
<td>417.5</td>
<td>Gray translucent and some tan chert, Zn shines</td>
</tr>
<tr>
<td>420.0</td>
<td>Dull gray chert and Zn (probably filling?)</td>
</tr>
<tr>
<td>422.5</td>
<td>Dull gray chert, Zn</td>
</tr>
<tr>
<td>425.0</td>
<td>Dull gray chert, trace Zn</td>
</tr>
</tbody>
</table>

Bottom

Nine samples taken.

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Sample Depth, Feet</th>
<th>Sample Depth, Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>From - To</td>
<td>Zinc</td>
<td>Lead</td>
</tr>
<tr>
<td>400.0</td>
<td>405.0</td>
<td>16.85</td>
</tr>
<tr>
<td>405.0</td>
<td>407.5</td>
<td>12.60</td>
</tr>
<tr>
<td>407.5</td>
<td>410.0</td>
<td>7.98</td>
</tr>
<tr>
<td>410.0</td>
<td>412.5</td>
<td>3.84</td>
</tr>
<tr>
<td>412.5</td>
<td>415.0</td>
<td>1.74</td>
</tr>
</tbody>
</table>

2462

Hole BM-41
Coordinates: 11,657 N - 9,035 E

Started: 2/13/45  
Completed: 2/23/45
Elevation of collar: 805 feet  
H. W. Smith (Man.)
Water encountered at 270 feet  
Water stands at 270 feet
Size of hole: 25 feet, 10 inch; 155 feet, 6 inch; 122 feet, 6 inch

Depth, Feet
From - To -

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Soil and clay</td>
</tr>
<tr>
<td>18.0</td>
<td>Soil</td>
</tr>
<tr>
<td>25.0</td>
<td>Gravel, sand, clay and surface water</td>
</tr>
<tr>
<td>25.0</td>
<td>Shale</td>
</tr>
<tr>
<td>186.0</td>
<td>Gray sandstone</td>
</tr>
<tr>
<td>175.0</td>
<td>Gray limestone</td>
</tr>
<tr>
<td>192.0</td>
<td>Shale</td>
</tr>
<tr>
<td>197.0</td>
<td>Gray Chester limestone</td>
</tr>
<tr>
<td>220.0</td>
<td>Gray limestone and some gray chert</td>
</tr>
<tr>
<td>220.0</td>
<td>Gray chert and gray limestone</td>
</tr>
<tr>
<td>250.0</td>
<td>Gray and blue chert, gray limestone</td>
</tr>
<tr>
<td>250.0</td>
<td>Gray and brown chert, blue chert, a flow of gas</td>
</tr>
<tr>
<td>255.0</td>
<td>Gray chert, blue and gray chert, some calcite crystals</td>
</tr>
<tr>
<td>265.0</td>
<td>Gray and blue chert, some calcite crystals</td>
</tr>
<tr>
<td>270.0</td>
<td>Gray and some blue chert, a little gray limestone</td>
</tr>
<tr>
<td>270.0</td>
<td>Loose gray, white and blue chert, some tar, struck strong sulphur water</td>
</tr>
<tr>
<td>275.0</td>
<td>Pinn brown limestone, blue and gray chert</td>
</tr>
<tr>
<td>280.0</td>
<td>Gray, blue and a little brown chert</td>
</tr>
<tr>
<td>285.0</td>
<td>Dark gray limestone, blue and a little brown chert</td>
</tr>
<tr>
<td>290.0</td>
<td>Loose blue and gray chert, gray limestone</td>
</tr>
<tr>
<td>295.0</td>
<td>Loose blue and gray chert, gray shale limestone</td>
</tr>
<tr>
<td>305.0</td>
<td>Greenish gray glauconitic limestone, blue and gray chert</td>
</tr>
<tr>
<td>310.0</td>
<td>Loose gray, blue, brown and some black chert</td>
</tr>
<tr>
<td>320.0</td>
<td>Brown calcitic limestone, blue and gray chert, some calcite crystals</td>
</tr>
<tr>
<td>325.0</td>
<td>Opening, no cuttings except caving calcitic limestone</td>
</tr>
<tr>
<td>325.0</td>
<td>Blue and gray chert</td>
</tr>
<tr>
<td>325.0</td>
<td>Dark gray and some blue chert</td>
</tr>
<tr>
<td>337.5</td>
<td>Gray and brown chert, a little tan and white spotted chert, some limestone falling</td>
</tr>
<tr>
<td>340.0</td>
<td>Gray, tan and white, some faintly spotted limestone falling</td>
</tr>
</tbody>
</table>

Bottom

No samples taken.
R.I. 4337

Hole DW-42
Coordinates: 6,796 N - 22,125 E

Started: 2/17/45
Completed: 2/27/45
Elevation of collar: 798 feet
T. R. Smith Tract (Okl.0)
Water encountered at 302 feet
Water stands at 233 feet
Size of hole: 18 feet, 10 inch; 182 feet, 8 inch; 167 feet, 6 inch

Depth, Feet
From-- To--

0.0  10.0 Soll and clay
10.0  147.0 Shale
147.0  170.0 Gray Chester limestone
170.0  200.0 Gray limestone, gray chert, some green shale and selvage seams
200.0  215.0 Soft dirty white limestone, some gas at 210 ft.
215.0  225.0 Cotton rock and white chert
225.0  230.0 Gray chert, some brown limestone
230.0  235.0 Gray chert, some blue chert, some calcite and marcasite crystals
235.0  245.0 Gray chert and some blue chert, some selvage
245.0  250.0 Gray chert and some blue chert, brown limestone
250.0  255.0 Gray and some light blue chert, brown limestone
255.0  265.0 Light blue chert and brown limestone
265.0  270.0 Gray and blue chert, brown limestone, calcite crystals
270.0  280.0 Gray and blue chert, brown limestone, some selvage
280.0  290.0 Gray and blue chert, brown limestone, some dolomite crystals and selvage
290.0  295.0 Gray and blue chert, some marcasite and calcite crystals, some black shaly limestone
295.0  300.0 Gray, blue and brown mottled chert, some selvage and black shaly limestone
300.0  310.0 Gray, brown and some blue chert
310.0  314.0 Dull white and some translucent chert

No samples taken.

Hole DW-43
Coordinates: 6,150 N - 22,446 E

Started: 2/10/45
Completed: 2/20/45
Elevation of collar: 798 feet
Alsbaugh Tract (Okl.0)
Water encountered at 300 feet
Water stands at 235 feet
Size of hole: 18 feet, 10 inch; 136 feet, 8 inch; 177 feet, 6 inch

Depth, Feet
From-- To--

0.0  12.0 Soll and clay
12.0  15.0 Gravel and water
15.0  147.0 Shale
147.0  152.0 Gray Chester Limestone
152.0  185.0 Gray Chester limestone, some green shale, selvage seams
185.0  200.0 Gray limestone and blue chert
200.0  205.0 Gray limestone
205.0  220.0 Gray limestone, a very little gray to blue chert
220.0  225.0 Blue, brown and gray chert, brown limestone, some selvage
225.0  230.0 Gray and brown chert, brown limestone, selvage and cotton rock
230.0  240.0 Gray and blue chert, gray limestone, cotton rock
240.0  250.0 Blue and gray chert, brown limestone
250.0  255.0 Blue, gray and brown chert, brown limestone
255.0  275.0 Brown limestone, blue and gray chert
275.0  285.0 Blue and brown chert, brown limestone, some calcite crystals and tan limestone
285.0  295.0 Black and gray shaly limestone
295.0  300.0 Black limestone, a very little chert gray, trace Zn and Pb
300.0  305.0 Black limestone, a mud and selvage filled crevice, strong sulphur water, fair Zn shines
305.0  307.5 Loose and open blue and some black chert, only a few cuttings, Zn ore
307.5  310.0 Loose blue chert, good Zn shines
310.0  312.5 Loose gray translucent and a little dull tan chert, trace Zn
312.5  315.0 Loose gray, brown, blue and some black chert, Zn shines
315.0  317.5 Gray translucent and some dull white chert, trace Zn
317.5  320.0 Dull gray, some brown and black and a little white chert, thin trace Zn
320.0  322.5 Dull gray and a little brown and white chert, a trace jasperoid, thin trace Zn
322.5  329.0 Dull gray chert, a little brown chert and jasperoid with a thin trace of Zn, probably falling

No samples taken.

Sr: samples taken.

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From-- To--</th>
<th>Zine</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>300.0</td>
<td>305.0</td>
<td>0.62</td>
<td>--</td>
</tr>
<tr>
<td>305.0</td>
<td>307.5</td>
<td>4.70</td>
<td>--</td>
</tr>
<tr>
<td>307.5</td>
<td>310.0</td>
<td>1.60</td>
<td>--</td>
</tr>
</tbody>
</table>
**R.I. 4337**

**Hole BM-44**
Coordinates: 31° 10' N - 14° 608' W

- **Started:** 2/17/45
- **Completed:** 2/27/45
- **Elevation of collar:** 865 feet
- **Vanatta Tract (Kan.)**
- **Water encountered at 410 feet**
- **Water stands at 295 feet**
- **Size of hole:** 265 feet, 8 inch; 165 feet, 6 inch

**Depth, Feet**
From - To -

<table>
<thead>
<tr>
<th>Depth</th>
<th>From</th>
<th>To</th>
<th>Lead</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>18.0</td>
<td>Soil, clay and sandstone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.0</td>
<td>253.0</td>
<td>Slate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>253.0</td>
<td>290.0</td>
<td>Gray Chester limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>290.0</td>
<td>300.0</td>
<td>Gray limestone, some dark gray limestone and white chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300.0</td>
<td>320.0</td>
<td>Gray limestone and some blue chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>320.0</td>
<td>345.0</td>
<td>Blue chert, gray and brown limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>345.0</td>
<td>350.0</td>
<td>Gray limestone and gray chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>350.0</td>
<td>360.0</td>
<td>Blue and brown chert, tan limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>360.0</td>
<td>365.0</td>
<td>Blue chert and brown limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>365.0</td>
<td>395.0</td>
<td>Blue chert and brown limestone, some green glauconitic limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>395.0</td>
<td>400.0</td>
<td>Greenish-gray glauconitic limestone, some blue chert, Pb shines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400.0</td>
<td>402.5</td>
<td>Greenish-gray glauconitic limestone, trace Zn and Pb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>402.5</td>
<td>405.0</td>
<td>Black limestone, Zn shiness, trace Pb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>405.0</td>
<td>407.5</td>
<td>Black and brown limestone, Zn ore, trace Pb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>407.5</td>
<td>410.0</td>
<td>Black, brown and colloitic limestone, Zn ore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>410.0</td>
<td>415.0</td>
<td>Brown-gray colloitic limestone, calcite crystals, very good Zn ore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>415.0</td>
<td>417.5</td>
<td>Gray, brown and some black limestone, gray chert, Zn ore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>417.5</td>
<td>420.0</td>
<td>Gray and brown limestone, gray chert, Zn shiness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>420.0</td>
<td>422.5</td>
<td>Gray chert, some brown limestone, trace Zn and Pb (probably falling?)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>422.5</td>
<td>425.0</td>
<td>Gray translucent chert, small openings, black sulphur water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>425.0</td>
<td>427.5</td>
<td>Gray and brown limestone, brown chert, calcite crystals, fair Zn and Pb ore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>427.5</td>
<td>450.0</td>
<td>Gray and some white translucent chert</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bottom**

Eleven samples taken.

**Analysis, Percent**

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Lead</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 18.0</td>
<td>0.24</td>
<td>1.20</td>
</tr>
<tr>
<td>18.0 - 253.0</td>
<td>0.20</td>
<td>0.39</td>
</tr>
<tr>
<td>253.0 - 290.0</td>
<td>0.44</td>
<td>0.15</td>
</tr>
<tr>
<td>290.0 - 300.0</td>
<td>0.30</td>
<td>0.24</td>
</tr>
<tr>
<td>300.0 - 320.0</td>
<td>1.80</td>
<td>0.04</td>
</tr>
<tr>
<td>320.0 - 345.0</td>
<td>2.64</td>
<td>1.65</td>
</tr>
</tbody>
</table>

**Hole BM-45**
Coordinates: 6° 12' S - 23° 490' W

- **Started:** 2/20/45
- **Completed:** 3/5/45
- **Elevation of collar:** 790 feet
- **Albaugh Tract (Okla.)**
- **Water encountered at 318 feet**
- **Water stands at 240 feet**
- **Size of hole:** 16 feet, 10 inch; 129 feet, 8 inch; 175 feet, 6-1/4 inch

**Depth, Feet**
From - To -

<table>
<thead>
<tr>
<th>Depth</th>
<th>From</th>
<th>To</th>
<th>Lead</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>16.0</td>
<td>Soil, clay and gravel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.0</td>
<td>142.0</td>
<td>Blue and gray shale, coal 65-70'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>142.0</td>
<td>145.0</td>
<td>Gray Chester limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>145.0</td>
<td>165.0</td>
<td>Gray Chester limestone, green shale and selvage seams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>165.0</td>
<td>170.0</td>
<td>Gray Chester limestone, a little gray chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>170.0</td>
<td>180.0</td>
<td>Gray limestone, gray and blue chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>180.0</td>
<td>190.0</td>
<td>Blue and gray chert, gray limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>190.0</td>
<td>195.0</td>
<td>Gray limestone, some gray and blue chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>195.0</td>
<td>205.0</td>
<td>Gray limestone, some gray and blue chert, cotton rock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>205.0</td>
<td>220.0</td>
<td>Blue and gray chert, gray limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>220.0</td>
<td>225.0</td>
<td>Light gray limestone, gray and blue chert</td>
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<tr>
<td>225.0</td>
<td>235.0</td>
<td>Blue and gray chert, gray limestone</td>
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</tr>
<tr>
<td>235.0</td>
<td>250.0</td>
<td>Blue and gray chert, gray limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>250.0</td>
<td>255.0</td>
<td>Blue and gray chert, brown limestone, some calcite crystals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>255.0</td>
<td>260.0</td>
<td>Black limestone, gray and blue chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>260.0</td>
<td>270.0</td>
<td>Blue and gray chert, gray limestone, some calcite crystals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>270.0</td>
<td>282.0</td>
<td>Blue and gray chert, gray limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>282.0</td>
<td>285.0</td>
<td>Blue and gray chert, shaly black limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>285.0</td>
<td>290.0</td>
<td>Blue, gray and black chert, some black limestone, much pyrite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>290.0</td>
<td>292.5</td>
<td>Black shaly limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>292.5</td>
<td>299.0</td>
<td>Brown and gray (some colloitic) limestone, some gray chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>299.0</td>
<td>305.0</td>
<td>Blue and gray chert, tan limestone (some calcite)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>305.0</td>
<td>310.0</td>
<td>Gray, tan and a little white chert, gray limestone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>310.0</td>
<td>315.0</td>
<td>Brown and some white speckled chert, brown oolitic limestone, some selvage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>315.0</td>
<td>320.0</td>
<td>Gray, tan and white spotted chert, a little jasperoid, a faint trace of Zn and Pb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bottom**

No samples taken.
### Hole BM-46
Coordinates: 6,738 N - 23,029 E

- **Started:** 2/28/45
- **Completed:** 3/0/45
- **Elevation of collar:** 800 feet
- **Water encountered at:** 267 feet
- **Water stands at:** 235 feet
- **Size of hole:** 15 feet, 10 inch; 133 feet, 8 inch; 160 feet, 6 inch

#### Depth, Feet

<table>
<thead>
<tr>
<th>Depth (Feet)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>14.0 Soil, clay and gravel</td>
</tr>
<tr>
<td>14.0</td>
<td>147.0 Shale</td>
</tr>
<tr>
<td>147.0</td>
<td>165.0 Gray Chester limestone</td>
</tr>
<tr>
<td>165.0</td>
<td>170.0 Gray chert, gray limestone, some selvage and green shale</td>
</tr>
<tr>
<td>170.0</td>
<td>185.0 Tan limestone and gray chert</td>
</tr>
<tr>
<td>185.0</td>
<td>195.0 Tan and some gray limestone, some gray chert</td>
</tr>
<tr>
<td>195.0</td>
<td>225.0 Soft dirty white limestone, some gray chert</td>
</tr>
<tr>
<td>225.0</td>
<td>235.0 Gray and blue chert, brown limestone, some selvage and marcasite</td>
</tr>
<tr>
<td>235.0</td>
<td>245.0 Brown limestone, blue and gray chert</td>
</tr>
<tr>
<td>245.0</td>
<td>270.0 Blue-gray chert, brown limestone</td>
</tr>
<tr>
<td>270.0</td>
<td>281.0 Brown limestone, blue and gray chert</td>
</tr>
<tr>
<td>281.0</td>
<td>285.0 Brown limestone, black shaly limestone, light gray translucent chert, some marcasite</td>
</tr>
<tr>
<td>285.0</td>
<td>290.0 Gray and blue chert, gray and some oolitic limestone, trace Zn (falling?)</td>
</tr>
<tr>
<td>290.0</td>
<td>292.5 Gray and tan oolitic limestone, some gray chert, trace Zn</td>
</tr>
<tr>
<td>292.5</td>
<td>295.0 Gray and tan and some blue chert, a little marcasite, trace Zn</td>
</tr>
<tr>
<td>295.0</td>
<td>300.0 Gray and tan limestone, blue and gray chert, a thin trace Zn</td>
</tr>
<tr>
<td>300.0</td>
<td>508.0 Dull gray and some tan chert</td>
</tr>
</tbody>
</table>

Three samples taken.

### Hole BM-47
Coordinates: 11,608 N - 9,073 E

- **Started:** 2/23/45
- **Completed:** 3/12/45
- **Elevation of collar:** 803 feet
- **Water encountered at:** 270 feet
- **Water stands at:** 270 feet
- **Size of hole:** 26 feet, 10 inch; 167 feet, 8 inch; 132 feet, 6 inch; 84 feet, 5 inch

#### Depth, Feet

<table>
<thead>
<tr>
<th>Depth (Feet)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>18.0 Soil and clay</td>
</tr>
<tr>
<td>18.0</td>
<td>25.0 Sand, gravel and clay</td>
</tr>
<tr>
<td>25.0</td>
<td>172.0 Shale</td>
</tr>
<tr>
<td>172.0</td>
<td>177.0 Gray sandstone</td>
</tr>
<tr>
<td>177.0</td>
<td>191.0 Shale</td>
</tr>
<tr>
<td>191.0</td>
<td>210.0 Gray limestone, a little gray chert, showing tar</td>
</tr>
<tr>
<td>210.0</td>
<td>220.0 Gray Chester limestone</td>
</tr>
<tr>
<td>220.0</td>
<td>235.0 White and some blue chert, soft dirty white limestone</td>
</tr>
<tr>
<td>235.0</td>
<td>240.0 Blue and gray chert, a small opening and gas flow</td>
</tr>
<tr>
<td>240.0</td>
<td>250.0 Gray and blue chert</td>
</tr>
<tr>
<td>250.0</td>
<td>265.0 Gray and blue chert, gray limestone</td>
</tr>
<tr>
<td>265.0</td>
<td>275.0 Gray and some blue chert, some cotton rock</td>
</tr>
<tr>
<td>275.0</td>
<td>280.0 Gray limestone, dark gray-blue chert</td>
</tr>
<tr>
<td>280.0</td>
<td>295.0 Blue-gray chert and gray limestone</td>
</tr>
<tr>
<td>295.0</td>
<td>300.0 Soft blue and gray chert, mud and selvage</td>
</tr>
<tr>
<td>300.0</td>
<td>305.0 Loos and open blue and gray chert, some marcasite</td>
</tr>
<tr>
<td>305.0</td>
<td>310.0 Loose blue and gray chert, a little cotton rock, marcasite, mud, selvage, trace Zn</td>
</tr>
<tr>
<td>310.0</td>
<td>315.0 Course loose black chert, brown sandy limestone, some gray chert, and gray limestone in mud and selvage, trace Zn and Pb</td>
</tr>
<tr>
<td>315.0</td>
<td>320.0 Loose blue and gray chert, a very little green gauconite limestone, some oolite mostly silicified, trace Zn and Pb</td>
</tr>
<tr>
<td>320.0</td>
<td>325.0 Loose blue, gray and brown chert, trace Zn, good Pb ore</td>
</tr>
<tr>
<td>325.0</td>
<td>325.0 Loose black, brown and gray chert, calcite, mud, selvage, trace Zn; Pb shines</td>
</tr>
<tr>
<td>325.0</td>
<td>327.5 Loose brown and some black chert, calcite, selvage, trace Zn; Pb shines</td>
</tr>
<tr>
<td>327.5</td>
<td>330.0 Loose gray mottled chert and some brown chert, trace Zn and Pb</td>
</tr>
<tr>
<td>330.0</td>
<td>335.0 Loose gray and black and tan chert, some calcite, trace Zn; Pb traces, jasperoid</td>
</tr>
<tr>
<td>335.0</td>
<td>337.5 Loose gray, brown and some tan chert, calcite, Zn shines disseminated through jasperoid, trace Pb</td>
</tr>
<tr>
<td>337.5</td>
<td>342.5 Loose gray and tan chert, jasperoid, dolomite crystals, good Zn ore; trace Pb</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Zinc</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>235.0 - 290.0</td>
<td>0.14</td>
<td>0.02</td>
</tr>
<tr>
<td>290.0 - 292.5</td>
<td>0.20</td>
<td>0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Zinc</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>292.5 - 295.0</td>
<td>0.16</td>
<td>0.01</td>
</tr>
</tbody>
</table>
R.I. 4337

Hole HM-47 (continued)

Depth, Feet
From- To-

342.5 347.5 Loose gray spotted and tan chert, some sarsasite, Zn shines, trace Pb
347.5 350.0 Gray and brown chert, calcite and some jasperoid, trace Zn and Pb
350.0 355.0 Gray, brown and blue chert, Zn shines, trace Pb
355.0 357.5 Gray, brown and blue chert, trace Zn and Pb
357.5 362.5 Gray and brown chert, little seams of jasperoid, trace Zn and Pb
362.5 365.0 Gray and brown chert, thin trace Zn and Pb
365.0 370.0 Dull gray chert, thin trace Zn and Pb
370.0 372.5 Dull gray and some brown chert, thin trace Zn and Pb
372.5 375.0 Dull gray chert, thin trace Zn
375.0 377.0 Gray, brown and some black spotted chert, some dolomite crystals, a very thin trace of Zn and Pb
377.5 400.0 Gray and brown spotted chert, some selvage
400.0 405.0 Gray and brown mottled chert, some dark gray chert and limestone
405.0 409.0 Dark gray chert, a little gray shaly limestone

Bottom

Sixteen samples taken.

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From- To</th>
<th>Zinc</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>315.0</td>
<td>320.0</td>
<td>0.14</td>
<td>0.26</td>
</tr>
<tr>
<td>320.0</td>
<td>322.5</td>
<td>0.18</td>
<td>2.45</td>
</tr>
<tr>
<td>322.5</td>
<td>325.0</td>
<td>0.20</td>
<td>0.62</td>
</tr>
<tr>
<td>325.0</td>
<td>327.5</td>
<td>0.14</td>
<td>0.44</td>
</tr>
<tr>
<td>327.5</td>
<td>330.0</td>
<td>0.12</td>
<td>0.11</td>
</tr>
<tr>
<td>330.0</td>
<td>332.5</td>
<td>0.16</td>
<td>0.77</td>
</tr>
<tr>
<td>332.5</td>
<td>335.0</td>
<td>0.12</td>
<td>0.19</td>
</tr>
<tr>
<td>335.0</td>
<td>337.5</td>
<td>0.52</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Hole HM-48

Coordinates: 15,502 N - 14,646 E

Started: 2/28/45
Completed: 5/10/45

Elevation of collar: 866 feet

Varaatta Tract (Kan.)

Upper water seeped in from an undetermined horizon in Chester limestone; there was no deep sulphur water flow.

Size of hole: 265 feet, 8 inch and 180 feet, 6 inch

Depth, Feet
From- To-

0.0 18.0 Dull, clay and sandstone
18.0 264.0 Shale
264.0 275.0 Gray and some brown limestone, some gray chert
275.0 280.0 Gray and some brown limestone, some gray chert, and selvage
280.0 290.0 Gray limestone, gray chert and cotton rock
290.0 300.0 Gray and some tan limestone, gray chert
300.0 305.0 Gray and brown limestone, gray chert
305.0 310.0 Gray limestone, gray and some light blue chert
310.0 325.0 Blue chert and gray limestone
325.0 345.0 Blue chert and gray and some brown limestone
345.0 350.0 Gray limestone and some gray chert
350.0 355.0 Gray and brown limestone, a little blue chert
355.0 385.0 Blue and gray chert, brown limestone
385.0 390.0 Gray and some blue mottled chert, brown limestone
390.0 395.0 Dark gray shaly limestone
395.0 400.0 Dark gray shaly limestone and some gray chert
400.0 405.0 Shaly gray-green glauconitic limestone, black chert
405.0 410.0 Shaly black and green glauconitic limestone, blue and gray chert
410.0 415.0 Dark brown and gray limestone, some coalitic, a little gray chert
415.0 420.0 Dark brown and gray coalitic limestone, some glauconite and some black coalitic limestone with calcite crystals
420.0 425.0 Gray chert, gray and brown limestone
425.0 430.0 Gray, tan and some light blue chert, calcite, selvage and green and brown limestone
430.0 435.0 Gray and tan spotted and some white chert
435.0 440.0 Dark and tan chert, a thin trace Zn
440.0 442.5 Gray translucent chert
442.5 445.0 Dull gray chert

Bottom

One sample taken.

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From- To</th>
<th>Zinc</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>435.0</td>
<td>440.0</td>
<td>0.14</td>
<td>0.02</td>
</tr>
</tbody>
</table>

2462 - 62 -
<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 17.0</td>
<td>Soil, clay and gravel</td>
</tr>
<tr>
<td>17.0 - 155.0</td>
<td>Shale</td>
</tr>
<tr>
<td>155.0 - 157.0</td>
<td>Gray Chester limestone</td>
</tr>
<tr>
<td>157.0 - 165.0</td>
<td>Gray and some brown Chester limestone</td>
</tr>
<tr>
<td>165.0 - 190.0</td>
<td>Gray Chester limestone, some oolitic and a little selvage</td>
</tr>
<tr>
<td>190.0 - 195.0</td>
<td>Gray limestone and gray chert</td>
</tr>
<tr>
<td>195.0 - 225.0</td>
<td>Gray limestone, cotton rock, some gray chert</td>
</tr>
<tr>
<td>225.0 - 255.0</td>
<td>Gray and brown limestone, cotton rock and gray chert</td>
</tr>
<tr>
<td>255.0 - 225.0</td>
<td>Gray and light blue chert, gray and tan limestone</td>
</tr>
<tr>
<td>225.0 - 250.0</td>
<td>Gray to dark gray chert, some gray limestone</td>
</tr>
<tr>
<td>250.0 - 285.0</td>
<td>Soft pinky gray and white limestone, some gray speckled and a little light blue chert</td>
</tr>
<tr>
<td>285.0 - 255.0</td>
<td>Gray limestone, gray and light blue chert, a little cotton rock</td>
</tr>
<tr>
<td>255.0 - 275.0</td>
<td>Gray chert, brown limestone, a little selvage</td>
</tr>
<tr>
<td>275.0 - 285.0</td>
<td>Gray chert and light blue chert, brown limestone</td>
</tr>
<tr>
<td>285.0 - 300.0</td>
<td>Gray, blue and white chert, brown limestone</td>
</tr>
<tr>
<td>300.0 - 305.0</td>
<td>Loose brown shaly limestone, gray and blue chert</td>
</tr>
<tr>
<td>315.0 - 315.0</td>
<td>Gray, brown and some light blue chert, brown limestone</td>
</tr>
<tr>
<td>315.0 - 280.0</td>
<td>Dark brown to black shaly limestone, gray blue and a little black chert, selvage</td>
</tr>
<tr>
<td>280.0 - 320.0</td>
<td>Black brown to black shaly limestone, much selvage, a trace of crude oil and a thin trace of rock and iron oxide</td>
</tr>
<tr>
<td>320.0 - 325.0</td>
<td>Black, gray and tan limestone, white and light blue chert, tan sand and gray selvage, mud, thin trace of rock and iron oxide</td>
</tr>
<tr>
<td>325.0 - 325.0</td>
<td>Gray, tan, white and some black chert, pasty gray and white selvage, black and brown limestone and mud</td>
</tr>
<tr>
<td>325.0 - 330.0</td>
<td>Gray and blue chert, dirty white leached limestone and cotton rock, pasty gray and dark brown selvage and mud</td>
</tr>
<tr>
<td>330.0 - 355.0</td>
<td>Gray spotted and some blue chert</td>
</tr>
<tr>
<td>355.0 - 355.0</td>
<td>Gray glassy and some blue chert</td>
</tr>
</tbody>
</table>

No samples taken.
Hole BM-50 (continued)

Depth, Feet
From- To-
297.5 302.5 Opening, no cuttings, (driller cased much cast iron to get through the crevice)
302.5 305.0 Brown gray chert, trace Zn and Pb
305.0 310.0 Gray white and brown translucent chert, trace Zn, Pb
310.0 315.0 Gray, white and brown chert, (some black chert falling), a very thin trace Pb

Bottom

Nineteen samples taken.

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Sample Depth, Feet</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>From- To-</td>
<td>Zinc Lead Rec.</td>
<td>From- To- Zinc Lead Rec.</td>
</tr>
<tr>
<td>255.0 260.0</td>
<td>0.16 0.05 1/2</td>
<td>282.5 285.0 0.36 0.01 1/5</td>
</tr>
<tr>
<td>260.0 262.5</td>
<td>0.20 0.01 1/3</td>
<td>285.0 287.5 5.52 0.01 1/6</td>
</tr>
<tr>
<td>262.5 266.0</td>
<td>0.04 0.09 1/3</td>
<td>287.5 290.0 2.10 0.01 1/4</td>
</tr>
<tr>
<td>265.0 287.5</td>
<td>1.70 0.71 1/4</td>
<td>290.0 282.5 1.14 0.01 1/5</td>
</tr>
<tr>
<td>287.5 270.0</td>
<td>1.44 0.06 1/3</td>
<td>292.5 295.0 7.64 0.04 1/4</td>
</tr>
<tr>
<td>270.0 272.5</td>
<td>0.84 0.13 1/3</td>
<td>295.0 297.5 1.12 0.05 1/4</td>
</tr>
<tr>
<td>272.5 275.0</td>
<td>0.96 0.25 1/6</td>
<td>302.5 305.0 0.26 0.04 1/4</td>
</tr>
<tr>
<td>275.0 277.5</td>
<td>2.23 0.06 1/3</td>
<td>305.0 307.5 0.56 0.07 1/6</td>
</tr>
<tr>
<td>277.5 280.0</td>
<td>1.12 0.03 1/3</td>
<td>307.5 310.0 0.36 0.07 1/6</td>
</tr>
<tr>
<td>280.0 282.5</td>
<td>1.04 0.01 1/6</td>
<td></td>
</tr>
</tbody>
</table>

Hole BM-51
Coordinates: 11,540 N = 9,100 E

Started: 3/13/45
Completed: 3/22/45
Elevation of collar: 605 feet
H. W. Smith Tract (Kan.)
Water encountered at 270 feet
Water stands at 270 feet
Size of hole: 20 feet, 10 inch; 170 feet, 8 inch; 112 feet, 6 inch and 35 feet, 8 inch

Depth, Feet
From- To-

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 22.0</td>
<td>Soil and clay</td>
</tr>
<tr>
<td>22.0 28.0</td>
<td>Gravel, clay and water</td>
</tr>
<tr>
<td>28.0 175.0</td>
<td>Shale</td>
</tr>
<tr>
<td>175.0 180.0</td>
<td>Gray sandstone</td>
</tr>
<tr>
<td>180.0 196.0</td>
<td>Shale</td>
</tr>
<tr>
<td>196.0 215.0</td>
<td>Gray Chester limestone</td>
</tr>
<tr>
<td>215.0 215.0</td>
<td>Gray and tan limestone, some gray chert</td>
</tr>
<tr>
<td>215.0 230.0</td>
<td>Gray and tan limestone, some gray chert, a little green shale and selvage</td>
</tr>
<tr>
<td>230.0 235.0</td>
<td>Gray limestone, very little gray chert</td>
</tr>
<tr>
<td>235.0 240.0</td>
<td>Gray chert, gray limestone, selvage and specks of shale</td>
</tr>
<tr>
<td>240.0 245.0</td>
<td>Gray and light blue limestone coated chert, gray limestone</td>
</tr>
<tr>
<td>245.0 250.0</td>
<td>Loose gray chert, gray limestone, small crevices</td>
</tr>
<tr>
<td>250.0 260.0</td>
<td>Loose gray rusty chert and gray limestone</td>
</tr>
<tr>
<td>260.0 270.0</td>
<td>Gray and light blue chert</td>
</tr>
<tr>
<td>270.0 275.0</td>
<td>Gray limestone, some gray chert</td>
</tr>
<tr>
<td>275.0 280.0</td>
<td>Gray chert, tan limestone and selvage</td>
</tr>
<tr>
<td>280.0 285.0</td>
<td>Loose gray and tan chert, some limestone coated gray chert, gray limestone</td>
</tr>
<tr>
<td>285.0 290.0</td>
<td>Loose brown and gray limestone, very little blue chert, dolomite crystals</td>
</tr>
<tr>
<td>290.0 295.0</td>
<td>Loose gray and brown limestone, blue and gray chert, marcasite, gray secondary limestone, mud</td>
</tr>
<tr>
<td>295.0 305.0</td>
<td>Loose limestone coated blue and gray chert, soft gray secondary limestone, calcite crystals, leached cotton rock</td>
</tr>
<tr>
<td>305.0 310.0</td>
<td>Loose limestone coated blue and gray chert, green specks of shale</td>
</tr>
<tr>
<td>310.0 320.0</td>
<td>Loose black, gray and black chert, brown limestone, marcasite and calcite crystals</td>
</tr>
<tr>
<td>320.0 325.0</td>
<td>Opening - no cuttings</td>
</tr>
<tr>
<td>325.0 330.0</td>
<td>Loose gray, blue and black chert</td>
</tr>
<tr>
<td>330.0 335.0</td>
<td>Opening - no cuttings</td>
</tr>
<tr>
<td>335.0 337.5</td>
<td>Loose gray, blue and brown chert</td>
</tr>
<tr>
<td>337.5 340.0</td>
<td>Loose gray, blue, and brown chert (gray limestone falling)</td>
</tr>
<tr>
<td>340.0 454.0</td>
<td>Firm gray and tan spotted translucent chert</td>
</tr>
</tbody>
</table>

Bottom

No samples taken.
Hole BW-52
Coordinates: 12,954 N - 14,415 E

Started: 3/12/45  
Completed: 3/20/45
Elevation of collar: 857 feet  
Vanatta Tract (Okl.)
A little fresh water seeped in  
Water stands at 345 feet
from some undetermined horizon
in the upper limestone beds.  No deep
sulphur water flow was encountered.
Size of hole: 264 feet, 6 inch; 164 feet, 6 inch

Depth, Feet
From - To

0.0 20.0 Surface, soil and sandy clay (no sandstone outlier remains)
20.0 261.0 Shale
261.0 285.0 Gray and a little brown Chester limestone
285.0 300.0 Soft dirty white to gray limestone and some cotton rock
300.0 310.0 Gray limestone, blue and some gray chert
310.0 330.0 Blue chert, brown and gray limestone
330.0 355.0 Brown and gray limestone, blue chert and selvage
355.0 390.0 Blue-gray chert, gray and brown limestone
390.0 395.0 Brown and a little gray shaly limestone, gray chert
395.0 400.0 Gray and brown chert, brown limestone, trace Pb
400.0 402.5 Black and brown limestone, trace Pb
402.5 406.0 Black and some dark brown oolitic limestone, trace Pb
406.0 407.5 Black and some dark brown oolitic limestone, some gray chert, trace Pb and Zn
407.5 410.0 Gray and black chert, dolomite crystals, trace Zn
410.0 415.0 Gray and brown chert, some jasperoid, trace Zn
415.0 417.5 Gray and tan chert, some jasperoid, thin trace Zn and Pb
417.5 420.0 Dark and light gray chert
420.0 425.0 Gray and tan spotted translucent chert
425.0 428.0 Dull gray chert
Bottom

No samples taken.

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From - To</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>290.0</td>
<td>295.0</td>
<td>0.28</td>
</tr>
<tr>
<td>295.0</td>
<td>297.5</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Hole BW-53
Coordinates: 6,285 N - 23,535 E

Started: 3/15/45  
Completed: 3/22/45
Elevation of collar: 801 feet  
Alshaugh Tract (Okl.)
Water encountered at 220 feet  
Water stands at 225 feet
Size of hole: 16 feet, 10 inch; 141 feet, 8 inch; 179 feet, 6 inch

Depth, Feet
From - To

0.0 16.0 Soil, clay and gravel
16.0 186.0 Blue-gray shale
186.0 187.0 Gray Chester limestone, some selvage
187.0 190.0 Light gray crystalline limestone
190.0 195.0 Soft dirty white limestone
195.0 200.0 Soft dirty white limestone and shale seams
200.0 220.0 Black shale and sandy limestone; ribs, some selvage and marcasite
220.0 250.0 Gray sandy limestone, some shale
250.0 253.0 Gray limestone, some sandstone and shale
253.0 240.0 Gray limestone and selvage
240.0 245.0 Gray limestone, a very little blue chert and selvage
245.0 250.0 Blue chert, gray and brown limestone
250.0 270.0 Gray limestone, blue and gray chert
270.0 260.0 Blue and gray chert, brown limestone
260.0 290.0 Blue and gray chert, brown limestone, some selvage
290.0 295.0 Loose muddy blue, gray and brown chert, some brown limestone, trace Zn
295.0 297.5 Gray, blue and brown chert, a little green and black shaly lime-
stone and mud, trace Zn
297.5 300.0 Gray and brown mottled chert, marcasite, trace Zn
300.0 302.5 Gray, some tan and blue limestone coated chert, and cotton rock, a little green and black shaly limestone and mud
302.5 305.0 Light and dark gray and some blue chert, brown limestone, trace Zn
305.0 307.5 Brown and gray limestone, tan shaly secondary limestone mud, gray chert partially leached to cotton rock
307.5 310.0 Dark gray pasty selvage, gray oolitic limestone, gray chert, cal-
cite crystals, some glassy mottled limestone pebbles
310.0 315.0 Loose gray and light blue chert, selvage and mud
315.0 325.0 Mud and selvage, loose gray and some light blue chert
325.0 350.0 Blue, gray and tan spotted chert
350.0 356.0 Gray translucent and some tan spotted chert
Bottom

Three samples taken.
Hole BA-54
Coordinates: 6,990 N - 22,612 W

Started: 3/21/46  Completed: 3/28/46
Elevation of collar: 735 feet  T. R. Smith tract (Okl.)
Water encountered at 272 feet  water stands at 234 feet
Size of hole: 16 feet, 10 inch; 134 feet, 8 inch; 157 feet, 6 inch

Depth, Feet
From--To--

0.0 10.0 Soil, clay and gravel
10.0 148.0 Shale
148.0 165.0 Gray Chester limestone
165.0 170.0 Gray Chester limestone, some gray chert
170.0 175.0 Soft dirty white limestone with tar, a little gray chert
175.0 185.0 Gray and white chert, soft dirty white limestone
185.0 205.0 Cotton rock, some gray chert
205.0 215.0 Gray and white chert, soft dirty white limestone
215.0 230.0 Gray and light blue chert, brown limestone
230.0 235.0 Gray and tan chert
235.0 250.0 Gray, brown and some light blue chert, brown limestone
250.0 255.0 Blue and gray chert, brown limestone
255.0 265.0 Brown limestone, blue and gray chert
265.0 270.0 Blue, brown and gray chert, brown limestone, selvage, fair Zn
shines, trace Pb
270.0 272.5 Blue, brown and gray chert, brown limestone, selvage, trace Zn and
Pb, sulphur water at 272 ft.
272.5 275.0 Firm brown, gray and blue chert, trace Zn and Pb
275.0 280.0 Blue, brown and gray chert, trace Zn and Pb
280.0 282.5 Brown and blue chert, brown limestone, dolomite crystals, trace
Zn and Pb
282.5 285.0 Blue and brown chert, dolomite and calcite crystals, Zn shiners
285.0 287.5 Blue and brown chert, dolomite and calcite crystals, good Zn ore,
trace Pb
287.5 290.0 Opening - few cuttings, blue, gray, brown and some black chert,
dolomite crystals, good Zn ore, trace Pb
290.0 292.5 Loose blue and gray, brown and some black chert, dolomite crystals,
fair Zn ore, trace Pb
292.5 295.0 Gray, blue and brown chert, Zn shiners
295.0 297.5 Dark and light gray and some brown chert, dolomite crystals, trace
Zn
297.5 300.0 Gray and brown chert, dolomite crystals, Zn shiners
300.0 302.5 Brown and gray chert, dolomite crystals
302.5 307.0 Gray, tan, spotted chert, some translucent chert, a little jasper-
oid
Bottom

13.0 feet of sand, clay and gravel taken.

Analysis, percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Sample Depth, Feet</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>From--To--</td>
<td>Zinc</td>
<td>Lead</td>
</tr>
<tr>
<td>265.0 270.0</td>
<td>0.52</td>
<td>0.04</td>
</tr>
<tr>
<td>270.0 272.5</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>272.5 275.0</td>
<td>0.06</td>
<td>0.01</td>
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<tr>
<td>275.0 280.0</td>
<td>0.06</td>
<td>0.04</td>
</tr>
<tr>
<td>280.0 282.5</td>
<td>0.14</td>
<td>0.04</td>
</tr>
<tr>
<td>282.5 285.0</td>
<td>0.52</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Note: Upon completion, the hole was blasted with a string of powder held at 285-292 foot horizon. The resulting sample was pulverized with the 6-1/4" drill bit and the hole again cleaned out amounting to over 1/2 barrel of cuttings. These were quartered and assayed 5.06 percent Zn, 0.88 percent Pb.

24262
Hole BM-55
Coordinates: 5,761 N - 22,974 E

Started: 3/22/45
Completed: 4/7/45
Elevation of collar: 796 feet
Water encountered at 292 feet
Water stands at 235 feet
Size of hole: 16 feet, 10 inch; 134 feet, 8 inch; 150 feet, 6 inch; 20 feet, 8 inch

Depth, Feet

<table>
<thead>
<tr>
<th>Feet</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>16.0 Still, clay and gravel</td>
</tr>
<tr>
<td>16.0</td>
<td>145.0 Shale</td>
</tr>
<tr>
<td>145.0</td>
<td>160.0 Gray limestone, some gray, white and tan flint</td>
</tr>
<tr>
<td>160.0</td>
<td>180.0 Gray Chester limestone, some gray selvage, a little gray chert and green shale</td>
</tr>
<tr>
<td>180.0</td>
<td>210.0 Gray, limestone, some gray and blue chert</td>
</tr>
<tr>
<td>210.0</td>
<td>225.0 Blue and gray chert, gray and brown limestone and selvage</td>
</tr>
<tr>
<td>225.0</td>
<td>230.0 Gray and blue chert, gray limestone</td>
</tr>
<tr>
<td>230.0</td>
<td>265.0 Blue and gray chert, gray and brown limestone</td>
</tr>
<tr>
<td>265.0</td>
<td>280.0 Gray limestone and gray chert</td>
</tr>
<tr>
<td>280.0</td>
<td>285.0 Gray shaly and greenish glaucomorphic limestone, some gray chert and selvage, trace Zn and Pb</td>
</tr>
<tr>
<td>285.0</td>
<td>290.0 Loose black chert and black glaucomorphic limestone, some selvage</td>
</tr>
<tr>
<td>290.0</td>
<td>295.0 Loose black chert and some black limestone, gray selvage, trace Zn</td>
</tr>
<tr>
<td>295.0</td>
<td>300.0 Loose black chert, black limestone, a little gray chert, good Zn ore</td>
</tr>
<tr>
<td>300.0</td>
<td>305.0 Brecciated light gray chert showing some silicified dolomite with jasperoid, black chert and disseminated sphalerite in crevices, fair Zn ore</td>
</tr>
<tr>
<td>305.0</td>
<td>307.5 Brecciated light gray chert showing some silicified dolomite with jasperoid, light gray-blue chert, black chert and disseminated sphalerite in crevices, fair Zn ore</td>
</tr>
<tr>
<td>307.5</td>
<td>310.0 Firm light blue and some gray chert, a few pieces of oolitic limestone falling, good Zn shives</td>
</tr>
<tr>
<td>310.0</td>
<td>312.5 Firm light blue and some gray chert, a few pieces of oolitic limestone falling, trace Zn, (falling?)</td>
</tr>
<tr>
<td>312.5</td>
<td>315.0 Gray-blue and tan chert, a little jasperoid, thin trace Zn</td>
</tr>
<tr>
<td>315.0</td>
<td>317.0 Black, gray and some brown chert, trace Zn</td>
</tr>
<tr>
<td>317.0</td>
<td>320.0 Dull gray and some translucent tan and white spotted chert</td>
</tr>
</tbody>
</table>

Bottom

Eight samples taken.

Hole BM-55 (continued)

Analysis, Percent

<table>
<thead>
<tr>
<th>Feet</th>
<th>Sample to</th>
<th>Zinc</th>
<th>Rec.</th>
<th>Depth, Feet</th>
<th>Sample to</th>
<th>Zinc</th>
<th>Rec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>295.0</td>
<td>0.28</td>
<td>1/40</td>
<td></td>
<td>302.5</td>
<td>305.0</td>
<td>2.62</td>
<td>1/60</td>
</tr>
<tr>
<td>297.5</td>
<td>4.50</td>
<td>1/10</td>
<td></td>
<td>305.0</td>
<td>307.5</td>
<td>2.74</td>
<td>1/15</td>
</tr>
<tr>
<td>300.0</td>
<td>7.40</td>
<td>1/7</td>
<td></td>
<td>307.5</td>
<td>310.0</td>
<td>1.28</td>
<td>1/50</td>
</tr>
<tr>
<td>302.5</td>
<td>2.92</td>
<td>1/50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Upon reaching the change of formation to light and gray chert and jasperoid at 307.5 feet in depth, it was impossible to drill deeper due to crevices and openings deflecting the bit, so the 6 inch casing was pulled and the hole reamed to that depth with a 6-1/4 inch bit. The larger sample cleaned out of the hole after the reaming job, assayed 7.12 percent Zn. Then the casing was reset to 307.5 feet and drilling was continued with the 4-7/8 inch bit.
Hole BM-56
Coordinates: 12°9'15"N - 14°6'07"W

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>15.0 Soil, clay, sand and some sandstone</td>
</tr>
<tr>
<td>15.0</td>
<td>252.0 Shale</td>
</tr>
<tr>
<td>252.0</td>
<td>275.0 Gray Chester limestone</td>
</tr>
<tr>
<td>275.0</td>
<td>285.0 Gray Chest limestone, some gray chert and silt</td>
</tr>
<tr>
<td>285.0</td>
<td>290.0 Gray Chester limestone, some gray chert</td>
</tr>
<tr>
<td>290.0</td>
<td>295.0 Gray chert, some gray Chester limestone but changing to tan limestone</td>
</tr>
<tr>
<td>295.0</td>
<td>315.0 Gray chert, tan to brown limestone</td>
</tr>
<tr>
<td>315.0</td>
<td>330.0 Gray limestone, gray chert</td>
</tr>
<tr>
<td>330.0</td>
<td>350.0 Gray and light blue chert, brown and gray limestone, little shale seams</td>
</tr>
<tr>
<td>350.0</td>
<td>355.0 Blue and gray chert, brown limestone</td>
</tr>
<tr>
<td>355.0</td>
<td>360.0 Blue and gray chert and brown limestone changing to cotton rock</td>
</tr>
<tr>
<td>360.0</td>
<td>350.0 Cotton rock, brown limestone, a very little gray chert</td>
</tr>
<tr>
<td>350.0</td>
<td>355.0 Blue chert, brown limestone</td>
</tr>
<tr>
<td>355.0</td>
<td>370.0 Gray-blue chert, gray and brown limestone</td>
</tr>
<tr>
<td>370.0</td>
<td>380.0 Brown limestone, blue-gray chert</td>
</tr>
<tr>
<td>380.0</td>
<td>390.0 Brown limestone changing to a little gray shaly limestone, gray chert, trace Zn</td>
</tr>
<tr>
<td>390.0</td>
<td>392.5 Gray shaly glauconitic limestone, selvage, trace Pb and Zn</td>
</tr>
<tr>
<td>392.5</td>
<td>395.0 Gray shaly glauconitic limestone, selvage, dolomite crystals, trace Pb and Zn</td>
</tr>
<tr>
<td>395.0</td>
<td>397.5 Dark brown limestone, shale seams, trace Zn and Pb</td>
</tr>
<tr>
<td>397.5</td>
<td>400.0 Dark brown limestone, calcite crystals, trace Pb ore, and trace Zn</td>
</tr>
<tr>
<td>400.0</td>
<td>402.5 Dark brown and green speckled oolithic limestone, dolomite and calcite crystals, Zn and Pb</td>
</tr>
<tr>
<td>402.5</td>
<td>405.0 Dark brown and green speckled oolithic limestone, dolomite and calcite crystals, much selvage, Zn and Pb</td>
</tr>
<tr>
<td>405.0</td>
<td>407.5 Dark brown and some black limestone, some jasperoid, dolomite crystals, selvage, Zn and Pb</td>
</tr>
<tr>
<td>407.5</td>
<td>410.0 Dark brown and some black limestone, some jasperoid, dolomite crystals, selvage, Zn and Pb</td>
</tr>
<tr>
<td>410.0</td>
<td>412.5 Dark brown and black oolithic limestone, trace Pb ore and trace Zn</td>
</tr>
<tr>
<td>412.5</td>
<td>415.0 Dark brown and black oolithic limestone, good Pb shines and trace Zn</td>
</tr>
<tr>
<td>415.0</td>
<td>417.5 Gray and some black chert, brown limestone, selvage, good Zn shines and trace Pb</td>
</tr>
<tr>
<td>417.5</td>
<td>420.0 Opening at about 418-420, few cuttings, gray and brown chert, calcite crystals, strong sulphur water flow, trace Zn and Pb</td>
</tr>
<tr>
<td>420.0</td>
<td>422.5 Brown and gray chert, calcite crystals, trace Zn and Pb</td>
</tr>
<tr>
<td>422.5</td>
<td>425.0 Brown, gray and some black chert, trace Zn</td>
</tr>
<tr>
<td>425.0</td>
<td>428.0 Dull gray and some tan and translucent spotted chert</td>
</tr>
</tbody>
</table>

Twelve samples taken.
R.I. 4337

Hole BM-57
Coordinates: 11,595 N - 9,137 E

Started: 3/25/45  Completed: 4/6/45
Elevation of collar: 804 feet  H. V. Smith Tract (Kan.)
Water encountered at 322 feet  Water stands at 270 feet
Size of hole: 28 feet, 10 inch; 168 feet, 8 inch; 219 feet, 6 inch

Depth, Feet
From—To—

0.0 18.0 Soil and clay
18.0 24.0 Gravel, sand, clay and water
24.0 170.0 Shale
170.0 175.0 Oily sandstone
176.0 192.0 Shale
192.0 195.0 Gray limestone, some blue chert
195.0 210.0 Gray limestone, gray chert, some tar
210.0 225.0 Gray Chester limestone
225.0 250.0 Light gray to white chert and limestone
250.0 265.0 Light gray to blue chert
265.0 280.0 Gray chert and gray limestone
280.0 290.0 Gray to dirty white limestone, chert and some cotton rock
270.0 305.0 Brown limestone, gray-blue chert
305.0 310.0 Brown, gray and some blue chert, brown limestone
310.0 330.0 Shaly gray to greenish and black glauconitic limestone, some black chert
320.0 325.0 Blue and gray chert, some silicified dolomite gray limestone, trace Pb, sulphur water
325.0 340.0 Brownish gray limestone, a little oolitic blue and gray chert, traces Pb and Zn
340.0 347.5 Gray, brown and blue chert, a little limestone and jasperoid, trace Zn and Pb
347.5 350.0 Speckled translucent gray and brown chert, some brown and white chert, a little gray limestone, jasperoid, marcasite and trace Zn
350.0 355.0 Hard gray, brown and white chert, some marcasite, trace Zn
355.0 357.5 Gray, brown and white chert, marcasite, trace Zn and Pb
357.5 370.0 Gray, brown and white chert, marcasite
370.0 380.0 Light to darker gray spotted chert, trace Pb and Zn
380.0 385.0 Gray and brown chert
385.0 395.0 Gray, brown and some blue chert
395.0 405.0 Soft dull gray and a little blue mottled chert, cotton rock reccemented with some light gray secondary limestone
405.0 410.0 Gray and brown chert
410.0 415.0 Darker gray-blue chert, some dark gray, gray and white shaly limestone

Bottom
No samples taken.

2462

Hole BM-58
Coordinates: 6,942 N - 22,538 E

Started: 5/29/45  Completed: 4/6/45
Elevation of collar: 800 feet  V. R. Smith Tract (Okl.,)
Water encountered at 245 feet  Water stands at 265 feet
Size of hole: 15 feet, 10 inch; 145 feet, 8 inch; 157 feet, 6 inch

Depth, Feet
From—To—

0.0 14.0 Soil, clay and sand
14.0 155.0 Silt
155.0 170.0 Gray Chester limestone
170.0 180.0 Gray Chester limestone, some gray chert
180.0 185.0 Brown and some gray Chester limestone, gray chert
185.0 195.0 Gray chert, gray limestone
195.0 205.0 Soft cotton rock and light gray limestone
205.0 210.0 Soft gray and light blue chert, light gray limestone, some cotton rock
210.0 230.0 Gray and blue chert, a little gray to tan limestone
230.0 235.0 Blue and gray chert, some brown limestone and cotton rock
255.0 240.0 Light gray limestone, cotton rock, gray chert
240.0 250.0 Blue and gray chert, some tan limestone and cotton rock
245.0 275.0 Blue and gray chert, some gray to brown limestone
275.0 280.0 Gray, brown and some white chert, a little brown limestone
280.0 325.0 Salvage, gray, blue and brown chert, a little limestone
325.0 350.0 Salvage, gray, blue and brown chert, some limestone, dolomite, calcite and marcasite crystals
300.0 305.0 Gray, tan and white chert, salvage, very little limestone
305.0 310.0 Dull gray and tan chert, some jasperoid
310.0 315.0 Dull gray and tan spotted chert

Bottom
No samples taken.
R.I. 4337

Hole BW-59
Coordinates: 11,746 N - 8,859 E

Started: 4/6/45
Completed: 4/20/45
Elevation of collar: 801 feet
Water encountered at 270 feet
Size of hole: 19 feet, 10 inch; 127 feet, 8 inch; 156 feet, 6 inch; 19 feet, 5 inch

Depth, Feet
From To

0.0 12.0 Soil and clay
12.0 18.0 Gravel, clay and water
12.0 185.0 Shale
155.0 170.0 Dark brown sandstone
170.0 187.0 Shale
187.0 190.0 Gray Chester limestone, much marcasite
190.0 205.0 Gray Chester limestone, some white limestone, tar
205.0 215.0 Gray Chester limestone, selvage, some gray chert
215.0 220.0 Gray chert, gray limestone
220.0 230.0 Gray limestone, some gray to light blue chert
230.0 240.0 Light blue-gray chert, gray limestone, some marcasite
240.0 255.0 Gray-brown limestone, blue chert
255.0 265.0 Brown and gray limestone, blue and gray chert
265.0 270.0 Tan limestone, gray chert, sulphur water at 270 ft.
270.0 285.0 Brown limestone, blue and gray chert, some marcasite
285.0 305.0 Loose gray and brown limestone, blue chert, some marcasite and soft pulverized limestone mud
305.0 310.0 Partially firm greenish brown-gray glaucolithic limestone, black and some gray chert
310.0 315.0 Loose dark gray chert, brown, some greenish glaucolithic limestone, selvage
315.0 320.0 Loose gray, brown and some black chert, gray limestone (some colitic), much selvage and calcite
320.0 327.0 Loose coarse gray chert, brown limestone, much selvage
327.0 350.0 Loose coarse gray crystalline limestone, calcite crystals, cotton rock and some gray chert
350.0 353.0 Loose dark and light gray chert, some leached gray to white chert and cotton rock, calcite crystals
353.0 355.0 Loose gray translucent and some dull tan and white chert, marcasite
355.0 360.0 Tan, some dull white and gray chert
340.0 346.0 Dull to translucent white and tan spotted chert, a trace of jasperoid

Bottom
No samples taken.

2462 - 70 -

Hole BW-60
Coordinates: 12,965 N - 14,515 E

Started: 3/29/45
Completed: 4/9/45
Elevation of collar: 858 feet
Vanatta Tract (Kan.)
Water encountered at 367 feet
Size of hole: 263 feet, 8 inch; 154 feet, 6 inch; 15 feet, 5 inch

Depth, Feet
From To

0.0 20.0 Soil, clay and sand
20.0 258.0 Shale
258.0 265.0 Gray Chester limestone
265.0 270.0 Gray Chester limestone, green shale seams
270.0 285.0 Gray Chester limestone, a little gray chert and tar
285.0 300.0 Gray and some light blue chert, gray limestone
300.0 325.0 Gray limestone, gray and light blue chert
325.0 330.0 Gray limestone, gray and blue chert
330.0 340.0 Cotton rock, gray and blue chert, gray limestone
340.0 345.0 Gray and blue chert, tan and gray limestone, a little cotton rock
345.0 350.0 Gray, gray-blue and some brown chert, brown to gray limestone
350.0 355.0 Shaly gray limestone, some gray chert
355.0 350.0 Salage, brown and gray limestone, a very little gray and black chert, some marcasite, and a strong sulphur water flow in crevices
350.0 400.0 Dark brown and black limestone and chert, calcite and marcasite, crystals, selvage
400.0 404.0 Opening, few cuttings, dark brown and black chert, and limestone, much marcasite
404.0 407.0 Hard black and brown limestone and chert, a little selvage and marcasite
407.0 410.0 Opening, few cuttings, green brown and white silicified colite, black colitic and a little greenish glaucolithic limestone, marcasite and trace Zn
410.0 412.6 Opening, lost all cuttings
412.5 415.0 Loose black colitic limestone partially silicified, a little white chert, marcasite, trace Zn
415.0 417.5 Loose gray chert, some black limestone falling, trace Zn
417.5 420.0 Firm dark and light gray chert, marcasite, trace Zn
420.0 425.0 Gray and tan translucent chert, marcasite, trace Zn
425.0 430.0 Gray and tan spotted translucent chert, marcasite

Bottom
No samples taken.
R.I. 4337

Hole BM-61
Coordinates: 5,922 N - 22,770 E

Started: 4/9/45  Completed: 4/24/45
Elevation of collar: 798 feet  Alsbaugh Tract (Okla.)
Water encountered at 398 feet  Water stands at 611 feet
Size of hole: 18 feet, 10 inch; 140 feet, 8 inch; 171 feet, 6 inch

Depth, Feet
From - To -

0.0 18.0 Soil, clay and gravel
18.0 152.0 Shale
152.0 157.0 Shale, sand and pyrite
157.0 160.0 Gray Chester limestone
160.0 165.0 Light gray to tan limestone, some cotton rock
165.0 195.0 Soft light gray to tan pasty limestone
195.0 200.0 Soft light gray to tan pasty limestone, some blue and gray chert
200.0 205.0 Darker gray and brown limestone, selvage, a little gray chert
205.0 210.0 Light gray to tan limestone, selvage, a little gray chert
210.0 215.0 Light gray lime stone, same bluish limestone
215.0 220.0 Light gray shelly limestone
220.0 225.0 Light and dark gray chert, some gray limestone
225.0 240.0 Gray, tan and blue chert, tan limestone
240.0 250.0 Brown limestone and gray chert
250.0 255.0 Gray and brown chert, brown limestone
255.0 270.0 Brown limestone and gray chert
270.0 290.0 Blue and gray chert, brown limestone
290.0 295.0 Brown, black and gray shaly limestone
295.0 300.0 Black and brown limestone, some dark gray chert
300.0 305.0 Black and a very little brown limestone, calcite crystals, some selvage
305.0 307.5 Shaly black and some brown limestone, light gray chert, dolomite and calcite crystals, thin trace Zn and Pb
307.5 310.0 Gray, brown and some light blue chert, some water
310.0 315.0 Gray, brown, white and a little black chert, shale seams
315.0 320.0 Dull gray and brown chert, some gray limestone
320.0 325.0 Dull gray, tan and some white brecciated chert recremented with a little jasperoid
325.0 329.0 Dull white and gray spotted chert, a trace of jasperoid

No samples taken.

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Hole BM-62
Coordinates: 15,062 N - 15,016 E

Started: 4/10/45  Completed: 4/24/45
Elevation of collar: 860 feet  Vanatta Tract (Kan.)
Water encountered at 428 feet  Water stands at 305 feet
Size of hole: 264 feet, 8 inch; 178 feet, 6 inch

Depth, Feet
From - To -

0.0 20.0 Soil, sand, gravel and clay
20.0 250.0 Shale
250.0 255.0 Gray Chester limestone, marcasite, shale seams
265.0 275.0 Gray Chester limestone
275.0 280.0 Gray Chester limestone, some gray chert
280.0 290.0 Light gray limestone, a little gray chert, selvage
285.0 290.0 Light gray limestone, very little gray chert
290.0 300.0 Light and some dark gray limestone, gray chert
300.0 310.0 Gray limestone, light blue chert, cotton rock
310.0 335.0 Gray limestone, light blue chert
335.0 350.0 Gray chert and gray limestone
350.0 355.0 Gray limestone, gray chert and cotton rock
355.0 370.0 Gray limestone, blue and gray chert
370.0 385.0 Gray chert, brown and gray limestone
385.0 390.0 Gray and brown chert, brown limestone, selvage, shale seams
390.0 405.0 Brown limestone, gray and tan chert
405.0 415.0 Black and gray speckled limestone
415.0 420.0 Black and gray oolitic limestone
420.0 425.0 Brown to black limestone, some gray and white chert
425.0 440.0 Brown and gray chert, a little black limestone, some water, trace Zn and Pb
430.0 432.0 Gray, tan and some white chert, thin trace Pb and Zn
432.5 437.5 Light blue-gray translucent chert, some tan chert
437.5 442.0 Dull gray and tan spotted chert
Bottom

One sample taken.

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Analysis, Percent

Depth, Feet
From - To - Zn  Pb  Lead

425.0 450.0 0.40 0.05
Hole BM-63
Coordinates: 5,670 W - 22,975 E
Started: 4/27/45
Completed: 5/10/45
Elevation of collar: 787 feet
Alseaugh Tract (Okla.)
Water encountered at 238 feet
Water stands at 218 feet
Size of hole: 18 feet, 10 inch; 131 feet, 6 inch; 172 feet, 6 inch

Depth, Feet
From — To —

0.0 18.0 Surface, clay and gravel
18.0 149.0 Shale
149.0 170.0 Gray Chester limestone
170.0 175.0 Light gray to tan limestone
175.0 185.0 Gray limestone, gray and light blue chert
185.0 200.0 Grayish tan limestone
200.0 205.0 Grayish tan limestone, a little gray and light blue chert
205.0 210.0 Gray and light blue chert, gray and some tan limestone
210.0 220.0 Gray blue chert, tan limestone
220.0 230.0 Light tan limestone, tan, gray and light blue chert
230.0 240.0 Gray and light blue chert, tan limestone
240.0 255.0 Gray and light blue chert, brown limestone
255.0 265.0 Brown limestone, gray and light blue chert
265.0 280.0 Brown limestone, gray, light blue chert
280.0 285.0 Brown limestone, gray chert, selavage
285.0 275.0 Brown limestone, gray chert
275.0 290.0 Brown and some gray shaly limestone, gray chert
290.0 300.0 Brown limestone, dark gray and some brown chert
290.0 295.0 Dark brown shaly limestone, a little black limestone, trace Pb
295.0 300.0 Black and dark brown limestone, trace Zn and Pb
300.0 305.0 Black and dark brown limestone, dolomite crystals, trace Zn, Zn, trace Pb, sulphur water
305.0 302.5 Loose black and dark brown limestone, dolomite crystals, fair ore Zn
297.5 300.0 Loose black and dark brown limestone, dolomite crystals, fair ore Zn, trace Pb, sulphur water
300.0 302.5 Loose gray and black chert, fair ore Zn
302.5 305.0 Blue and a little black chert
305.0 307.5 Gray and blue chert
307.5 310.0 Gray and a little blue chert
310.0 315.0 Gray and a little blue chert, and some tan spotted chert
315.0 321.0 Gray and tan spotted chert, some dull white chert

Bottom

Five samples taken.

Analysis, Percent
Depth, Feet
From — To — Depth, Feet
Sample
From — To — Depth, Feet
Sample

0.0 10.0 Soil and clay
10.0 250.0 Shale
250.0 260.0 Gray limestone and shale seams
260.0 275.0 Gray Chester limestone
275.0 280.0 Gray Chester limestone, very little gray and white chert
280.0 290.0 Gray spotted limestone, some gray, white and light blue chert
290.0 305.0 Gray limestone, light blue chert
305.0 325.0 Brown limestone, gray and light blue chert, selavage
325.0 335.0 Blue and gray chert, gray limestone
335.0 340.0 Gray and brown limestone, gray and light blue chert
340.0 350.0 Cotton rock, gray chert and tan limestone
350.0 360.0 Gray and light blue chert, brown limestone, selavage
360.0 375.0 Brown limestone, gray and blue chert
375.0 380.0 Gray and light blue chert, brown limestone, trace Zn
380.0 381.5 Gray and light blue chert, brown limestone, trace Zn
381.5 385.0 Brown limestone, gray chert, trace Zn and Pb
385.0 390.0 Brown limestone, gray and blue chert, trace Zn and Pb
390.0 395.0 Brown limestone, blue, gray and brown chert, calcite crystals, Pb shales, trace Zn
395.0 397.5 Gray and brown limestone, blue-gray chert, calcite crystals, good Pb shales
397.5 400.0 Gray and brown limestone, calcite and marcasite crystals, fair Pb ore
400.0 402.5 Green glauconitic limestone, black and gray chert, selavage, dolomite crystals, Pb shales
402.5 406.0 Brown limestone, some gray and brown chert, selavage, Pb shales
406.0 407.5 Brown limestone, gray, brown and white chert, calcite crystals, trace of Pb and Zn
407.5 410.0 Dark brown limestone, some white chert, calcite crystals, slight trace Zn and Pb
410.0 415.0 Shaly green glauconitic limestone, calcite and marcasite crystals, much selavage, slight traces Zn and Pb
415.0 420.0 Gray, brown and some black chert, marcasite crystals, Pb and Zn shales

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R.I. 4337

Hole BM-64 (continued)

Depth, Feet
From - To -

420.0 422.5 Gray, brown and black chert, much marcasite, trace Pb
422.5 425.0 Gray, tan and some white chert, much marcasite, trace Zn and Pb
425.0 430.0 Hard gray trumesculent and some gray and brown spotted chert, some marcasite
430.0 435.0 Hard gray, brown and white, partially spotted chert
435.0 441.0 Gray and tan spotted chert, some marcasite

Eighteen samples taken.

Analysis, Percent

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<td>380.0 382.5</td>
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<td>382.5 385.0</td>
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<td>402.5 405.0</td>
<td>0.08 0.82</td>
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<td>390.0 392.5</td>
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Bottom

Six samples taken.

Analysis, Percent

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<td>307.5 310.0</td>
<td>2.20 0.02</td>
<td>315.0 317.5</td>
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Bottom

Hole BM-65

Coordinates: 6,049 N - 23,301 E

Started: 5/11/45
Elevation of collar: 798 feet
Completed: 5/22/45
Albaugh Tract (Okl.)
Water encountered at 502 feet
Water stands at 227 feet
Size of hole: 18 feet, 10 inch; 156 feet, 8 inch; 166 feet, 6-1/4 inch

Depth, Feet
From - To -

0.0 19.0 Surface clay and gravel
19.0 152.0 Blue-gray shale
152.0 175.0 Gray Chester limestone and green shale
175.0 180.0 Gray Chester limestone, green shale and selvage
180.0 185.0 Gray limestone, gray chert, some cotton rock
185.0 190.0 Gray limestone, cotton rock and some gray chert
190.0 195.0 Gray limestone, cotton rock, some gray chert and selvage
195.0 200.0 Gray chert and some tan limestone
200.0 205.0 Gray limestone, a very little gray chert
205.0 210.0 Gray limestone
210.0 215.0 Gray limestone and gray chert
220.0 225.0 Gray and tan chert, very little tan limestone, selvage
225.0 230.0 Gray and some light blue chert, tan limestone
230.0 240.0 Gray chert and tan limestone
240.0 245.0 Gray chert, tan limestone and selvage
245.0 250.0 Gray chert and brown limestone
250.0 255.0 Gray and blue chert, brown limestone
255.0 260.0 Light blue and gray chert, brown limestone
260.0 265.0 Brown limestone, gray and some light blue chert
265.0 270.0 Brown limestone, gray chert, small shale seams
270.0 300.0 Gray and brown chert, selvage and mud, trace Pb
300.0 302.5 Dark brown and gray chert, selvage, shale seams, trace Zn
302.5 307.5 Gray and some brown chert, selvage, shale seams, Zn shines, trace Pb
307.5 310.0 Gray and some brown chert, shale, good zinc shines, trace Pb
310.0 312.5 Gray and some brown chert, shale, zinc shines, trace Pb
312.5 315.0 Gray and tan spotted chert, some shale Zn shines
315.0 317.5 Dull gray tan spotted chert, Zn shines
317.5 320.0 Gray and tan chert

Bottom

Six samples taken.
Hole BM-66
Coordinates: 12,985 N - 14,970 W

Started: 5/16/45  Completed: 5/25/45
Elevation of collar: 861 feet  Vanatta Tract (Kan.)
Water encountered at 450 feet  Water stands at 300 feet
Size of hole: 6-4 feet, 10 inch; 4-264 feet, 8 inch; 264-439 feet, 6 inch

Depth, Feet
From-- To--

0.0  18.0  Surface, sandstone and clay
18.0  260.0  Shale
260.0  270.0  Gray Chester limestone
270.0  280.0  Gray limestone, gray chert, a green shale seam
280.0  295.0  Gray speckled limestone, gray and white chert
295.0  300.0  Gray speckled limestone, gray and some light blue chert
300.0  305.0  Gray limestone and gray chert
305.0  310.0  Gray chert and gray limestone
310.0  320.0  Cotton rock, gray limestone and gray chert
320.0  325.0  Gray limestone and gray chert
325.0  330.0  Tan limestone and light blue chert and gray chert
330.0  340.0  Tan limestone, gray and light blue chert
340.0  350.0  Tan limestone, cotton rock, light blue and gray chert
350.0  370.0  Brown and gray limestone, light blue and gray chert
370.0  390.0  Gray chert and tan limestone
390.0  395.0  Brown and gray limestone, gray and some tan and white chert
395.0  395.0  Tan limestone, gray and white chert
395.0  400.0  Brown and gray shaly limestone and gray chert
400.0  405.0  Tan and some gray limestone, black and a little gray and brown chert
405.0  410.0  Black and some gray limestone, some gray and brown chert
410.0  415.0  Black and some gray limestone, some gray and brown chert, selvage
415.0  420.0  Gray and some tan limestone, some gray chert, marcasite
420.0  425.0  Dark gray and tan limestone, some gray chert, marcasite
425.0  435.0  Gray, tan and some white chert, marcasite and a few specks of Zn
435.0  439.0  Dark gray and tan chert, marcasite
439.0  445.0  Gray, tan and blue spotted chert, marcasite

Bottom

No samples taken.

Hole BM-67
Coordinates: 6,088 N - 23,254 E

Elevation of collar: 799 feet  Alisha Tract (Okl.
Water encountered at 305 feet  Water stands at 437 feet
Size of hole: 10 feet, 10 inch; 140 feet, 8 inch; 166 feet, 6-1/4 inch

Depth, Feet
From-- To--

0.0  18.0  Soil, clay and gravel
18.0  152.0  Blue and gray shale
152.0  156.0  Gray Chester limestone, very much pyrite
156.0  160.0  Gray Chester limestone, much pyrite
160.0  175.0  Gray Chester limestone
175.0  180.0  Gray and some tan limestone, some gray chert, a green shale seam, some tar
180.0  185.0  Gray and some tan limestone, cotton rock
185.0  205.0  Gray shaly limestone, gray and some light blue chert, cotton rock
205.0  220.0  Gray limestone and some selvage
225.0  225.0  Gray chert, some gray limestone
225.0  230.0  Gray chert, tan limestone and selvage
230.0  240.0  Gray and brown limestone, blue and gray chert, selvage
240.0  250.0  Gray chert, gray and brown limestone
250.0  270.0  Brown limestone, gray and light blue chert
270.0  275.0  Light blue and gray chert, brown limestone
275.0  285.0  Gray and tan chert, brown limestone, marcasite
285.0  290.0  Gray, white and brown chert, brown limestone
290.0  295.0  Black and some gray limestone, a little gray and blue chert
295.0  300.0  Black and some brown limestone, selvage, trace Pb
300.0  305.0  Brown limestone, some gray chert, Pb shives, trace Zn
305.0  307.5  Brown limestone, some brown chert, Zn shives, trace
307.5  310.0  Gray and brown chert, calcite crystals, fair Zn ore, trace Pb
310.0  312.5  Gray and brown chert, a shale seam, Zn shives
312.5  315.0  Gray and brown chert, trace Zn
315.0  317.5  Hard gray, brown and some white chert
317.5  320.0  Hard gray and brown chert, some spotted

Bottom

Five samples.

Analysis, Percent

<table>
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<th>Sample Depth, Feet From-- To--</th>
<th>Zinc Lead Percent</th>
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<td>312.5</td>
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R.I. 4337

Hole BD-68
Coordinates: 12,765 N - 15,018 E

Elevation of collar: 858 feet Varanita Tract (San.)
Water encountered at 400 feet Water stands at 305 feet
Size of hole: 259 feet, 8 inch; 177 feet, 6-1/4 inch

Depth, Feet
From-- To--

0.0 15.0 Soil, clay and gravel 15.0 257.0 Shale
257.0 290.0 Gray Chester limestone
290.0 325.0 Gray and some light blue chert, gray limestone
325.0 355.0 Gray and some light blue chert, gray limestone, salve
355.0 380.0 Gray, brown and some white chert, brown and gray limestone
380.0 405.0 Gray and tan limestone, some white and gray chert
405.0 425.0 Gray and brown limestone and gray chert
425.0 470.0 Brown limestone, blue and gray chert
470.0 505.0 Blue and gray chert, brown and gray limestone
505.0 520.0 Gray and tan limestone, gray and blue chert, some salve and
marcasite crystals
520.0 545.0 Brown, gray and blue chert, brown limestone, marcasite, trace Pb
545.0 560.0 Brown, gray and blue chert, brown limestone, marcasite, trace Zn
and Pb
560.0 575.0 About 8 inch crevice, lost all cuttings
575.0 600.0 Loose black and some gray chert, marcasite crystals, trace Zn and
Pb
600.0 615.0 Loose black and some gray chert, marcasite crystals
615.0 630.0 Loose black and some gray chert, marcasite crystals, trace Zn and
Pb
630.0 645.0 Loose black chert, trace Zn and Pb
645.0 675.0 Crevice, lost all cuttings
675.0 700.0 Loose black chert and black limestone
700.0 725.0 Loose black chert and black limestone, some gray and white chert,
calcite and marcasite crystals, slight trace Zn
725.0 750.0 Loose black (some leached), some gray and some white mottled chert,
some black limestone, calcite and marcasite crystals, fair Zn shines
750.0 775.0 Loose gray translucent, tan, black and white chert, trace Zn and Pb
775.0 800.0 Bull gray, tan, some white spotted chert and some black chert
(falling)

Bottom

Eight samples taken.

2462
Hole HM-60
Coordinates: 12,180 N - 6,875 E

Started: 8/10/45  Completed: 8/27/45
Elevation of collar: 798 feet  Meade Tract (Kan.)
Water encountered at 250 feet  Water stands at 212 feet
Size of hole: 54 feet, 10 inch; 250 feet, 8 inch; 196 feet, 6-1/4 inch

Depth, Feet
From - To -

0.0  5.0 Soil and clay
5.0  50.0 Creek gravel
30.0  60.0 Sandy clay
60.0  230.0 Gray and black shale
230.0  260.0 Gray Chester limestone, some pyrite
260.0  270.0 Gray speckled limestone, gray chert
270.0  285.0 Light blue and gray chert, gray limestone
285.0  290.0 Blue and gray mottled chert, gray limestone, calcite crystals
290.0  297.0 Loose gray and light blue rusty water course chert, some gray limestone and calcite crystals. (Note: Struck crevice at 290 to 297 ft., apparently dipping flat to southeast. Blasted to straighten the hole at 297 ft. Cutting showed evidence of opening or water course continuing to 325 ft. in depth.)
297.0  300.0 Gray, gray-blue spotted and white water course chert, some gray limestone
300.0  305.0 Gray and white water course chert, some gray limestone
305.0  315.0 Gray, white, blue and tan chert
315.0  330.0 Brown, white and gray chert, some brown limestone
330.0  340.0 Brown limestone, white and gray chert
340.0  345.0 Shaly green glosanitic and some black limestone, a very little gray and white chert, marcasite
345.0  350.0 Shaly black and some green glosanitic limestone, some gray chert, calcite crystals
350.0  355.0 Brown limestone, partially oolithic, some gray chert
355.0  360.0 Gray limestone and gray chert
360.0  375.0 Leached gray chert, gray limestone
375.0  380.0 Gray translucent chert, gray and some brown limestone
380.0  385.0 Brown limestone, some leached gray white chert
385.0  390.0 Loose coarse light and dark gray and brown chert, calcite crystals, some black chert with disseminated sphalerite, Zn shines; open crevice at 385 ft.
390.0  392.5 Gray spotted, tan and some white chert, some calcite crystals; Zn shines
392.5  395.0 Hard gray, tan and some white chert, trace Zn
395.0  397.5 Hard gray, tan and some white chert, some jasperoid and good Zn and Pb shines
397.5  402.6 Gray, tan, white and translucent chert, calcite crystals, jasperoid, Zn shines, trace Pb

R.I. 4337

Hole Md-69 (continued)

Depth, Feet
From - To -

402.6  405.0 Dull gray and tan chert, jasperoid, Zn shines
405.0  410.0 Gray, tan and some white chert, Zn shines
410.0  412.5 Hard gray, tan and white chert, jasperoid, Zn shines
412.5  415.0 Dull gray to dark gray and some blue chert, some gray limestone, Zn shines, small opening at 414.5 ft.
415.0  417.5 Dark gray limestone, some gray and tan chert, Zn shines
417.5  420.0 Dark brown and gray spotted chert, some blue and brown limestone
420.0  422.5 Dark brown, gray and some white chert, gray limestone, trace Zn
422.5  425.0 Dark gray and brown chert

Bottom

Thirteen samples taken.

Analysis, Percent

Depth, Feet
From - To -

0.0  5.0 Soil and clay
5.0  50.0 Creek gravel
30.0  60.0 Sandy clay
60.0  230.0 Gray and black shale
230.0  260.0 Gray Chester limestone, some pyrite
260.0  270.0 Gray speckled limestone, gray chert
270.0  285.0 Light blue and gray chert, gray limestone
285.0  290.0 Blue and gray mottled chert, gray limestone, calcite crystals
290.0  297.0 Loose gray and light blue rusty water course chert, some gray limestone and calcite crystals. (Note: Struck crevice at 290 to 297 ft., apparently dipping flat to southeast. Blasted to straighten the hole at 297 ft. Cutting showed evidence of opening or water course continuing to 325 ft. in depth.)
297.0  300.0 Gray, gray-blue spotted and white water course chert, some gray limestone
300.0  305.0 Gray and white water course chert, some gray limestone
305.0  315.0 Gray, white, blue and tan chert
315.0  330.0 Brown, white and gray chert, some brown limestone
330.0  340.0 Brown limestone, white and gray chert
340.0  345.0 Shaly green glosanitic and some black limestone, a very little gray and white chert, marcasite
345.0  350.0 Shaly black and some green glosanitic limestone, some gray chert, calcite crystals
350.0  355.0 Brown limestone, partially oolithic, some gray chert
355.0  360.0 Gray limestone and gray chert
360.0  375.0 Leached gray chert, gray limestone
375.0  380.0 Gray translucent chert, gray and some brown limestone
380.0  385.0 Brown limestone, some leached gray white chert
385.0  390.0 Loose coarse light and dark gray and brown chert, calcite crystals, some black chert with disseminated sphalerite, Zn shines; open crevice at 385 ft.
390.0  392.5 Gray spotted, tan and some white chert, some calcite crystals; Zn shines
392.5  395.0 Hard gray, tan and some white chert, trace Zn
395.0  397.5 Hard gray, tan and some white chert, some jasperoid and good Zn and Pb shines
397.5  402.6 Gray, tan, white and translucent chert, calcite crystals, jasperoid, Zn shines, trace Pb

Zinc  Lead
385.0  390.0 0.80 0.05
390.0  392.5 0.50 0.03
392.5  395.0 0.32 0.01
395.0  397.5 1.60 0.56
397.5  400.0 0.60 0.03
400.0  402.5 0.64 0.03
402.5  405.0 0.46 0.03

405.0  410.0 0.52 0.02
410.0  412.5 0.40 0.02
412.5  415.0 0.42 0.02
415.0  417.5 0.56 0.03
417.5  420.0 0.66 0.02
420.0  422.5 0.56 0.03

422.5  425.0 0.46 0.03
R.I. 4337

Hole BM-70
Coordinates: 12,723 N - 15,025 E

Started: 7/50/45    Completed: 8/6/45
Elevation of collar: 652 feet    Vanatta Tract (Kan.)
Water encountered at 405 feet  *water stands at 500 feet
Size of hole: 234 feet, 8 inch; 171 feet, 6-1/4 inch

Depth, Feet
From-  To-

0.0  16.0  Soil, clay, sand and gravel
16.0  257.0  Dark gray and blue shale
257.0  270.0  Gray Chester limestone
270.0  280.0  Gray limestone, gray chert
280.0  285.0  Oil stained gray spotted limestone, gray chert
285.0  300.0  Gray limestone, gray chert, selvage
300.0  310.0  Gray limestone, gray chert
310.0  320.0  Gray and a little spotted chert, tan and some gray limestone
320.0  325.0  Gray, tan and some white chert, tan limestone
325.0  330.0  Gray, light tan and some white chert, soft white limestone, a black shale seam at 228 ft.
330.0  340.0  Tan limestone, gray chert
340.0  345.0  Soft gray and white limestone, gray chert
345.0  350.0  Gray and tan chert, soft white shaly limestone
350.0  375.0  Light blue-gray and some white chert, gray and white limestone
375.0  390.0  Gray and tan limestone, some blue chert
390.0  405.0  Gray, blue and tan chert, brown limestone, 4" crevice at 382 ft.
405.0  590.0  Brown limestone, gray chert
590.0  635.0  Greenish gray shaly glauconitic limestone, selvage
635.0  405.0  Dark gray, tan chert, brown limestone, trace Pb and marcasite
405.0  420.0  Black, dark and light gray chert, brown limestone, much marcasite, trace Zn, sulfur water at 405 ft.
420.0  420.0  Loose gray and black chert, brown limestone, calcite crystals, trace Zn and Pb
420.0  425.0  Loose gray, tan, blue and black chert, marcasite, calcite crystals, trace Zn
425.0  430.0  Loose dark and light gray and brown chert, dolomite, marcasite and calcite crystals, trace Zn and Pb
430.0  435.0  Hard gray and tan spotted and some translucent chert, marcasite

Bottom

No samples taken.

2462    - 77 -

Hole BM-71
Coordinates: 11,965 N - 7,120 E

Started: 8/27/45    Completed: 9/7/45
Elevation of collar: 801 feet    Beade Tract (Fan.)
Water encountered at 576 feet  *water stands at 215 feet
Size of hole: 236 feet, 10 inch; 188 feet, 8 inch; 196 feet, 6-1/4 inch

Depth, Feet
From-  To-

0.0  24.0  Surface clay, some shale
24.0  28.0  Clay and creek gravel
28.0  225.0  Black and gray shale
225.0  245.0  Gray Chester limestone
245.0  240.0  Gray limestone and gray chert (oil stained)
240.0  270.0  Gray chert, gray limestone
270.0  275.0  Light blue and gray chert, tan limestone
275.0  280.0  Leached white and gray chert in a water course, cotton rock
280.0  285.0  Gray and white chert, a little cotton rock
285.0  290.0  Light blue and gray chert, tan limestone
290.0  295.0  Gray and some light blue chert, tan limestone
295.0  310.0  Gray and some tan chert
310.0  325.0  Gray and tan chert, brown limestone
325.0  350.0  Gray and tan chert, a little brown limestone, a green selvage seam
350.0  355.0  Light blue and gray chert, brown limestone
355.0  365.0  Greenish gray glauconitic and some black limestone, selvage, a little gray chert
365.0  370.0  Brown and gray oolitic limestone, some gray chert
370.0  375.0  Gray and tan chert, a very little brown limestone
370.0  375.0  Gray, tan and translucent chert
375.0  380.0  About a 2 ft. opening at 378 ft., lost all cuttings
380.0  385.0  Loose brown and gray chert, trace Zn in crevices
385.0  387.5  Loose gray, tan and dark brown speckled chert, Zn shives, trace Pb
387.5  390.0  Loose gray and tan chert, trace Zn
390.0  395.0  Loose gray, tan and dark brown speckled chert, trace Zn
395.0  400.0  Firm dull gray and some dull white chert, Zn shives
397.5  400.0  Gray and tan spotted chert, Zn shives
397.5  400.0  Dull white, gray, tan and some black chert, a little jasperoid, trace Zn and Pb
400.0  402.5  Gray, tan and some black chert, a little jasperoid, Zn shives, trace Pb
402.5  405.0  Gray and tan chert, a little jasperoid, Zn shives and trace Pb
405.0  407.5  Gray and tan chert, a little jasperoid, trace Zn and Pb (falling?)
407.5  410.0  Dull gray and tan chert, some gray limestone, trace Zn and Pb
Hole BM-71 (continued)

**Depth, Feet**

From - 410.0 415.0 Gray and tan chert, some dark gray chert
415.0 420.0 Dull gray white chert, some dark gray chert
420.0 422.0 Dark gray, dark brown and deep blue chert, gray limestone
Bottom

Nine samples taken.

**Analysis, Percent**

<table>
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<tr>
<th>Depth, Feet</th>
<th>Sample</th>
<th>Depth, Feet</th>
<th>Sample</th>
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<tr>
<td>360.0 365.0</td>
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<td>0.01</td>
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<td>365.0 375.5</td>
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<td>375.5 390.0</td>
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<td>0.02</td>
<td>1/16</td>
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<tr>
<td>390.0 392.5</td>
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<tr>
<td>392.5 395.0</td>
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</table>

**Depth, Feet**

From - 422.5

Hole BM-72

Coordinates: 12,565 N - 15,107 E

**Started:** 5/3/45
**Completed:** 6/22/45
**Elevation of collar:** 850 feet
**Vanesta Tract (Kan.)**
**No sulphur water encountered**
**Water stands at 125 feet (surface)**
**Size of hole:** 260 feet, 8 inch; 185 feet, 6-1/4 inch

**Depth, Feet**

From - 20.0

0.0 12.0 Soil, clay and gravel
12.0 20.0 Gray shale
20.0 36.0 Sandstone
36.0 259.0 Shale
259.0 270.0 Gray Chester limestone, some pyrite
270.0 275.0 Gray Chester limestone, a very little gray chert
275.0 285.0 Gray Chester limestone, some white limestone
285.0 290.0 Gray Chester limestone, some gray chert, a green shale seam
290.0 295.0 Gray chert, gray limestone
295.0 315.0 Gray and light blue chert, gray limestone
315.0 325.0 Gray and some light blue chert, tan and some gray limestone, marcasite
325.0 335.0 Dark gray to brown limestone, blue-gray chert, marcasite
335.0 340.0 Gray chert, gray and brown limestone
340.0 345.0 Gray and light blue chert, brown limestone, some marcasite
345.0 355.0 Gray limestone, some gray chert
355.0 370.0 Gray chert, gray and brown limestone
370.0 380.0 Brown and gray chert, brown and gray limestone
380.0 385.0 Brown limestone, gray and some brown mottled chert
385.0 390.0 Brown and gray chert, brown limestone
390.0 395.0 Dark gray limestone, gray and some dark brown limestone, calcite crystals
395.0 400.0 Dark gray and brown limestone, some dark gray chert
400.0 405.0 Tan and dull gray brown limestone, black chert, trace Pb
405.0 410.0 Black limestone, black and some gray chert, dolomite crystals, Zn and Pb shives
410.0 415.0 Black limestone, calcite crystals, some gray chert, selvage, Zn shives and trace Pb
415.0 422.5 Black and green glauconitic limestone, calcite crystals, gray chert, good Zn ore, trace Pb
422.5 425.0 Gray translucent and blue chert, some black limestone, marcasite and dolomite crystals, fair Zn ore and Pb shives
425.0 427.5 Gray, brown and blue chert, Zn and Pb ore
427.5 430.0 Gray, white and tan chert, Zn and Pb shives
430.0 435.0 Gray, brown and blue chert, marcasite, trace Pb
435.0 443.0 Gray and brown spotted chert
Bottom

Eleven samples taken.
**Hole BM-75**

**Coordinates:** 11,700 N - 7,240 E  
**Started:** 9/6/45  
**Completed:** 9/19/45  
**Elevation of collar:** 805 feet  
**Meade Tract (Kan.)**  
**Water encountered at 225 feet.**  
**Water stands at 220 feet.**  
**Size of hole:** 29 feet, 10 inch; 197 feet, 8 inch; 154 feet, 6-1/4 inch; 40 feet, 4-7/8 inch.

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From- To</th>
<th>Depth, Feet</th>
<th>From- To</th>
</tr>
</thead>
</table>
| 0.0- 28.0   | Clay, gravel, brown sandy clay  
| 28.0- 223.0 | Shale  
| 223.0- 245.0 | Gray Chester limestone, a little gray chert, much pyrite  
| 245.0- 255.0 | Gray speckled Chester limestone, iron, black shale seams, some tar  
| 255.0- 263.0 | Gray Chester limestone, some gray chert, some tar  
| 263.0- 265.0 | White and gray chert, gray limestone  
| 265.0- 275.0 | Light blue and gray chert  
| 275.0- 280.0 | Brown limestone, blue and some gray chert  
| 280.0- 293.0 | Gray and blue chert, tan limestone  
| 293.0- 295.0 | Coarse white and gray leached chert, some cotton rock, sulphur  
| 295.0- 300.0 | Very porous cotton rock, some white chert  
| 300.0- 320.0 | Gray, blue and some tan chert, gray limestone  
| 320.0- 330.0 | Open cavern, no cuttings  
| 330.0- 331.0 | Firm dark gray and some blue chert, gray limestone  
| 331.0- 335.0 | Opening filled with loose material, no cuttings  
| 335.0- 340.0 | Loose gray and blue chert, some gray limestone  
| 340.0- 350.0 | Loose coarse pieces of gray and blue chert, some greenish gray  
| 350.0- 355.0 | Glauconitic limestone  
| 355.0- 360.0 | Loose gray glauconitic limestone, some gray chert, some dark  
| 360.0- 365.0 | Brown decomposed limestone mud, marcasite crystals  
| 365.0- 369.0 | Loose gray chert, dark brown decomposed limestone mud, calcified  
| 369.0- 370.0 | Oolite, some green glauconitic limestone, selvage, marcasite,  
| 370.0- 380.0 | Slight trace Pb  
| 380.0- 385.0 | Loose dull gray and white leached chert, cotton rock  
| 385.0- 390.0 | Loose dull gray and white leached chert, calcite crystals, cotton  
| 390.0- 392.5 | Rock  
| 392.5- 395.0 | Hard dull white, gray and some tan chert, gray limestone  
| 395.0- 397.5 | Gray and some tan chert, gray limestone  
| 397.5- 400.0 | Gray and tan translucent chert, some spotted chert  
| 400.0- 407.5 | Loose gray and black chert, calcite crystals, small crevices,  
| 407.5- 410.0 | Disseminated Zn shives throughout black chert  
| 410.0- 414.0 | Loose light and dark gray and tan chert, good Zn shives  
| 414.0- 415.0 | Loose light and dark gray and tan chert, some spotted chert, fair  
| 415.0- 416.0 | Zn shives  
| 416.0- 419.0 | Fractured dull gray chert  

**Bottom**

**Three samples taken.**

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<th>From- To</th>
<th>Sample</th>
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<td>392.5- 395.0</td>
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**Hole BM-72 (continued)**

**Analysis, Percent**

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<td>0.56</td>
<td>420.0</td>
<td>422.5</td>
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<td>407.5</td>
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<td>0.42</td>
<td>422.5</td>
<td>423.0</td>
<td>2.56</td>
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<tr>
<td>410.0</td>
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<td>0.60</td>
<td>425.0</td>
<td>427.5</td>
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<td>412.5</td>
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Hole EM-74
Coordinates: 12,935 N = 15,157 E

**Depth, Feet**

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<td>422.5</td>
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<td>422.5</td>
<td>425.0</td>
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**Analysis, Percent**

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<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>427.5</td>
<td>430.0</td>
<td>White, gray and brown chert, trace Pb</td>
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<tr>
<td>430.0</td>
<td>435.0</td>
<td>White and gray chert</td>
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<tr>
<td>435.0</td>
<td>440.0</td>
<td>White, gray and spotted chert, a little dark brown chert</td>
</tr>
</tbody>
</table>

Bottom

Eight samples taken.
Hole BM-78
Coordinates: 12,480 N - 14,990 E

Started: 9/1/45  Completed: 9/11/45
Elevation of collar: 846 feet  Varana Tract (Kan.)
Water encountered at 421 feet  Water stands at 505 feet
Size of hole: 280 feet, 6 inch; 178 feet, 6-1/4 inch

Depth, Feet  From - To -
0.0  12.0  Soil and clay
12.0  24.0  Shale
24.0  36.0  Sandstone
36.0  257.0  Shale
257.0  285.0  Gray Chester limestone
285.0  290.0  Gray Chester limestone, some gray chert
290.0  300.0  Gray limestone, gray and some light blue chert
300.0  305.0  Gray limestone
305.0  325.0  Gray and tan limestone, light blue to gray chert
325.0  345.0  Brown and gray limestone, gray and blue chert
345.0  355.0  Cotton rock, some gray and blue chert and gray limestone
355.0  370.0  Blue and gray chert, brown limestone
370.0  385.0  Brown and gray chert, brown limestone
385.0  390.0  Greenish gray shaly limestone, some dark gray chert
390.0  395.0  Dark brown shaly limestone, selvage, dark gray and brown chert, dolomite crystals, trace Zn and Pb
395.0  397.5  Dark brown shaly limestone, selvage, dark gray, brown, and some black chert, dolomite and calcite crystals, trace Zn and Pb shives
397.0  400.0  Green selavage and loose green glaucophanic limestone, some gray and black chert, calcite and dolomite crystals, trace Zn and Pb
400.0  402.5  Muddy green selavage, loose green glaucophanic, black and dark brown shaly limestone, calcite, Zn and Pb shives
402.5  405.0  Selavage and soft loose shaly dark brown limestone, Zn and Pb shives
405.0  407.5  Loose shaly dark brown to black shaly limestone, dolomite and marcasite crystals, Zn and Pb shives
407.5  410.0  Loose shaly dark brown to black shaly limestone, dolomite and much marcasite crystals, calcite, Zn shives and trace Pb
410.0  412.5  Loose shaly dark brown to black shaly limestone, dolomite and much marcasite crystals, calcite, gray chert, silicified olivine, trace Zn and Pb
412.5  415.0  Firm gray and tan chert, marcasite and calcite, Pb ore
415.0  417.5  Gray, tan and some dark gray chert, much marcasite, dolomite and calcite crystals, trace Zn and Pb
417.5  420.0  Gray and tan chert, much marcasite, Pb shives
420.0  422.5  Lost practically all cuttings in opening at 421 ft.; struck strong flow of sulphur water, a very small sample of gray, tan and white chert, seams of shale, marcasite, Zn ore and Pb shives were recovered

2462  - 81 -

Hole BM-75
Coordinates: 11,655 N - 7,280 E

Started: 9/20/45  Completed: 9/29/45
Elevation of collar: 804 feet  Meade Tract (Kan.)
Water encountered at 300 feet  Water stands at 217 feet
Size of hole: 24 feet, 10 inch; 198 feet, 6 inch; 186 feet, 6-1/4 inch

Depth, Feet  From - To -
0.0  25.0  Soil, clay and gravel
25.0  212.0  Shale
212.0  250.0  Gray Chester limestone
250.0  255.0  Gray Chester limestone, some dull white chert
255.0  265.0  Gray limestone, soft gray and white chert; some cotton rock
265.0  270.0  Gray and light blue chert, gray limestone; a little selvage
270.0  275.0  Cotton rock; some gray chert; gray limestone
275.0  290.0  Light blue and dark gray chert; gray and tan limestone
290.0  300.0  Soft light gray-tan limestone; gray and light blue chert
300.0  305.0  Soft shelly gray limestone; gray and brown chert
305.0  310.0  Tan limestone; brown and gray chert
310.0  315.0  Brown and gray chert; gray and tan limestone
315.0  335.0  Brown limestone; dark gray and brown chert
335.0  340.0  Dark brown, black and some greenish glaucophonic limestone; Pb ore
340.0  345.0  Dark brown limestone, some coarse, soft, shaly tan colitic limestone
345.0  350.0  Tan limestone; some colitic; gray chert
350.0  355.0  Gray-tan limestone; some gray chert
355.0  360.0  Brown limestone; a little gray chert
360.0  365.0  Gray and brown chert; some slightly translucent and mottled; tan limestone, marcasite; some brown chert; trace jasperoid
365.0  392.5  Dull gray-white chert; tan limestone; a little jasperoid
392.5  395.0  Slightly spotted gray and tan chert, a little limestone
395.0  397.5  Gray and tan spotted chert; some jasperoid; trace Zn
397.5  400.0  Gray and tan spotted chert; some jasperoid; thin Zn shives
400.0  405.0  Gray and tan spotted chert; some jasperoid; better thin Zn shives than above (4st. less than 1/2 Zn)
405.0  408.0  Dark gray-blue and brown mottled chert; a very little dark brown limestone; a faint trace Zn
Bottom

No samples taken.
Depth, Feet
From- To-
422.5 425.0 Firm white, gray and tan, partially translucent chert, Zn ore and trace Pb
425.0 450.0 Firm white, gray and tan, partially translucent chert, some speckled brown chert, Zn shines
430.0 452.5 Firm white, gray and tan, partially translucent chert, some speckled brown chert, trace Zn, probably falling
452.5 459.0 Gray, tan and some gray and blue spotted chert, a little jasperoid Bottom

Fifteen samples taken.

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<th>Sample</th>
<th>Depth, Feet</th>
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<td>0.11</td>
<td>7/8</td>
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<td>397.5 400.0</td>
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<td>400.0 402.5</td>
<td>0.70</td>
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<td>402.5 405.0</td>
<td>0.62</td>
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<td>405.0 407.5</td>
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Analysis, Percent

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<td>400.0 402.5</td>
<td>0.70 1.04 All 420.0</td>
<td>422.5</td>
</tr>
<tr>
<td>402.5 405.0</td>
<td>0.62 1.40 5/8 422.5</td>
<td>425.0</td>
</tr>
<tr>
<td>405.0 407.5</td>
<td>0.72 0.68 5/8 425.0</td>
<td>427.5</td>
</tr>
<tr>
<td>407.5 410.0</td>
<td>0.74 0.12 3/4 427.5</td>
<td>430.0</td>
</tr>
<tr>
<td>410.0 412.5</td>
<td>0.40 0.38 5/4 430.0</td>
<td>432.5</td>
</tr>
</tbody>
</table>

Hole BM-77
Coordinates: 12,900 N - 13,060 E

Started: 12/8/45   Completed: 12/26/45
Elevation of collar: 830 feet   Von Tretaba Tract (Kan.)
Water encountered at 556 feet   Water stands at 270 feet
Size of hole: 0-54 feet, 10 inch; 54-250 feet, 8 inch; 250-427 feet, 6-1/4 inch

Depth, Feet
From- To-
0.0 25.0 Surface soil and clay
25.0 55.0 Sand and clay
55.0 47.0 Stream gravel and surface water
47.0 90.0 Shale
90.0 110.0 Sandstone and shale
110.0 228.0 Shale
228.0 235.0 Gray limestone, some chert, pyrite
235.0 255.0 Gray limestone, some gray chert
255.0 280.0 Brown and gray limestone, blue and some gray chert
280.0 300.0 Cotton rock; some blue and gray chert
300.0 320.0 Brown limestone, gray chert
320.0 350.0 Gray-blue chert, brown limestone
350.0 360.0 Gray and brown chert, brown limestone
360.0 380.0 Brown and some glauconitic greenish limestone, patty selavage, some gray-blue chert, marcasite
380.0 400.0 Gray, black limestone, selavage, some gray chert, marcasite
400.0 425.0 Opening with strong water flow at 358 ft. Few cuttings recovered black limestone, selavage, some gray chert, marcasite, thin Pb and Zn shives
425.0 427.5 Loose black limestone, gray chert, selavage, Zn and Pb shives
427.5 435.0 Gray chert, black and some brown glauconitic limestone, jasperoid, Zn shives, trace Pb
435.0 450.0 Tan, gray and black chert, jasperoid, Zn and Pb shives
450.0 457.5 Gray and black chert, jasperoid, thin Zn and Pb shives
457.5 460.0 Hard light blue, gray and a little dull white chert
460.0 465.0 Blue, brown and dull white chert, trace Zn
465.0 469.0 White and blue chert
469.0 470.0 Gray and tan chert
470.0 475.0 Tan and dark gray chert, a little gray limestone
475.0 490.0 Dark bluish-gray limestone, dark gray and brown spotted chert Bottom

Four samples taken.
Hole BM-78
Coordinates: 12,468 N - 14,955 E

Started: 9/12/45  
Completed: 9/26/45

Elevation of collar: 847 feet  
Vanatta Tract (Kan.)

Water encountered at 422 feet  
Water stands at 505 feet

Size of hole: 259 feet, 8 inch; 166 feet, 6-1/4 inch

Depth, Feet

<table>
<thead>
<tr>
<th>Depth</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>0.0</td>
<td>12.0 Soln and clay</td>
</tr>
<tr>
<td>12.0</td>
<td>24.0</td>
<td>Shale</td>
</tr>
<tr>
<td>24.0</td>
<td>34.0</td>
<td>Sandstone</td>
</tr>
<tr>
<td>34.0</td>
<td>257.0</td>
<td>Shale</td>
</tr>
<tr>
<td>257.0</td>
<td>275.0</td>
<td>Gray Chester limestone; pyrite</td>
</tr>
<tr>
<td>275.0</td>
<td>290.0</td>
<td>Soft leached gray, brown and white Chester limestone; some dull white chert</td>
</tr>
<tr>
<td>290.0</td>
<td>295.0</td>
<td>Bul white chert and some soft leached Chester limestone</td>
</tr>
<tr>
<td>295.0</td>
<td>300.0</td>
<td>Gray limestone and gray chert</td>
</tr>
<tr>
<td>300.0</td>
<td>315.0</td>
<td>Light blue and gray chert; tan limestone</td>
</tr>
<tr>
<td>315.0</td>
<td>320.0</td>
<td>Light blue and gray chert; tan limestone, leached and corroded some by solution action</td>
</tr>
<tr>
<td>320.0</td>
<td>330.0</td>
<td>Blue chert; gray and brown limestone</td>
</tr>
<tr>
<td>330.0</td>
<td>345.0</td>
<td>Dark blue-gray chert; brown to gray limestone</td>
</tr>
<tr>
<td>345.0</td>
<td>355.0</td>
<td>Soft gray and tan chert; tan limestone</td>
</tr>
<tr>
<td>355.0</td>
<td>370.0</td>
<td>Blue-gray chert; brown limestone</td>
</tr>
<tr>
<td>370.0</td>
<td>385.0</td>
<td>Brown limestone; blue and some gray chert</td>
</tr>
<tr>
<td>385.0</td>
<td>390.0</td>
<td>Brown limestone; some blue and brown chert</td>
</tr>
<tr>
<td>390.0</td>
<td>395.0</td>
<td>Soft gray, tan, white and a trace of green shaly limestone</td>
</tr>
<tr>
<td>395.0</td>
<td>597.5</td>
<td>Greenish gray shaly limestone; dark brown and gray chert; a trace of Pb</td>
</tr>
<tr>
<td>597.5</td>
<td>600.0</td>
<td>Tan limestone; dark gray and brown chert; a trace Zn; Pb shives</td>
</tr>
<tr>
<td>600.0</td>
<td>602.5</td>
<td>Tan limestone; dark gray and brown chert; a trace Zn; little more Pb shives</td>
</tr>
<tr>
<td>602.5</td>
<td>605.0</td>
<td>Green glauconitic limestone; black chert and some black limestone; Pb and Zn shives</td>
</tr>
<tr>
<td>605.0</td>
<td>610.0</td>
<td>Black limestone; calcite crystals; Zn ore and Pb shives</td>
</tr>
<tr>
<td>610.0</td>
<td>612.5</td>
<td>Black limestone; dolomite and calcite crystals; some pasty white limestone selvage; good Zn ore</td>
</tr>
<tr>
<td>612.5</td>
<td>615.0</td>
<td>Dark brown oolitic limestone; calcite and dolomite crystals; very good Zn ore; trace Pb</td>
</tr>
<tr>
<td>615.0</td>
<td>617.5</td>
<td>Dark brown and green (glauconite) oolitic limestone; selvage; dolomite and calcite crystals; good Zn and Pb ore</td>
</tr>
<tr>
<td>617.5</td>
<td>620.0</td>
<td>Gray and some tan chert; selvage; dolomite; calcite and marcasite crystals; brown limestone; Zn and Pb shives</td>
</tr>
<tr>
<td>620.0</td>
<td>622.5</td>
<td>Gray and tan chert; dolomite and much marcasite crystals in a water course; trace of Zn and Pb</td>
</tr>
<tr>
<td>622.5</td>
<td>625.0</td>
<td>Gray and tan (some spotted) chert; marcasite and slight trace Pb</td>
</tr>
</tbody>
</table>

Bottom

Ten samples taken.

- 83 -
### Hole BM-79

- **Coordinates:** 12,800 N - 12,940 E
- **Started:** 12/27/45
- **Completed:** 1/9/45
- **Elevation of collar:** 828 feet
- **Von Trebra Tract (Kan.)**
- **Water encountered at:** 540 feet
- **Water stands at:** 258 feet
- **Size of hole:** 0-47 feet, 10 inch; 47-225 feet, 8 inch; 225-378 feet, 6-1/4 inch

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From-</th>
<th>To-</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>18.0</td>
<td>Clay and soil</td>
</tr>
<tr>
<td>18.0</td>
<td>35.0</td>
<td>Sandy clay</td>
</tr>
<tr>
<td>35.0</td>
<td>45.0</td>
<td>Sand, stream gravel and surface water</td>
</tr>
<tr>
<td>45.0</td>
<td>85.0</td>
<td>Shale</td>
</tr>
<tr>
<td>85.0</td>
<td>100.0</td>
<td>Sandstone and shale</td>
</tr>
<tr>
<td>100.0</td>
<td>225.0</td>
<td>Shale</td>
</tr>
<tr>
<td>225.0</td>
<td>225.0</td>
<td>Gray Chester limestone, gray chert and much pyrite</td>
</tr>
<tr>
<td>225.0</td>
<td>240.0</td>
<td>Gray Chester limestone, gray chert and some &quot;tar&quot;</td>
</tr>
<tr>
<td>240.0</td>
<td>265.0</td>
<td>Gray limestone, gray chert</td>
</tr>
<tr>
<td>265.0</td>
<td>285.0</td>
<td>Tan limestone, light blue chert</td>
</tr>
<tr>
<td>285.0</td>
<td>295.0</td>
<td>Cotton rock, a very little gray chert and limestone</td>
</tr>
<tr>
<td>295.0</td>
<td>310.0</td>
<td>Brown limestone, gray chert</td>
</tr>
<tr>
<td>310.0</td>
<td>340.0</td>
<td>Gray chert, brown limestone</td>
</tr>
<tr>
<td>340.0</td>
<td>345.0</td>
<td>Brown and gray chert, brown and some greenish glauconitic limestone</td>
</tr>
<tr>
<td>345.0</td>
<td>550.0</td>
<td>Opening and strong sulphur water at 540 ft., few cuttings black limestone, gray and coarse black chert, much marcasite</td>
</tr>
<tr>
<td>550.0</td>
<td>555.0</td>
<td>Loose boulders, black limestone, gray and coarse black chert, very much marcasite</td>
</tr>
<tr>
<td>555.0</td>
<td>575.5</td>
<td>Loose black limestone, mud, some gray chert, marcasite, trace Zn</td>
</tr>
<tr>
<td>575.5</td>
<td>580.0</td>
<td>Loose dull gray, some brown and blue chert, silicified oolites, a little black limestone, much marcasite, trace Zn</td>
</tr>
<tr>
<td>560.0</td>
<td>562.5</td>
<td>Firr tan, white and light blue chert, marcasite, trace Zn</td>
</tr>
<tr>
<td>562.5</td>
<td>565.0</td>
<td>Loose dark gray, some brown and black chert, Jasperoid with disseminated Zn shines, trace Pb</td>
</tr>
<tr>
<td>565.0</td>
<td>567.5</td>
<td>Firm gray, tan and some white mottled chert, dolomite, crystals, trace Zn</td>
</tr>
<tr>
<td>567.5</td>
<td>570.0</td>
<td>Loose gray and tan spotted and some dull white chert</td>
</tr>
<tr>
<td>570.0</td>
<td>575.0</td>
<td>Loose caving gray, brown and some dull white chert, some gray limestone</td>
</tr>
<tr>
<td>575.0</td>
<td>578.0</td>
<td>Hard dull gray, tan and white chert</td>
</tr>
</tbody>
</table>

**Bottom**

One sample taken.

**Analysis, Percent**

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From-</th>
<th>To-</th>
<th>Zine</th>
<th>Lead</th>
<th>Rem.</th>
</tr>
</thead>
<tbody>
<tr>
<td>562.5</td>
<td>565.0</td>
<td>1.56</td>
<td>0.07</td>
<td>1/2</td>
<td></td>
</tr>
</tbody>
</table>

2462

---

### Hole BM-80

- **Coordinates:** 15,054 N - 14,224 E
- **Started:** 10/29/45
- **Completed:** 11/8/45
- **Elevation of collar:** 856 feet
- **Vanatta Tract (Kan.)**
- **Water encountered at:** 375 feet
- **Water stands at:** 295 feet
- **Size of hole:** 0-257 feet, 8 inch; 257-395 feet, 6 inch; 395-415 feet, 6 inch

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From-</th>
<th>To-</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>28.0</td>
<td>Soil, clay and gravel</td>
</tr>
<tr>
<td>28.0</td>
<td>250.0</td>
<td>Shale</td>
</tr>
<tr>
<td>250.0</td>
<td>255.0</td>
<td>Shales with much pyrite</td>
</tr>
<tr>
<td>255.0</td>
<td>265.0</td>
<td>Gray Chester limestone</td>
</tr>
<tr>
<td>265.0</td>
<td>285.0</td>
<td>Soft leached &quot;Tar&quot; stained white limestone and white chert</td>
</tr>
<tr>
<td>285.0</td>
<td>300.0</td>
<td>Gray limestone, gray and some light blue chert</td>
</tr>
<tr>
<td>300.0</td>
<td>325.0</td>
<td>Brown limestone, light blue and gray chert</td>
</tr>
<tr>
<td>325.0</td>
<td>355.0</td>
<td>Soft white cotton rock, some light gray chert</td>
</tr>
<tr>
<td>355.0</td>
<td>360.0</td>
<td>Brown limestone, blue and gray chert</td>
</tr>
<tr>
<td>360.0</td>
<td>365.0</td>
<td>Thin bedded &quot;shelly&quot; brown limestone, blue and gray chert</td>
</tr>
<tr>
<td>365.0</td>
<td>370.0</td>
<td>Very hard blue and gray chert, brown and a few thin seams of soft white limestone</td>
</tr>
<tr>
<td>370.0</td>
<td>375.0</td>
<td>Laid all cuttings in opening at 374 ft., strong sulphur water at 375 ft.</td>
</tr>
<tr>
<td>375.0</td>
<td>380.0</td>
<td>Soft gray secondary limestone mud redeposition, many coarse calcite crystals, some shale and dark gray chert nodules</td>
</tr>
<tr>
<td>380.0</td>
<td>582.5</td>
<td>Soft gray secondary limestone mud redeposition, many coarse calcite crystals, some shale and dark gray chert nodules</td>
</tr>
<tr>
<td>380.0</td>
<td>595.0</td>
<td>Loose brown limestone, some dark and light gray chert, recemented with much secondary limestone mud, trace Pb</td>
</tr>
<tr>
<td>360.0</td>
<td>595.0</td>
<td>Loose brown limestone, some dark and light gray and little black chert, recemented with secondary limestone mud, salvage, marcasite and trace Pb</td>
</tr>
<tr>
<td>395.0</td>
<td>397.0</td>
<td>Loose and firm ribs of black limestone, some gray and black chert, calcite crystals, and trace Zn and Pb</td>
</tr>
<tr>
<td>397.0</td>
<td>400.0</td>
<td>Firm soft black limestone, some greenish-brown leached oolitic limestone, calcite, a very little gray chert, trace Zn and Pb</td>
</tr>
<tr>
<td>400.0</td>
<td>402.5</td>
<td>Firm soft greenish-brown oolitic limestone, a very little gray chert</td>
</tr>
<tr>
<td>402.5</td>
<td>405.0</td>
<td>Gray speckled chert with silicified oolite, some brown limestone, Zn shines, trace Pb</td>
</tr>
<tr>
<td>405.0</td>
<td>407.5</td>
<td>Gray, black and some white mottled chert, fair Zn shines</td>
</tr>
<tr>
<td>407.5</td>
<td>410.0</td>
<td>Fractured gray and tan faintly spotted chert, trace Zn</td>
</tr>
<tr>
<td>410.0</td>
<td>412.5</td>
<td>Fractured gray and dark gray spotted and some brown chert, trace Zn and Pb</td>
</tr>
<tr>
<td>412.5</td>
<td>415.0</td>
<td>Hard gray and tan spotted and some white chert</td>
</tr>
</tbody>
</table>

**Bottom**

Two samples taken.

**Analysis, Percent**

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From-</th>
<th>To-</th>
<th>Zinc</th>
<th>Lead</th>
<th>Rem.</th>
</tr>
</thead>
<tbody>
<tr>
<td>402.5</td>
<td>405.0</td>
<td>0.84</td>
<td>0.07</td>
<td>1/2</td>
<td></td>
</tr>
<tr>
<td>405.0</td>
<td>407.5</td>
<td>1.20</td>
<td>0.06</td>
<td>1/2</td>
<td></td>
</tr>
</tbody>
</table>

- 84 -
Hole BM-61
Coordinates: 12,908 N - 15,182 E

Started: 1/10/25  Completed: 1/22/25
Elevation of collar: 855 feet  Von Trebra Tract (Kan.)
Water encountered at 374 feet  Water stands at 280 feet
Size of hole: 0-49 feet, 10 inch; 49-235 feet, 8 inch; 235-588 feet, 6-1/4 inch

Depth, Feet
From- To-

0.0  50.0 Soil, sand, clay and loose sandstone rocks
30.0  54.0 Sandy clay
54.0  68.0 Sand, stream gravel and surface water
68.0  85.0 Shale
85.0  115.0 Thin sandstone beds and shale
115.0  235.0 Shale
235.0  275.0 Soft gray (Chester?) limestone, some chert, much pyrite to 235 ft.
275.0  285.0 Tan limestone, light blue and gray chert
285.0  300.0 Tan limestone, light blue and gray chert, some cotton rock
300.0  305.0 Cotton rock, a very little gray chert
305.0  310.0 Light brown limestone, some gray chert and cotton rock
310.0  355.0 Light brown limestone, some gray and brown chert
355.0  365.0 Brown limestone, gray chert
365.0  370.0 Hard brown limestone, a few greenish speckled glauconitic seams
370.0  375.0 Greenish glauconitic and brown limestone, a little gray chert
375.0  380.0 Soft black, gray and greenish glauconitic limestone, selvage and mud
380.0  565.0 Soft black, brown and oolithic gray limestone, selvage, mud and a shale seam
385.0  390.0 Gray, tan and black chert, pieces of silicified oolite, martasite and specks of sphalerite
370.0  375.0 Gray, tan and white chert, small crevice at 374 ft., trace Zn
375.0  377.5 Very hard gray, tan and white translucent chert
377.5  380.0 Dull white and gray, slightly spotted (N-bed) and a little hard
380.0  385.0 Dull white and slightly spotted gray chert
385.0  395.0 Dull white and hard gray translucent chert

No samples taken.

Hole BM-62
Coordinates: 15,102 N - 14,292 E

Started: 11/9/45  Completed: 11/19/45
Elevation of collar: 858 feet  Vanatta Tract (Kan.)
Water encountered at 396 feet  Water stands at 305 feet
Size of hole: 0-285 feet, 8 inch; 285-422 feet, 6-1/4 inch

Depth, Feet
From- To- Zn-

0.0  16.0 Soil, clay and gravel
16.0  259.0 Shale, hard and somewhat sandy
259.0  261.0 Shale and pyrite
261.0  285.0 Soft fractured gray Chester limestone with a little gray chert throughout
285.0  295.0 Soft speckled gray limestone, some gray chert
295.0  305.0 Hard gray limestone, gray chert
305.0  350.0 Tan limestone, gray and some light blue chert
350.0  360.0 Soft cotton rock, some white chert
360.0  365.0 Tan limestone, gray and some blue chert
365.0  380.0 Hard brown limestone, gray chert
380.0  385.0 Hard brown limestone, a very little gray chert
385.0  390.0 Hard brown limestone, a very little gray chert, some calcite seams and fair Pb shins
390.0  392.5 Soft black and some green glauconitic limestone, calcite, dolomite, Pb shins
392.5  395.0 Soft black limestone, calcite, dolomite, trace Pb
395.0  397.5 Soft black limestone, selvage, mud, trace Pb
397.5  400.0 Loose black limestone, silicified oolite, some selvage mud, calcite, trace Pb
400.0  402.5 Loose black limestone, silicified oolite, selvage mud, calcite, trace Pb
402.5  405.0 Loose black limestone, black chert, jasperoid with disseminated sphalerite, calcite, selvage mud, some gray chert, Zn shins
405.0  407.5 Light and dark gray and tan mottled translucent chert, thin Zn shins
407.5  410.0 Gray and some brown translucent chert, trace Zn and Pb
410.0  415.0 Gray, tan, some white and a little black chert, martasite, trace Zn and Pb
415.0  422.0 Dull white and some white and tan spotted chert

One sample taken.

Analysis, Percent

Depth, Feet
From- To- Zn  Pb  Lead

402.5  405.5  1.30  0.12
Hole RM-63
Coordinates: 13,060 N - 13,218 E

Started: 1/23/46  
Completed: 2/1/46
Elevation of collar: 837 feet  
von Trebra Tract (Kan.)
Water encountered at 375 feet  
Water stands at 265 feet
Size of hole: 0-54 feet, 10 inch; 54-241 feet, 8 inch; 241-410 feet, 6-1/4 inch

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>44.0</td>
<td>Soil, clay and sand</td>
</tr>
<tr>
<td>44.0</td>
<td>54.0</td>
<td>Sand, stream gravel and surface water</td>
</tr>
<tr>
<td>54.0</td>
<td>90.0</td>
<td>Shale</td>
</tr>
<tr>
<td>90.0</td>
<td>110.0</td>
<td>Sandstone and shale</td>
</tr>
<tr>
<td>110.0</td>
<td>259.0</td>
<td>Shale, much pyrite at 259 ft.</td>
</tr>
<tr>
<td>259.0</td>
<td>260.0</td>
<td>Gray Chester limestone</td>
</tr>
<tr>
<td>260.0</td>
<td>270.0</td>
<td>Soft gray limestone, gray chert and selvage seams</td>
</tr>
<tr>
<td>270.0</td>
<td>280.0</td>
<td>Soft gray limestone, a little blue chert</td>
</tr>
<tr>
<td>280.0</td>
<td>295.0</td>
<td>Tan and gray limestone, gray and blue chert</td>
</tr>
<tr>
<td>295.0</td>
<td>305.0</td>
<td>Blue and gray chert, tan limestone</td>
</tr>
<tr>
<td>305.0</td>
<td>310.0</td>
<td>Cotton rock, a little gray chert</td>
</tr>
<tr>
<td>310.0</td>
<td>315.0</td>
<td>Gray and some brown chert, brown limestone, some cotton rock</td>
</tr>
<tr>
<td>315.0</td>
<td>340.0</td>
<td>Brown limestone, gray chert</td>
</tr>
<tr>
<td>340.0</td>
<td>345.0</td>
<td>Gray-blue chert, brown limestone</td>
</tr>
<tr>
<td>345.0</td>
<td>350.0</td>
<td>Soft dark gray, pesty limestone, gray chert</td>
</tr>
<tr>
<td>350.0</td>
<td>355.0</td>
<td>Dark gray to light gray limestone, a very little gray chert</td>
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<tr>
<td>355.0</td>
<td>360.0</td>
<td>Brown, dark gray and some greenish glauconitic speckled limestone</td>
</tr>
<tr>
<td>360.0</td>
<td>365.0</td>
<td>Soft black, brown, dark gray and some glauconitic limestone, gray chert, marcasite in selvage mud seams</td>
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<tr>
<td>365.0</td>
<td>375.5</td>
<td>Soft black, brown, dark gray and some glauconitic limestone, gray chert, marcasite in selvage mud seams, some silicified colite</td>
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<tr>
<td>375.5</td>
<td>370.0</td>
<td>Brown and gray, doliolic limestone, marcasite</td>
</tr>
<tr>
<td>370.0</td>
<td>380.0</td>
<td>Gray, tan and some white partially translucent chert, marcasite and a trace Pb, sulphur water at 278 ft.</td>
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<tr>
<td>380.0</td>
<td>385.0</td>
<td>Hard dull white, some tan and white translucent chert, trace Zn and Pb</td>
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<td>385.0</td>
<td>390.0</td>
<td>Dull white to gray and some tan and white spotted translucent chert, trace Pb</td>
</tr>
<tr>
<td>390.0</td>
<td>395.0</td>
<td>Dull gray, tan and white chert, a little brown limestone, trace Pb</td>
</tr>
<tr>
<td>395.0</td>
<td>400.0</td>
<td>Soft larched dull gray and white chert, a little tan and gray limestone</td>
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<tr>
<td>400.0</td>
<td>405.0</td>
<td>Gray, tan, white and some brown chert</td>
</tr>
<tr>
<td>405.0</td>
<td>410.0</td>
<td>Dull gray, brown and some dark blue chert, dark gray limestone</td>
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One sample taken.

Analysis, Percent

<table>
<thead>
<tr>
<th>Depth, Feet</th>
<th>From</th>
<th>To</th>
<th>Zinc</th>
<th>Lead</th>
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2462

Hole RM-64
Coordinates: 12,980 N - 14,535 E

Started: 11/20/45  
Completed: 11/23/45
Elevation of collar: 855 feet  
Vanatta Tract (Kan.)
Water encountered at 405 feet  
Water stands at 226 feet
Size of hole: 0-254 feet, 8 inch; 254-421 feet, 6-1/4 inch

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<tr>
<th>Depth, Feet</th>
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<td>Soil, clay, gravel and surface water</td>
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<td>25.0</td>
<td>255.0</td>
<td>Shale</td>
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<tr>
<td>255.0</td>
<td>260.0</td>
<td>Shale, much pyrite</td>
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<tr>
<td>260.0</td>
<td>280.0</td>
<td>Gray Chester, limestone</td>
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<tr>
<td>280.0</td>
<td>290.0</td>
<td>Soft gray and dirty white spotted limestone, some gray chert</td>
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<td>290.0</td>
<td>300.0</td>
<td>Gray limestone, gray chert</td>
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<tr>
<td>300.0</td>
<td>320.0</td>
<td>Van limestone, light blue and some gray chert</td>
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<tr>
<td>320.0</td>
<td>325.0</td>
<td>Blue-gray chert, brown limestone</td>
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<tr>
<td>325.0</td>
<td>335.0</td>
<td>Cotton rock, some gray chert</td>
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<tr>
<td>335.0</td>
<td>340.0</td>
<td>Cotton rock</td>
</tr>
<tr>
<td>340.0</td>
<td>345.0</td>
<td>Gray and blue chert, some tan limestone, selvage</td>
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<tr>
<td>345.0</td>
<td>360.0</td>
<td>Gray and blue chert, brown limestone</td>
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<td>370.0</td>
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<td>Brown limestone, blue and gray chert</td>
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<td>390.0</td>
<td>Brown limestone, selvage, very little chert</td>
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<td>390.0</td>
<td>392.5</td>
<td>Greenish glauconitic and brown limestone, some gray chert</td>
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<td>392.5</td>
<td>395.0</td>
<td>Gray and brown limestone, selvage, mud, some chert, trace Pb</td>
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<td>398.5</td>
<td>Black and brown limestone, selvage mud, Pb shives</td>
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<td>Silicified colite, calcite and dolomite crystals, selvage</td>
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<td>Gray, tan and some white chert, some brown limestone, selvage in a small crevice</td>
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<td>402.5</td>
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<td>Gray, tan and some dark gray mottled chert</td>
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<tr>
<td>405.0</td>
<td>410.0</td>
<td>Gray, tan and some gray and dark brown mottled translucent chert, crevice 400-410 ft.</td>
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<td>410.0</td>
<td>412.5</td>
<td>Gray and brown translucent chert, jasperoid, Zn and Pb shives</td>
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<tr>
<td>412.5</td>
<td>415.0</td>
<td>Gray and brown translucent chert, jasperoid, trace Zn and Pb</td>
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<td>415.0</td>
<td>417.5</td>
<td>Gray, tan and some white chert</td>
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<tr>
<td>417.5</td>
<td>421.0</td>
<td>Dull gray and white, slightly spotted chert</td>
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One sample taken.

Analysis, Percent

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<tr>
<th>Depth, Feet</th>
<th>From</th>
<th>To</th>
<th>Zinc</th>
<th>Lead</th>
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<td>412.5</td>
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Hole BM-85
 Coordinates: 12,750 N - 12,903 E

Depth, Feet

0.0 Soil, clay, sand and sandstone
45.0 50.0 Sand, stream gravel and surface water
50.0 85.0 Shale
85.0 120.0 Interbedded sandstone and shale
120.0 135.0 Shale
135.0 225.0 Soft gray spotted Chester limestone, much pyrite, selvage seams, some dull white, light blue and gray chert
225.0 240.0 Soft gray-brown and white spotted limestone, some gray and white chert and marcasite
240.0 250.0 Fine speckled brown and white oil-stained limestone, a little white chert
250.0 255.0 Soft speckled gray and white oily limestone, a little gray-white chert
255.0 270.0 Soft spotted gray and white limestone, cotton rock and some gray-white chert
270.0 280.0 Light blue chert, cotton rock, a little gray-white limestone
280.0 300.0 Light gray-blue and some white chert, some tan limestone, a little marcasite
300.0 295.0 Light gray-blue, dull tan and white chert, cotton rock
295.0 305.0 Cotton rock, a little gray chert and light brown limestone
305.0 310.0 Light brown and buff limestone, light and dark gray chert
310.0 320.0 Gray, white and tan chert, some light brown limestone
320.0 335.0 Light and dark gray, white and some tan chert, light brown limestone
335.0 340.0 Calico light brown and white and a little gray chert, light brown limestone
340.0 345.0 Grayish-brown limestone, a little gray-white chert, selvage seams
345.0 350.0 Hard dark grayish-brown limestone, a little light and dark gray white chert
350.0 360.0 Shaly dark gray, brown and a little glauconitic speckled limestone, a little gray and white chert, a black shale seam, selvage and a few of marcasite and dolomite crystals
355.0 360.0 Brown, greenish-stained, partially silicified, oolitic limestone, black shaly limestone, selvage seams and a little marcasite
360.0 365.0 Speckled brown and white oolitic limestone, selvage, a few of dolomite and marcasite
365.0 370.0 Brown crystalline limestone, a few calcite crystals, and specks of Zn
370.0 372.5 White and some tan spotted translucent chert, trace Zn

Hole SM-85 (continued)

Depth, Feet

372.5 377.5 Speckled brown and gray partially translucent chert
377.5 380.0 Speckled brown gray and tan partially translucent chert, a very little brown limestone, dark brown shaly seams and black jasperoid, trace Zn
380.0 383.5 Speckled brown gray and tan partially translucent chert, a very little brown limestone, dark brown shaly seams and a trace of black jasperoid, little marcasite, few specks of Zn
383.5 386.0 Slightly speckled brown, tan, gray and white translucent chert, a very little brown limestone, a few specks Pb, and Zn in jasperoid
386.0 388.5 Breciated white, blue and tan translucent chert recemented with jasperoid, a buff limestone seam, a little dull white chert, trace Pb
388.5 391.0 Softer dull white chert, a seam of black shale and green selvage with a trace of marcasite, some mixed translucent chert and a trace Pb (probably falling)

Bottom

No samples taken.
Hole BM-86
Coordinates: 12,620 N - 12,688 E

Started: 2/15/46
Completed: 2/26/46
Elevation of collar: 853 feet
von Trebra Tract (Kan.)
Water encountered at 362 feet
Water stands at 249 feet
Size of hole: 0-50 feet, 10 inch; 50-220 feet, 8 inch; 220-304 feet, 6-1/4 inch

Depth, Feet
From-- To--

0.0 36.0 Soil, clay, sand and loose sandstone
36.0 48.0 Sand, gravel and surface water
48.0 60.0 Shale
60.0 120.0 Interbedded sandstones and shales
120.0 181.0 Shale
181.0 190.0 Hard dark gray sandstone
190.0 200.0 Black shale, gray selavage seams with a trace of calcite, a small gas flow
200.0 224.0 Shale
224.0 250.0 Dark and light gray speckled Chester limestone, much marcasite, a little gray chert
230.0 245.0 Soft dirty white leached and some gray and brown oily, speckled limestone, some cotton rock and dull gray to white chert
245.0 250.0 Dull, oily, white chert, soft gray limestone
250.0 260.0 White and gray chert, a little cotton rock gray and speckled limestone
260.0 270.0 White and faint light blue, corroded chert and cotton rock
270.0 285.0 White and light bluish-gray chert, buff and gray limestone
285.0 305.0 Buff to darker tan and gray limestone, white chert, a little cotton rock
305.0 320.0 Buff, gray to light brown and dark gray limestones, some gray and white chert
320.0 325.0 Dark gray and light brown limestone, some white and calico gray and white chert
325.0 335.0 Shelly brownish-gray limestone with light gray seams, gray and white chert
335.0 345.0 Hard dark greenish-gray shelly limestone with a trace of green specks, dark gray, white and a little brown chert
345.0 350.0 Hard dark greenish-gray shelly limestone with a trace of green specks, some green and black speckled glauconitic gray limestone and trace hard dark brown limestone, dark gray, white and a little brown chert
350.0 360.0 Hard dark brown to black shaly limestone with tan seams, trace dolomite and marcasite crystals
360.0 365.0 Dark gray, greenish-speckled dolomite limestone
365.0 370.0 Dark and light gray crystalline limestone, some dolomite limestone, a crack at 527 ft.

- 86 -

Hole BM-86 (continued)

Depth, Feet
From- To-

370.0 375.0 Brown crystalline limestone, a trace of flint and calcite crystals
375.0 380.0 Gray, tan and a little white speckled chert, some brown limestone, a selavage seam
380.0 385.0 Tan, white and brown speckled translucent chert, trace marcasite, Pb and few specks Zn
385.0 390.0 Dull brown, tan, gray and a little white speckled chert, a trace of dark brown jasperoid, limestone and marcasite
390.0 394.0 Dull white chert, some hard gray, tan and white spotted partially translucent chert

Bottom

No samples taken.
Hole BM-67
Coordinates: 12.470 N - 12.840 E

Started: 2/27/46  Completed: 3/9/46
Elevation of collar: 833 feet  von Trebra Tract (Kan.)
Water encountered at 565 feet  Water stands at 248 feet
Size of hole: 0-49 feet, 10 inch; 49-229 feet, 8 inch; 229-397 feet, 6-1/4 inch

Depth, Feet  From- To-

0.0  30.0  Soil and clay
30.0  47.0  Sand, gravel and surface water
47.0  85.0  Shale
85.0  110.0  Sandy shale
110.0  194.0  Shale
194.0  230.0  Hard, brown, porous, oily sandstone
230.0  225.0  Shale
225.0  235.0  Gray, brown and white spotted limestone, some gray and white chert
235.0  260.0  Soft white, brown and gray speckled limestone, some chert, and cotton rock, marcasite
260.0  270.0  Firm buff limestone, light gray-blue chert
270.0  275.0  Gray-white chert, some cotton rock and buff limestone
275.0  285.0  Hard blue chert, light and dark gray limestone
285.0  300.0  Hard gray and tan limestone, gray and white chert, trace marcasite
300.0  310.0  Firm tan and white limestone, white chert, trace marcasite
310.0  315.0  Dark and light gray limestone, dark gray to white chert
315.0  345.0  Hard dark gray, tan and white chert, brownish-gray limestone
345.0  350.0  Hard dark greenish-gray and brown limestone with tan seams, little gray chert and marcasite
350.0  355.0  Hard black to dark brown and some greenish-gray limestone, white selvage seam, trace chert and marcasite
355.0  370.0  Hard dark gray, olitic light gray, some crystalline pale brown and a little black limestone, trace gray and white chert
370.0  375.0  Gray and brown speckled translucent chert, a little gray limestone, trace Pb and calcite in a crevice at 374 ft.
375.0  380.0  Softer dull white and a little tan and gray translucent chert
380.0  390.0  Faintly tan and gray spotted white vitreous chert, some dull white chert, a faint trace Pb and black jasperoid
Bottom

No samples taken.

2462

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Hole BM-68
Coordinates: 15.637 N - 13.931 E

Started: 5/11/46  Completed: 5/21/46
Elevation of collar: 855 feet  von Trebra Tract (Kan.)
Water encountered at 380 feet  Water stands at 290 feet
Size of hole: 0-260 feet, 8 inch; 260-423 feet, 6-1/4 inch

Depth, Feet  From- To-

0.0  10.0  Soil, clay and loose sandstone
10.0  225.0  Shale
225.0  240.0  Sandy shale, much marcasite, some selvage seams
240.0  255.0  Shale
255.0  265.0  Much marcasite, some shale, limestone, selvage seams, trace chert
265.0  260.0  Dark and light gray and white speckled, partially translucent chert, much marcasite
260.0  265.0  Dull white and some gray chert, a little brown limestone, a little marcasite
265.0  270.0  White and brown spotted cotton rock, dull white chert
270.0  275.0  White and brown spotted cotton rock, gray and white speckled limestone, a little dull white chert
275.0  300.0  Dull white and a little light blue leached chert, some gray and white speckled cotton rock
300.0  310.0  Light blue-gray and white chert, buff and grayish-tan limestone
310.0  320.0  Grayish-tan and buff limestone, gray-blue and white chert, trace marcasite
320.0  325.0  Tan limestone, cotton rock, gray-blue and white chert
325.0  335.0  Cotton rock, tan limestone, a little gray-blue, tan and white chert
335.0  360.0  Grayish-brown shelly limestone with soft buff colored seams, dark gray-blue, brown and a little white chert
360.0  370.0  Brown, gray and white chert, a little brown limestone, trace marcasite
370.0  375.0  Hard greenish-gray shaly limestone, specks of glauconite, a trace of chert
375.0  380.0  Hard greenish-gray shaly limestone, specks of glauconite, some gray tan and a little black chert
380.0  385.0  Hard brown limestone, brown and a little gray and white chert, trace of marcasite
385.0  390.0  Coarse pieces of loose shaly dark to light brown and some gray glauconitic speckled limestone, selvage seams, a little brown, gray and white chert
390.0  392.5  Loose black shaly limestone, much marcasite, trace of dolomite crystals and gray chert
392.5  395.0  Loose black shaly limestone, gray and brown limestone and pasty selvage seams, marcasite, a trace of dolomite crystals, gray and a little dull white chert

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Hole BM-69
Coordinates: 13,525 N - 15,892 E

Depth, Feet
From-- To--

395.0 400.0 Loose, only and few cuttings of brown limestone in selvage, a trace of silicified oolite, some tan and gray chert, some gray glauconitic speckled and black limestone and marcasite probably caved from above

400.0 405.0 Soft impervious soapy black shale pasty gray selvage, much marcasite, a trace of dull tan chert, strong sulphur water at 405 ft.

405.0 410.0 Dark and light brown crystalline shelly limestone with numerous openings, dull light gray and tan speckled chert, much marcasite

410.0 415.0 Firma gray white and tan speckled translucent and a little black chert, brown limestone, much marcasite

415.0 420.0 Brown, white and gray speckled translucent and a trace of dull white chert, some brown limestone, marcasite, a little dark brown jasperoid, a trace of tan and specks of Pb

420.0 425.0 Firma dull white and a little dull grayish-tan chert

Bottom

No samples taken.

2462 - 90 -
Hole BM-89 (continued)

Depth, Feet
From - To
395.0 400.0 Loose and open, few cuttings recovered of dark and light brown limestone, a very little chert, some marcasite, specks Pb
400.0 402.5 Loose dull brown, white and gray speckled silicified oolitic chert, a little black and brown limestone, some marcasite
402.5 405.0 Loose brown and gray silicified oolite and some gray translucent chert, a little black and brown limestone, marcasite, trace Zn
405.0 407.5 Fractured brown, tan and white partially translucent and a trace of dull white chert, much marcasite, a little dark brown jasperoid and dark gray limestone, trace Zn, strong sulphur water at 405 ft.
407.5 411.0 Fractured brown, tan and white partially translucent and a trace of dull white chert, much marcasite, a little dark brown jasperoid and dark gray and a little greenish glauconitic and black limestone, trace Zn, specks Pb
411.0 415.0 Firm brown, gray and some white translucent, a little dark brown jasperoid, a few little crevices, Zn shines
415.0 417.5 Loose fractured dull brown, white, tan and a little gray speckled chert, a little dark brown jasperoid, with disseminated Zn crystals, Zn shines
417.5 420.0 Fractured dull white and some gray and brown speckled translucent chert, recemented with a little dark brown sugar jasperoid, Zn shines
420.0 422.0 Fractured dull white and a little tan chert with much gray and brown glauconitic speckled chert and silicified oolite caving from above
Bottom
Four samples taken.

Analysis, Percent

<table>
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<tr>
<th>Depth, Feet</th>
<th>Sample</th>
<th>Depth, Feet</th>
<th>Sample</th>
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<td>From - To</td>
<td>Zinc</td>
<td>From - To</td>
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<td>405.0</td>
<td>0.60</td>
<td>411.0 415.0</td>
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<td>407.5</td>
<td>0.54</td>
<td>415.0 417.5</td>
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Hole BM-90

Coordinates: 15,540 N - 12,790 E

Started: 4/2/46
Completed: 4/2/46

Elevation of collar: 824 feet
von Trebra Tract (Kan.)

Water encountered at 362 feet
Water stands at 270 feet

Size of hole: 0-42 feet, 10 inch; 42-242 feet, 8 inch; 242-375 feet, 6 inch; 375-424 feet, 5 inch

Depth, Feet
From - To
0.0 33.0 Soil, gravel and clay
33.0 40.0 Sand, stream gravel and surface water
40.0 205.0 Shale
205.0 215.0 Hard sandstone
215.0 240.0 Shale
240.0 250.0 Gray Chester limestone, heavy pyrite to 242 ft.
250.0 260.0 Gray Chester limestone, a little gray chert
260.0 270.0 Soft gray speckled limestone, some gray chert
270.0 290.0 Gray limestone, a very little gray and light blue chert
290.0 315.0 Tan limestone, very light blue chert
315.0 520.0 Grayish-white limestone and chert
520.0 550.0 Gray and some bluish-gray chert with black shale seams
550.0 555.0 Pasty gray siltstone, shale and some sandy shale
555.0 550.0 Brown limestone, bluish-gray chert
550.0 555.0 Brown limestone, partially decomposed, shaly and earthy around blue chert nodules
555.0 560.0 Greenish-gray glauconitic, some brown and a little gray limestone, selvage and a very little gray and white chert
560.0 565.0 Very loose-few cuttings, large pieces of dark to light grayish-brown decomposed limestone, selvage, some white and light blue chert
565.0 567.5 Very loose, few cuttings, coarse pieces of silicified and dolomitized dark grayish-brown oolite, black and brown decomposed limestone, some dark gray chert and mud
567.5 370.0 Loose, few cuttings, black and dark limestone, black and a little gray and dull white chert, trace Zn, specks Pb
370.0 372.5 Loose gray and dull white chert, some black and brown limestone and black chert, fair Zn shines, specks Pb
372.5 375.0 Loose gray and dull white chert, some black and brown limestone and black chert, trace Zn, specks Pb
375.0 377.5 Firm gray, tan (translucent) and black chert, marcasite Zn shines, trace Pb
377.5 380.0 Hard gray, tan (partially translucent) and a little black chert, marcasite, trace Zn
380.0 385.0 Hard dull white, gray and some tan chert, trace Zn
385.0 395.0 Hard dull white and some gray and tan chert, faint trace Pb, specks Zn

2462
Hole BM-90 (continued)

Depth, Feet
From— To—

395.0 400.0 Gray and white partially translucent chert, trace jasperoid, faint trace Pb
400.0 405.0 Gray and tan and some white partially translucent chert, faint trace Pb
405.0 420.0 Dull gray and white chert, a very little gray limestone
420.0 424.0 Dull light gray and a very little dark brown chert and gray limestone, specks Zn and Pb

Bottom

Six samples taken.

Analysis, Percent

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<th>Depth, Feet</th>
<th>Zinc</th>
<th>Lead</th>
<th>Sample</th>
<th>Depth, Feet</th>
<th>Zinc</th>
<th>Lead</th>
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<td>370.0 372.5</td>
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<td>0.03</td>
<td>1/2</td>
<td>377.5 380.0</td>
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<td>372.5 375.0</td>
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<td>2/5</td>
<td>380.0 385.0</td>
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