

CHAPTER III.

HISTORICAL SKETCH OF MINING

The early history of mining in the Upper Mississippi valley readily resolves itself into two quite distinct phases. One relates almost wholly to the development of the lead industry; the other to the growth of coal-mining. The first had a fundamental influence upon the early settlement of the region and the establishment of routes of commerce which persists even to the present day. To the second main phase economic importance came later.

Champlain's far-sighted policy of winning the good graces of the Indians of western Canada rapidly bore fruit. By means of it the fur-trade of the Northwest was long retained by the French, almost to the complete exclusion of all other nations. Before the middle of the Seventeenth century French missionaries had already penetrated to the head of the Great Lakes and to the Mississippi river. In rapid succession traders established, at advantageous points, suitable, and often fortified, depots. Because of a lack of proper waterways to the westward the Upper Mississippi region was long the halting place of French advancement; although occasionally the hardy *coureurs des bois* passed on into the unknown country beyond, even to the Rocky mountains.

It has been long commonly regarded that the first mining within the boundaries of our state was undertaken by Julian Dubuque. It has been related, that in 1788 he began mining lead-ores on the west bank of the Mississippi river, in north-eastern Iowa, within the corporate limits of the present city bearing his name. Dubuque gave the place the name of "Spanish Mines," and the patent granted him by Spain eight years later thus distinguished the tract. The year 1788 is thus generally counted as the date of discovery of lead and zinc deposits in Iowa.

A century and a quarter has passed since Dubuque first began mining. It now appears than an even longer period had elapsed before Dubuque's time in which lead was taken out of Iowa-land. Moreover, the first knowledge and mining of lead in America belongs properly to the present Dubuque region. The circumstances surrounding this early development of the oldest industry of our State have at this time a special interest.

The mineral galena, the common ore of lead, occurring in bright sparkling masses, appears to have been known to the aborigines of the Mississippi valley long before the advent of white men. It is found in many tumuli of the so-called Mound-builders. It was brought in by the Indians to some of the very first French posts established in the region. In the first half of the last century the Sioux Indians of Minnesota and Iowa were accustomed to inlay with metallic lead in geometric designs their catlinite pipes. This was probably not a recently acquired accomplishment but had its origin in the long ago.

As early as 1634 Europeans had already penetrated nearly, or quite to the Mississippi river. In order to stimulate the hunting of the fur-bearing animals the French soon introduced the use of fire-arms among the Indians; and with it grew a strong demand for ammunition. As the traders garnered furs they also kept a sharp look-out for minerals suitable for moulding into bullets. Their Indian allies early conducted them to the district, long afterwards designated as the Dubuque country, where they found ample deposits of the mineral they so much sought. So rich proved the mines that they soon in fame surpassed even the fur-interests of the region.

The early history of lead-mining in northeastern Iowa is inseparably interwoven with that of southwestern Wisconsin and northwestern Illinois. Geologically there is only a single circumscribed field. The division of the lead-bearing country by the Mississippi river did not deter the early traders from dealing on both sides of the great stream. Even Julian Dubuque operated in Illinois as extensively as he did in Iowa.

The first white man to visit the lead region and to leave a record of his movements was a Frenchman by the name of Jean

Nicolet.⁷⁶ In the autumn of 1634, after having discovered Lake Michigan, this explorer entered Green bay, and passed up Fox river to the portage to the Wisconsin. Although he appears not to have actually passed over the portage or to have descended the latter stream to the Mississippi river, as Neil⁷⁷ and others have fancied, and thus reached the district in which the lead abounds, he seems to have made the Indians fully acquainted with the use of fire-arms. Whether he saw or even heard of lead among the Indians is not clearly recorded.

When, however, twenty years later (1655), Radisson and Grosseilliers⁷⁸ entered the region they visited among others the Mascoutin and other Indian tribes, in the vicinity of the present city of Dubuque. "In their country are mines of copper, of pewter, and of the lead. There are mountains covered with a kind of Stone that is transparent and tender, and like to that of Venice." This reference to pewter suggests that they also noted the occurrence of zinc. These travelers actually reached the Mississippi river and spent some time upon its banks.

Marquette and Joliet, in 1673, followed Nicolet's route to the grand portage of the Fox river, passed over to the Wisconsin river, thence down that stream to the Mississippi river and on to the latter's lower reaches. Marquette's Journal,⁷⁹ published sixteen years later, makes numerous references to the minerals of the Upper Mississippi valley. On his voyage down the great river he passed the lead region, where mining was perhaps going on, at least he must have had some direct knowledge of the location and product.

In 1687, Joutel⁸⁰ notes, that there were mines of lead in operation. Hennepin's map of the Upper Mississippi made the same year (1687) shows lead mines located near the present town of Galena, Illinois.

The evidence appears ample to sustain the contention that by the Indian fur-hunters and doubtless by many of the early French *voyageurs* who left no written record of their work, as

⁷⁶Shea: Discovery and Exploration of Mississippi Valley, p. 20, 1853.

⁷⁷History of Minnesota, p. 101, 1882.

⁷⁸Colls. State Hist. Soc. Wisconsin, Vol. XI, p. 93, 1888.

⁷⁹Jesuit Relations and Allied Documents, Vol. LVIII, p. 94, Cleveland, 1899.

⁸⁰Journal historique, Paris, 1713.

Mills has suggested,⁸¹ lead-ore was mined and smelted in a crude fashion in this region before the year 1650. This was about the same time that the actual mining of the mineral was undertaken in other parts of our country. Along the Atlantic border mining of lead-ore near Austinville, in Wythe county, Virginia, and at Middletown, Connecticut, commenced in 1650. In the same year lead-mining was first carried on in far away Pima county, Arizona. Thus, in the three most distant parts of our present National domain lead-mining was simultaneously begun.

Although Nicolas Perrot has been sometimes credited with the first discovery of lead-ore in the Upper Mississippi region, in 1682,⁸² the mineral had already been mined there for a quarter of a century, and perhaps for a very much longer period before. Perrot had been in the upper Mississippi region since 1675, when he passed up the Fox river.⁸³ In the succeeding five years he appears to have visited most of the western tribes of Indians. In 1681 he was engaged in the district in trading. It may be that he discovered lead at this time. He probably was acquainted with its occurrence and mining several years before he actually began operations and built his trading-post below the mouth of the Wisconsin river, at a point which appears to have been nearly opposite the present city of Dubuque. This was in 1690; and at the same time he opened mines and erected a furnace.⁸⁴ His sudden determination, as record shows, to engage in mining after the Pottawattamies had brought him samples of lead-ore from one of the small tributaries of the Mississippi river must have had other reasons than mere announcements of the discovery. Within three weeks after this occurrence he had built a post and had begun mining ore.⁸⁵ Franquelin's "Carte de l'Amerique Septentrionale," of 1688, already had mines located below the mouth of the Wisconsin river. According to the reports of the time "The lead was hard to work, because it lay between rocks and required blasting; it had very little dross and was easily melted."

⁸¹Boundaries Prov. Ontario, p. 6, Ottawa, 1877.

⁸²Irving: Trans. American Inst. Mining Eng., Vol. VIII, p. 498, 1879.

⁸³Stickney: Parkman Club Pub., No. 1, p. 5, Milwaukee, 1895.

⁸⁴Colls. Wisconsin State Hist. Soc., Vol. XIII, p. 273, 1895.

⁸⁵Parkman Club Pub., No. 1, p. 11, 1885.

During the same year lead was brought to Fort Crève Cœur, near the present site of Peoria, on the Illinois river, from the Indian mines on what is now known as the Galena river.⁸⁶ The earliest mining of lead on Iowa territory thus dates definitely back at least to the year 1690, and doubtless to a period before 1650.

Five years later one Le Gueur also located a trading-post on an island a few miles above Perrot's, where the lead from the neighboring hills was regularly brought.

By the end of the Seventeenth century lead-mining in the present Dubuque district had assumed considerable proportions on both sides of the river. This is well shown by the unusual activity displayed by Sieur Pierre le Sueur. As early as 1683, with the express view of establishing trade relations in the region, Le Sueur had, with Perrot, visited the Upper Mississippi country. After spending several years in exploratory effort.⁸⁷ in this region, he was finally, ten years later, made commandant at Chequamegon bay. His trading-post, built in 1695, on Isle Pelée, in the Mississippi river, above Lake Pepin, became, according to Charlevoix, the center of commerce for the western parts.

During his residence of a decade and a half in this region Le Sueur had become acquainted with its mining possibilities, particularly of the lead, copper and green-earth. First knowledge of the latter he perhaps derived from some associates of La Hontan, who in the winter of 1688-9, had gone up the mythical Rivière Longue—probably the present Cannon river and the upper reaches of the Minnesota river together—and doubtless had discovered the large deposits of green shales so prominently displayed at the mouth of the present Blue Earth river. The locality was in the country occupied by the Aïouez (Toway) Indians.

At all events Le Sueur returned to France and succeeded in gaining from the King a commission to open the mines. Finally joining interests with D'Iberville, he got back with a numerous body of miners to the New World in 1699. The carpenter of

⁸⁶Hunt's Merchant's Magazine, Vol. XVIII, p. 285.

⁸⁷Shea: Early Voyages Up and Down the Mississippi, p. 89, Albany, 1861.

the expedition was named Penicaut, who was also the narrator. Margry⁸⁸ refers to Penicaut's account of the lead region as follows: "We found both on the right and left bank the lead-mines, called to this day the mines of Nicolas Perrot, the name of the discoverer." The Galena river is alluded to as the Rivière a la Mine; and a league and a half upstream was found a mine on the prairie. This was in August 1700.

The important point to note in the present connection is that the Le Sueur party found lead mines opened and in operation on the west bank of the Mississippi on what is now the site of the city of Dubuque. This was 80 years prior to the reputed first finding of lead in Iowa-land by the wife of Peosta, warrior of the Fox Indians, who eight later transferred her rights to Julian Dubuque.

Le Sueur wintered at the mouth of the Blue Earth river, where he built a stockade which he named Fort l'Huillier, after one of the King's chief collectors, who had assayed the ore in 1696. With the opening of spring, Le Sueur, having extracted a quantity of ore, placed 4,000 pounds aboard his boats, descended the Mississippi river and returned to France. He appears also to have discovered some lead-ore farther up the Mississippi river than any mines then opened, at a point which corresponds to the present site of the town of Potosi, Wisconsin. Here he extracted a quantity for his own immediate use.

Probably taking advantage of the information imparted by Le Sueur, as well as of that indicated on Hennepin's map of 1687, De l'Isle's map of Louisiana, published in 1703, notes the location of lead-mines at both the present sites of Galena and Dubuque. The "Map of North America," published in London, in 1710, by Senex, also records the presence of lead-mines on both sides of the Mississippi river at the Dubuque point.

The famous Crozat patents only incidentally effected the Upper Mississippi region, as all efforts at mining were confined to the Missouri district. These patents from Louis XIV were issued in 1712. In the present connection they are of interest only for the fact that they granted for a term of fifteen years a complete monopoly of trade and mining in Louisiana. Special

⁸⁸Mém. et doc. pour servir la l'histoire des origines Francaises des pays d'outre-
mere, t. V, p. 412.

privileges applied to the discovery and operation of mines, among which, the rights were granted in perpetuity. Little advantage was taken of the patents by Crozat himself, no mining was begun, and he soon transferred his interests, in 1717, to the "Company of the West", which was at that time under the guidance of John Law.

Le Guis, in 1743, found a thriving mining camp on the present Galena river,⁸⁰ some twenty mines being in operation in this locality alone. Bauche's "Carte physique de Canada," published in 1752, has located upon it the Upper Mississippi lead-mines. Gütard⁹⁰ at this time described the mines as very rich.

At the end of the Seven-years' war between England and France, in 1762, the latter ceded to the former, Canada, together with all her possession east of the Mississippi river. A short time before France also turned over to Spain all of her possessions west of the river. A notable and immediate result was the complete diversion of the French trade of the Upper Mississippi region from its eastern course to the St. Lawrence to a southern direction. British traders pushed westward to the limits of the newly acquired English possessions and beyond.

In 1766, Jonathan Carver⁹¹ reached the Upper Mississippi lead-field by the Wisconsin River route. He locates on his map important lead-mines at the Blue mounds, in Wisconsin, in the largest hill of which were extensive mineral deposits. In the chief town of the Sac Indians, large bodies of lead-ores were also noted. Carver returned by the Wisconsin river and the Great Lakes to Boston, and thence to England, where he made arrangements for another expedition to the interior of America. In 1774 all preparations being completed the party was about to set out, when England's trouble with the colonies compelled the abandonment of the project.

Previous to the year 1769 there had been, in the Mississippi valley, no individual concession of lead-lands granted. On July 5 of that year, one Martin Miloney Duralde filed an application for a tract three arpents wide and the usual (40 arpents) deep,

⁸⁰Wallace: Illinois and Louisiana under French Rule, p. 274, Cincinnati, 1893.

⁹⁰Hist. de l'Acad. Royale des Sciences, Paris, p. 189, 1752.

⁹¹Travels through Interior Parts of North America, in years 1766-8, p. 47, Dublin, 1779.

along what is now the Galena river, across the Mississippi from the present site of the city of Dubuque. The grant was signed by Louis St. Ange de Bellerire, the captain-commandant of the Illinois; and by Joseph Labuxière "attorney of the attorney-general, judge, etc., of the royal jurisdiction of the Illinois for the French." In that day it was the custom for the Spaniards to confirm all French land-grants. Duralde appears never to have taken up his tract of lead-land, perhaps for reason of the fact that he soon found that it was located on English territory.

Although the first mining⁹² within the limits of the present state of Iowa is commonly stated to have begun in the year 1788 and first operations ascribed to Julian Dubuque, Le Sueur, almost a century before, found lead-mining thriving on the west bank of the Mississippi, while both white-man and Indian had probably engaged in taking out ore from the district for more than half a century longer. Schoolcraft,⁹³ who visited the Dubuque lead-region in 1820, states that Dubuque's rich discoveries of lead-ores were made by the wife of Peosta, a warrior of Kettle Chief's band of Foxes. This reputed discovery has a tinge of romance as well as a dash of Twentieth Century business method.

As already stated, mining in the vicinity had been in progress for more than a hundred years and was in a very flourishing condition when Dubuque appeared upon the scene. He sought not only to mine lead as others were doing but he endeavored to control the industry. Born in Canada, of Norman parentage, he is described as a man of wonderful energy and singular popularity among the Indians. By divers machinations he secured from the full council of Fox and Sac Indians permit peacefully to operate the mines. Thereby he established a monopoly of all lead-lands on the west side of the Mississippi river. Later (in 1796) he had the Indian grant confirmed by Carondelet, governor of Louisiana, under the title of the "Mines of Spain." Soon, on the east side of the river, the entire lead-bearing districts of what are now Wisconsin and Illinois, were in the hands

⁹²Leonard: Iowa Geol. Surv., Vol. VI, p. 15, 1897; also, Calvin and Bain, *Ibid.*, Vol. X, p. 481, 1900.

⁹³Narrative Journal of Travels to Northwest and Sources of Mississippi River, etc., p. 348, Albany, 1821.

of Dubuque's men. He built and operated the furnaces. He conducted extensive prospecting parties. He controlled the boats which carried the product down the river to market. In gaining absolute supremacy over the lead industry he displayed remarkable talent. For whatever lead-ores he purchased he established the rate. In market he fixed the price of the refined product. He tickled the fancy and touched the pride of the governmental powers by calling his properties the "Mines of Spain."

Dubuque continued actively in the business of mining and smelting of lead and of the buying and selling of furs until the day of his death in 1810. It was his custom to make two trips a year to St. Louis to market his various products. Until quite recently the ruins of two of his lead-furnaces were still visible in the city bearing his name—one on Eagle Point avenue, near Heeb's brewery, and the other between Main street and the Mississippi river. A third furnace was located south of the city-limits at the mouth of Catfish creek. His residence was nearby, in Kettle Chief's village. After Dubuque's death the Indians burned his house and destroyed all his improvements; but they continued to mine and smelt the lead-ores.

When, in 1803, Spain traded back Louisiana to France, who immediately sold it to the United States, the latter at once sent out exploring expeditions. With a small detachment of 20 soldiers Lieut. Z. M. Pike was dispatched to the Upper Mississippi region. Pike left St. Louis late in the summer of 1805. Of the two objects which he accomplished one was the investigation of the "lead tract," and the other was the pulling down of the British flags which were floating over a number of posts in that region. He found Dubuque "polite but evasive." While Dubuque received the distinguished visitor and his party with a salute from a field-piece, and lavishly entertained him, it was discovered that there were no horses with which to visit the mines which were said to be a considerable distance away. Consequently Pike who was ill at the time did not actually see the mines, and had to content himself with asking questions.⁹⁴ According to Dubuque's statement he annually produced from

⁹⁴Exploratory Travels to Sources of the Mississippi, etc., p. 13, London, 1811.

20,000 to 40,000 pounds of lead. These figures were doubtless much too small; since from other authentic sources it is now known that during the last years of his life more than ten times this amount of the metal was shipped yearly to St. Louis, the greater part of it being transported by his own agents and received by his partners in the business, for at this time Auguste Chouteau had already acquired a half interest in the undertaking. The latter also had made an agreement, which both signed, to the effect that all of the Dubuque grant should pass to him at the death of the original grantee. In after years the Federal government refused to recognize the Chouteau claim, the ground taken being that both Indians and the Spanish governor Carondelet gave Dubuque simply permission to work the mines and that this permission was personal to him. There was in the Spanish grant no provision for a survey of the land, nor were other forms customary in making a valid grant followed. Dubuque's original request for "peaceable possession of the mines" was merely endorsed, "granted as asked" (conedido como so solicito.) Long litigation resulted which after being vigorously contested for over forty years and being carried up to the Supreme court of the United States, was finally decided, in 1853, in favor of the Government. This was not only Iowa's greatest case of mining litigation, but one of the famous suits of the country.

In 1807 the United States government announced a new policy respecting the development of the public mineral lands. Such lands were reserved; in Iowa 184,320 acres being thus set aside. A system of leases was ordered, whereby individuals were permitted to extract mineral for a period of three or five years by paying to the Government a royalty of ten per cent.

During the years immediately following the promulgation of the new ruling large numbers of prospectors and miners entered the region; but they made agreements with the Indians rather than with the Government. It was not until 1816 that the Indian rights were definitely defined and the "tract five leagues square on the Mississippi river to be designated by the President" which the Indian treaty provided, was located in the lead region. The first leases from the Government were not executed until the beginning of 1822, when four miners from

Kentucky located 160 acres each. They were protected by a detachment of United States soldiers.

As the Government, after granting leases failed often to stand by the owners thereof continuous strife prevailed among the miners. Soon they began to pay little attention to the regulations, but carried on operations without license and with the aid of the Indians. Where there was one lease granted there were a score of unlicensed miners. So disastrous to all concerned was the experiment of leasing and so inconsequential was the revenue derived from this source that Congress finally, in 1846, abandoned the plan and a year later placed the lands on the market for sale.

Little wonder that during these years such remarkable industry was displayed by the "Indians," as was from time to time reported.

During the decade which elapsed between the date of Dubuque's death and the destruction of his properties in 1810, and Schoolcraft's visit to the lead-mines, in 1820, lead-mining seems not to have languished much. Nicholas Boiloin, a United States Indian agent who passed through the region in 1810, reported to the Government that the Indians were finding mining more profitable than hunting and were producing during that year 400,000 pounds of the metal. Doubtless many others than Indians, of whom no mention is made⁹⁵ were also engaged in mining. At any rate, a Henry Shreeve, in 1810, is reported to have returned from the Dubuque region to St. Louis with a boat-load of lead. It is also known that one George Jackson, a miner, who had come up the river from Missouri, established in the following year a lead-furnace on an island opposite the mouth of Catfish creek⁹⁶ (Dubuque's residence site), and took his product by boat to St. Louis. The next year he was joined by one John Miller. There were other white men engaged in this traffic at this time.

A few years later, in 1815, John Shaw began to make frequent trading trips up the Mississippi river from St. Louis. He is said often to have reached the lead region, and to have carried

⁹⁵Coll. Wisconsin State Hist. Soc., Vol. XI, p. 252, 1888.

⁹⁶Hist. LaFayette County, Illinois, p. 394, Chicago, 1881.

back considerable cargoes of metal, one of which contained nearly 150,000 pounds. In the following year George Davenport, who afterwards took up his residence near the Rock Island, conducted the first flat-boat laden with lead to the Lower Mississippi markets.

Notwithstanding the fact that in 1819 on the east side of the Mississippi river the lead-industry was enjoying prosperity and receiving as newcomers a number of Americans, the west side was closed to their claims, because of the Government's ruling reserving that part of the district for the Indians. At this time Forsyth, the United States Indian agent for the Foxes and Sacs, notes in his journal⁹⁷ the extent of the mining. The number, situation, and quality of all the lead-mines between Apple creek and Prairie du Chien are as follows: "The first he places about 15 miles up Apple creek, 'a short mile' from the right bank; the next at Red Hawk's village, 'six miles above the Grand Macoutely' [Maquoketa] on the west side of the Mississippi, but this had been abandoned; the next, four miles up Fever creek [Galena river], on both sides of that stream, flat-boats being able to approach within a mile and a half of the mine, the fourth, six miles above the mouth of the Fever river, on the east side of the Mississippi; the fifth, Dubuque's mines, 'too well known to require any description'; the sixth, 15 miles above the Dubuque mines on the west bank of the Mississippi, six miles up the 'Little Macoutely creek'; the seventh, six miles above the Little Macoutely, but on the east side of the Mississippi; he adds that 'There are many other lead-mines on the Ouisconsin river, but my informant says he never was at any of them.' "

During this year, and for several years following, the flat-boats and keel-boats loaded with lead for St. Louis were frequent sights on the Mississippi river. One James Johnson's boats were particularly numerous.

Schoolcraft, who was the chief narrator of Governor Cass' exploring expedition sent out from Detroit to the Upper Mississippi region in 1820, was particularly attracted to the Dubuque lead-mines. His description of them is the first really intelligent

⁹⁷Coll. Wisconsin State Hist. Soc., Vol. VI, p. 194, 1872.

one of which there is record.⁹⁸ Among many other interesting facts he states that:

“The district of country generally called Dubuque’s lead-mines, embraces an area of about twenty-one square leagues. Commencing at the mouth of the Little Maquanquitous river, sixty miles below Prairie du Chien, and extending along the west bank of the Mississippi seven leagues, commencing immediately at the Fox village of the Kettle chief, and extending westward. This is the seat of the mining operations formerly carried on by Dubuque, and of what are called the Indian diggings. The ore found is the common sulphuret of lead, with a broad foliated structure and high metallic lustre. It occurs massive, and disseminated, in a reddish loam, resting upon limestone rock, and sometimes is seen in small veins pervading the rock, but it has been chiefly explored in alluvial soil. It generally occurs in beds or veins which have no great width, and run in a certain direction 300 or 400 yards,—then cease, or are traced into some crevice in the rock, having the appearance of a regular vein. At this stage of the pursuit most of the diggings have been abandoned and frequently with small veins of ore in view. No matrix is found with the ore which is dug out of the alluvial soil, but it is enveloped by the naked earth, and the lumps of ore are incrustated by an ochereous earth. Occasionally, however, some pieces of calcareous spar are thrown out of the earth in digging after lead, and I picked up a solitary specimen of the transparent sulphate of barytes, but these substances appear to be very rare. There is none of the radiated quartz, or white, opaque heavy spar, which is so common at the Missouri mines. The calcareous rock upon which this alluvial formation, containing lead ore, rests, appears to be referable to the transition class. I have not ascertained its particular extent about the mines. The same formation is seen, overlaid by a distinct stratum of compact limestone, containing numerous petrifications, at several places between the mines and Prairie du Chien. The lead ore at these mines is now exclusively dug by the Fox Indians, and, as is usual among savage tribes, the chief labor devolves upon the women. The old and superannuated men

⁹⁸Narrative Jour. Trav., etc., to Sources of Mississippi River, p. 343, Albany, 1821.

also partake in these labors, but the warriors and young men, hold themselves above it. They employ the hoe, shovel and pickaxe, and crow-bar, in taking up the ore. These things are supplied by the traders, but no shafts are sunk, not even of the simplest kind, and the windlass and bucket are unknown among them. They run drifts into the hills so far as they can conveniently go without the use of gunpowder, and if a trench caves in it is abandoned. They always dig down at such an angle that they can walk in and out of the pits, and I descended into one of these which had probably been carried down for forty feet. All this is the work of the Indian women and old men, who discovered a degree of perseverance and industry, which is deserving of commendation. When a quantity of ore has been gotten out, it is carried in baskets by the women to the banks of the Mississippi, and then ferried over in canoes to the island, where it is purchased by the traders at the rate of \$2 for 120 pounds, payable in goods sold. At the profits at which these goods are usually sold it may be presumed to cost the traders from 75 cents to \$1, cash value, per 100 weight. The traders smelt the ore upon the island, in furnaces of the same construction used at the lead mines of Missouri, and observe that it yields the same per centum of metallic lead. Formerly the Indians were in the habit of smelting their ore themselves, upon log heaps, by which a great portion was converted into what are called lead-ashes, and thus lost. Now the traders induce them to search about the sites of the ancient fires, and carefully collect the lead ashes, for which they receive \$1 per bushel delivered at the island, payable in merchandise."

About this time (1822) a Moses Meeker was conducting important mining operations on the east side of the Mississippi river. Fifty years afterwards he recorded⁹⁹ his interesting experiences, and the facts of his connection with the early affairs of the mines.

A year later, 1823, the first steamboat from St. Louis arrived at the Dubuque mines. It was a vessel 118 feet long, and 22 feet wide, and 2,000 tons burden.¹⁰⁰ On board was a passenger by the

⁹⁹Coll. Wisconsin State Hist. Soc., Vol. VI, p. 271, 1872.

¹⁰⁰Beltrami: Pilgrimage in Europe and America, Vol. II, p. 127, London, 1828.

name of J. C. Beltrami, a former judge of a royal court in the ex-kingdom of Italy, who was on his way to St. Anthony's falls and the Northwest. He writes at some length of the lead industry on both sides of the river.¹⁰¹

During this year the Dubuque mines were producing over one-fourth of the total output of the district, or about 1,000,000 pounds of pig-lead.

In 1826 the United States superintendent of lead-mines, a Lieutenant Thomas, reported to Congress that during the year ending June 30, there were over 410 persons engaged in mining in the Fever River district (Illinois).

Notwithstanding the unsettled conditions of the mining industry on the west side of the Mississippi river the first attempts to regulate their relations among themselves were made by the miners in 1830. In June of that year a number of them met near Dubuque, and agreed, among other things, that "every man shall hold 200 yards square of ground by working said ground one day in six."

For a period of twenty years after Dubuque's death the lead-lands were generally regarded as private property, and little systematic mining was carried on there by white men. The miners and settlers who resided on the grant through permission of the Dubuque assigns and Indians were, in 1830, driven out and their cabins burned by the United States troops. The Government asserted its control to these lands as a part of the Louisiana purchase, but claimed that they still belonged, according to treaty, to the Indians, and that therefore they were not open to settlement. After the close of the Black Hawk war and the purchase of the lands from the Sacs and Foxes all claims of the former settlers were ignored by Congress and the lands sold in the regular way. In June 1833, the treaty went into effect, and all Spanish and Indian titles having been quieted large numbers of miners entered the district and began active operations in extracting the ores.

In an account of travels, published in 1833, Caleb Atwater,¹⁰² who visited the Upper Mississippi region at this time, described

¹⁰¹Ibid., p. 163 et seq.

¹⁰²Description of Antiquities Discovered in Western Country, etc., p. 355, Columbus, 1833.

the mining activities of the Dubuque district and brought away full statistics. He observed that the product "had to be carried to the Atlantic cities and had reduced the price of lead in all its forms one-half." In the mineral country it was selling at one cent a pound. He expressed the opinion that these are the richest lead mines in the known world.

Featherstonhaugh,¹⁰³ who undertook a canoe-trip down the Mississippi river, in 1835, stopped at Dubuque. He noted a marked difference between the character of the lead-ore of this region and that of Missouri. "When the present veins are exhausted, shafts will be sunk still deeper. There is in fact good reason to believe that the whole distance between the lead-mines of Missouri and those of Dubuque's is comprehended in the Galeniferous formation."¹⁰⁴ This notion of the continuity of the Missouri and Iowa lead deposits was one which seems to have been widely held at this time and for many years after. It appears to have originated a decade and a half previous in an argument by Schoolcraft.

Lea (Albert) states¹⁰⁵ that at this time a dozen steamboats plied regularly between St. Louis and the lead-mines, the voyage taking three days.

The dozen or fifteen years following the close of the Black Hawk war and the throwing open of the Dubuque district to settlement, witnessed a tremendous development in the mining of lead-ores. During this period improved smelting methods, better transportation facilities, and the beginnings of the manufacturing of lead-products were some of the factors greatly stimulating the industry.

The old and crude log-furnaces and ash-furnaces began to be discarded. In 1834 a cupola-furnace was erected by Peter Lorimer at the mouth of the Catfish creek, in south Dubuque—the first structure of the kind built in the state. In the following year two others were constructed—one in the town of Dubuque and the other on the Little Maquoketa river. In this year, also, the first Scotch-Hearth furnace erected in America was built

¹⁰³Rept. Geol. Reconnaissance to Coteau du Prairie, p. 158, Washington, 1836.

¹⁰⁴Ibid., p. 159.

¹⁰⁵Notes on Wisconsin Territory, particularly with reference to Iowa District, or Black Hawk Purchase, p. 16, Philadelphia, 1836.

midway between Dubuque and Mineral Point, Wisconsin. Soon after, the second in this country, and the first in Iowa, was erected on the Catfish creek, above Rockdale, in Dubuque county. This was the Watter's furnace; and it is still in operation (1912). This was followed by several others in the vicinity of Dubuque, of which the Brunskill and the Simpson were the best known.

The next few years in the Dubuque lead-region were marked by a rapid multiplication of modern furnaces. By 1840, when the census of Wisconsin was taken, there were in that state alone fifty smelters yielding over 15,000,000 pounds of metal.¹⁰⁶ Owen¹⁰⁷ gives the output of the Iowa part of the district for the preceding year at over 3,000,000 pounds of the refined product. The production of lead in the Upper Mississippi region continued to increase until it reached, in 1857, a total of more than a half million pigs (36,000,00 lbs.) Separate statistics for the Dubuque district do not exist. The lead receipts at New Orleans, during the two decades under consideration are instructive. The increase from 1836 to 1846 was from 295,000 to 785,000 pigs.¹⁰⁸ Receipts then rapidly declined until 1857, when they fell to 18,000 pigs practically extinguishing the trade for that city.

During the later years mentioned lead-receipts at St. Louis also sank. In 1857, at that city and New Orleans together, only 200,000 pigs were shipped, a considerable part of which was from the Upper Mississippi region, but the production of the latter district and of Missouri amounted to more than 485,000 pigs,¹⁰⁹ showing the large output of the more northern country that was being shipped east by way of the Great Lakes instead of south, as formerly, by river.

Already, in 1852, the mines of the Upper Mississippi valley were producing annually over 26,000,000 pounds of metal; which amount was nine-tenths of the total production in the country for that year, and ten per cent. of the world's supply.

¹⁰⁶Hunt's Merchants' Magazine, Vol. X, p. 552, 1840.

¹⁰⁷Twenty-sixth Cong., 1st Sess., Ex. Doc., Vol. VI, p. 39, 1840.

¹⁰⁸Hunt's Merchants' Magazine, Vol. XVI, p. 96, 1847.

¹⁰⁹Hunt's Merchants' Magazine, Vol. XL, p. 244, 1858.

The first shot-tower in the United States was built at Herculaneum, on the Joaquin river, south of St. Louis, in 1809. Others were soon erected nearby, and in St. Louis. The shot-tower at Helena, on the Wisconsin river near the present town of Hillside, was established in 1833, and gave great impetus to the lead mining industry of the entire Upper Mississippi region. From this time on much lead went east to the markets as shot.

The main stimulus to the mining of lead during the quarter of a century immediately preceding the Civil war was due to betterment of transportation facilities from the Upper Mississippi country to the Atlantic sea-board. In 1841 newspapers of the day report a freight-rate for lead of 93 cents a hundred pounds from the river to the lake at Milwaukee, and a rate from the latter point to New York of 50 cents a hundred. This was a saving of 25 per cent over the New Orleans route. Later this rate was further reduced.

The early change of trade-routes in 1763, from the Dubuque lead-district from an easterly direction to Montreal to a southerly direction by the Mississippi river was wholly political in character. The change back a century later was strictly commercial.

As early as 1822 lead from the Dubuque district was again finding its way up the Wisconsin river to the Portage and thence down the Fox river to Green Bay. From the latter place it was carried by boat to Detroit.¹¹⁰ Another forerunner of the new diversion of trade was the purchase, three years after its construction, of the Helena shot-tower by Buffalo, N. Y., merchants. Five years after, when the tolls on lead on the Erie canal were greatly reduced,¹¹¹ nearly 2,000,000 pounds of bar-lead and 2,614 kegs of shot reached New York in one year from Milwaukee alone.¹¹²

Another factor which contributed to the change in the routing of lead directly to eastern markets was the unsatisfactory condition of navigation at several points in the Mississippi river. Low water in the stream often prevented shipments from passing the Des Moines rapids for periods of two or three months.

¹¹⁰Philadelphia National Gazette, Oct. 19, 1822.

¹¹¹Lapham: Wisconsin, p. 46, 1846.

¹¹²McLeod: History of Wisconsin, p. 216, 1846.

In this respect the year 1839 was particularly disastrous. Lack of good facilities for navigation on the Mississippi river might not have turned the course of trade; but being sorely felt by the tradesmen at the same time that other excellent routes were reaching out for business the transformation was rapid, complete, and for all time. The year 1847 may be taken as marking the loss of supremacy by the Mississippi route and the completed ascendancy of the Great Lakes way in the lead-trade.

Still another factor joined in sounding the death knell of the southern route. This was the advent of the railroad. By 1850 railroad construction had already started out vigorously westward from the shores of the Great Lakes. Within a decade nearly 5,000 miles of road had been laid and placed in operation in the states of the Upper Mississippi valley. For securing a suitable tonnage the lead-district was one of the first objective points.

With the periods of great prosperity in lead-mining there have come at times declines. In 1846 the McKay tariff-bill, passed by Congress, whereby the prevailing duty of three cents per pound was reduced to 20 per cent. *ad valorem*, depressed the market for a short time. The output did not begin to sink until two years later.

In the next decade lead-mining was profoundly affected by the discovery of gold in California. For a time the mines were all but deserted by the men who fancied richer fields. The industry slowly recovered during a period of years. The mining of zinc-ores helped. In Wisconsin zinc began to reach market in 1860; in Missouri about ten years later. In 1880 the first zinc-ore mined on the west side of the river in the Dubuque district was shipped to Benton, Wisconsin. This was from the McNulty mines, at the head of Julian avenue. Since then many other old lead-mines have been reopened and worked for the zinc-ores which were left untouched when the lead was being taken out.

Later, with the fall in the price of silver and the consequent closing of many of the lead-silver mines of the Rocky Mountain region, attention was again directed to the soft-lead de-

posits of the Mississippi Valley. But the region to-day is more important as a zinc-field than as a lead producing district.

Beginning with the early days of its prosperity and continuing down to the present time the lead-region has been a constant interest to those who would know of the manner of the occurrence and origin of ore deposits. During the half-century a number of important descriptions of the lead-bearing formations have appeared. In 1835 Featherstonhaugh, the government expert, visited the Dubuque mines.¹¹³ The United States geologist, D. D. Owen, investigated the field in 1839,¹¹⁴ a revised edition of this report, with numerous illustrations, appearing four years later. This examination was preparatory to a plan for the sale of the public mineral-lands by the Federal government. It was one of the first, and at the same time the best scientific mineral inquiries undertaken in the country up to this time. This is the first real description of the geologic occurrence of the lead-ores, the detailed manner of extraction of the ores, and the location of the mines. As a result of his investigations Owen pronounced¹¹⁵ the district surveyed as "one of the richest mineral regions, compared to its extent, yet known in the world."

Owen definitely associated the ore deposits with a particular geologic formation, probably the first serious attempt of the kind ever proposed in the country.¹¹⁶ It was observed that the productive fissures (crevices) generally extended in an east and west direction.

In this year (1839) the four smelters at Dubuque produced about 3,000,000 pounds of the metal.

Owen noted¹¹⁷ at this time that thousands of tons of zinc ores were lying on the dumps around the lead-mines; and he suggested ways of using this refuse. With keen scientific foresight he anticipated by a generation the commercial demands of the industry. In after years these rejected zinc-ores were gathered up and sent to the smelteries. Zinc-mining finally became more important than lead-mining.

¹¹³Rept. Geol. Reconnaissance to Coteau du Prairie, etc., p. 158, Washington, 1836.

¹¹⁴Twenty-sixth Cong., 1st Sess., House Rep. Doc., No. 239, 161 pp., 1840.

¹¹⁵Ibid., No. 407, p. 8.

¹¹⁶Schoolcraft's and Featherstonhaugh's previous attempts were merely guesswork, and not based upon broad observations and detailed correlations.

¹¹⁷Loc. cit., p. 51.

James Hodge, in 1842, visited the Upper Mississippi lead-fields, and gave¹¹⁸ a concise account of his observations there.

By Owen the Chippeway Land district was also surveyed and reported upon in 1847.¹¹⁹ Two years later he made a further report¹²⁰ on the geology of the Northwest, in which the Dubuque lead-mines are again described.

The investigations¹²¹ of J. G. Percival, in 1854, were confined mainly to the Wisconsin part of the lead-field. This observer was the first correctly to recognize the presence of faults in this district, and their function in the localization of the ore-bodies.

In his "Metallic Wealth of the United States" J. D. Whitney gave the results of his professional examinations in the Dubuque region.¹²² This outline was afterwards greatly elaborated successively in each of the three states of Iowa,¹²³ Wisconsin,¹²⁴ and Illinois.¹²⁵

Whitney observed,¹²⁶ as early as 1855, the occurrence of considerable deposits of the carbonate and silicate of zinc in the Ewing mines, on the Little Maquoketa, a few miles northwest of Dubuque.

Actual mining of zinc-ores on a commercial basis was commenced in 1860 near Mineral Point, Wisconsin. The production steadily increased in the region, until the ores of this class became the principal mineral mined. The same year the first zinc-smelter in the West began operations at La Salle, Illinois. From that time to the present day this plant received its chief supplies of ores from the Dubuque district. Twenty years elapsed before zinc-ores were first mined for the market in Iowa.

White's inspection of the Dubuque mining district, in 1867,¹²⁷ notes signs of a decided revival of the lead-mining industry after a considerable period of stagnation.

¹¹⁸Am. Jour. Sci., (1), Vol. XLIII, p. 55, 1842.

¹¹⁹Thirtieth Cong., 1st Sess., Sen. Ex. Doc., No. 57, 134 pp., Washington 1848.

¹²⁰Rept. Geol. Sur. Wisconsin, Iowa and Minnesota, 638 pp., 1852.

¹²¹Geol. Surv. Wisconsin, Ann. Rept., 1855; also, *Ibid.*, Second Ann. Rept., 1856.

¹²²Metallic Wealth of United States, pp. 403-417, Philadelphia, 1854.

¹²³Geology of Iowa, Vol. I, p. 422, 1858.

¹²⁴Geology of Wisconsin, Vol. I, p. 73, 1862.

¹²⁵Geol. Surv. Illinois, Vol. I, p. 153, 1866.

¹²⁶Geology of Iowa, Vol. I, p. 470, 1858.

¹²⁷Rept. Geol. Surv. Iowa, Vol. II, p. 339, 1870.

Investigations in Wisconsin by Strong,¹²⁸ and by Chamberlin¹²⁹ refer only incidentally to the Iowa part of the mining-field.

Recently various members of the Iowa Geological corps examined in detail all the lead and zinc mines at present operating in the state. Calvin¹³⁰ described those of the Oneota limestone of Allamakee county. Leonard¹³¹ gave a very complete general account. Calvin and Bain¹³² summarized the present developments of Dubuque County deposits. Leonard¹³³ noted some new developments in Clayton county.

In the mineral industry the economical preparation of the ores for the artisan, after they have been extracted from the earth, is a process as important and as essential to general success as the mining itself. Especial interest attaches to the metallurgical treatment of the lead-ores as practiced in the Dubuque district for so many years from the fact that its history is really a history of lead-smelting in America. In the following notes on the subject the earlier descriptions of the methods are derived mainly from Schoolcraft, while the later phases are taken partly from Bain. On account of the long and intimate relationships of the Ozark and the Dubuque districts comparisons are instituted with the Missouri methods as described by Robertson. To these three sources of information reference may be made for fuller details.¹³⁴

The primary object of ore-smelting being the separation of the pure metal from the dross the process is essentially a chemical one and the various metallurgical functions have for their result the same chemical reactions. In the case of the sulphide-ores of lead, or galena, the preliminary procedure is their oxidation, or "roasting" as it is technically termed, and this is followed by reduction. In details the method of arriving at these reactions varies with the purity and richness of the ores, the magnitude of the operations, the kind and quantity of available fuel, and the sort of necessary accessory materials used in the smelting, or fluxes.

¹²⁸Geology of Wisconsin, Vol. II, p. 643, 1877.

¹²⁹Ibid., Vol. IV, p. 365, 1882.

¹³⁰Iowa Geol. Surv., Vol. IV, p. 103, 1895.

¹³¹Ibid., Vol. VI, p. 9, 1896.

¹³²Ibid., Vol. X, p. 480, 1900.

¹³³Ibid., Vol. XVI, p. 298, 1906.

¹³⁴View of Lead Mines of Missouri, etc., New York, 1819. Iowa Geol. Surv., Vol. X, p. 589, 1900. Missouri Geol. Surv., Vol. VI, p. 199, 1894.

To accomplish these reactions on a large scale various types of furnaces are used. These several types are known as the Log-hearth, the Reverberatory, the Scotch-hearth, the Cupola, and a combination of some of these. During the early stages of the industry in the Dubuque district the simple log-hearth was used. With this primitive affair was smeltered the great bulk of the lead-ores prior to the year 1834. In Missouri this type was discarded some years sooner than in Iowa. In some shape or other it served in the region during a period of nearly two centuries. In reality it is only an improved form of camp-fire surrounded by a wall. Commonly the furnace was constructed on a steep hill-side. Three large logs were rolled into the enclosure the ends resting on the side-ledges. Small split-logs were then set up vertically around and the ore in masses of 15 pounds weight was piled on top, 5,000 pounds being regarded as a large charge. The whole was then covered with wood and the fire started. This was kept low, so that the ore could be thoroughly roasted during a period of about twelve hours. For a like period a stronger heat was maintained during which process the metal flowed out into a basin in front. Frequently the process was not complete within the usual time, when another period of twelve hours was required. Compared with modern practise the method was wasteful, only about fifty per cent of the metal in the ore being recovered.

After the accumulation of a considerable quantity of the "lead-ashes" the latter were broken up rather finely, washed, and put into the ash-furnace for further treatment. The ash-furnace was built of limestone usually, with a long sloping flue. It was arranged so as to receive the ashes of lead, or residue, from the log-furnace. Since these ashes were already more or less completely oxidized further roasting was dispensed with and the charge at once submitted to a moderately high temperature and reduced, the charred wood in the residue assisting. The broken and washed ashes were charged into the door at the far end of the furnace, with a quantity of sand or crushed flint in alternate layers, and as fast as well-heated were shoved further in until the full charge was made. After about two hours' time the furnace was ready for tapping. The slag was removed first,

then the lead, on opposite sides of the furnace. As a general thing a good ash-furnace produced 25 tons of metal before it was discarded or rebuilt. Later it underwent improvement so that before its complete extinguishment in the business it often ran three times this quantity.

Another form of the reverberatory type of furnace, which was largely used and which was more effective than the ash-type, was what is widely known as the air-furnace. It was generally built of stone, sometimes of brick and lined with fire-clay. The hearth was commonly nine to ten feet long, and three to four feet in width at its widest part and had a slope of two inches to the foot towards the center. The grate was placed at right angles to the furnace and was two by five feet in size. Between it and the furnace a bridge of fire-brick was built, over which the flame passed.

The sulphide-ores were charged at the upper door of the furnace, a thousand or fifteen hundred pounds at a time. They were spread evenly over the hearth. The temperature was at first kept low, during which period partial oxidation of the ores took place. After a time, one or two hours, the heat was raised slightly, although not sufficiently to permit fusion. Reduction followed and the lead began to flow into the receptacle provided for the purpose. When the flow of metal began to diminish the operation was repeated, the attendant adding some of the ashes from the ash-pit for the double purpose of making the charge less liable to fuse and of aiding the reduction process by means of the partially charred wood in the ashes. The operation lasted ten to twelve hours, when the residue in the furnace was all oxidized and no more metal was obtainable from the earthy impurities remaining. The residual mass was then removed and a new charge introduced. The lead in the kettle was skimmed with chips of wood and cast into pigs. The process required the time of one attendant and one helper, and consumed about a cord and a half of wood. The recovery was between 80 and 90 per cent of the metal in the ores.

A crude form of the cupola-type of lead-furnace was introduced into the Iowa territory in 1834. The Lorimer smelter near the mouth of the Catfish creek, at the south end of Dubuque,

one in the city of Dubuque, and one on the Little Maquoketa river were of this kind. They were soon supplanted by Scotch-hearths. It was, however, a great improvement upon the then existing furnaces, since there was a saving of 65 to 70 per cent of the metal or 50 per cent over the old log and ash-furnaces.

For small plants the Scotch-hearth is probably the most efficient and satisfactory type of furnaces, all things considered. The procedure depends upon the same principles as in the case of the reverberatory process, but the roasting and reducing are carried on simultaneously. The plant consists of a rectangular basin, the back and sides of which are carried up a foot or more, leaving the front and top open. The basin is kept full of molten lead, and on this the fuel and ores are charged. A blast of air plays on the surface, raising the temperature and oxidizing the ore, which is then reduced principally by the heated lead-sulphide which has not been oxidized, and also by the carbon. The lead flows off into the well in front of the basin.

The basin is always kept full of lead. If a furnace is being started, it is filled by melted pig-lead. An ordinary hearth holds about 2,500 pounds of ore. The residues from previous runs are added, with a little charcoal; then charges of mixed charcoal and crushed galena, 20 to 30 pounds at a time. The lead is gradually extracted by oxidation and reduction. A little lime may be added from time to time and the slag scraped off. The molten metal as it runs into the well in front of the furnace is ladled into moulds. Two men treat 3,000 pounds of ore during an eight-hour shift. The recovery is 80 to 90 per cent of the metal. Fifteen bushels of charcoal are consumed per shift.

Since the slags contain often as high as 30 per cent of lead they are run in a second hearth of similar construction as the first. In operation charcoal or coke is used, in the latter case the lead produced being slightly harder. The two hearths are run alternately, being fired sixteen hours and at rest eight.

The Scotch-hearth lead-furnace is an instructive illustration of how in some cases simple old-fashioned methods are best adapted to meet local conditions. As the Watters furnace, at Rockdale, is now operated there is a more perfect recovery at less cost than would be possible in the most improved and mod-

ern high-priced plant. Although the modern cupola-furnace is not now in operation in Iowa, it is probable that its establishment would be not only profitable but would very greatly stimulate mining. The type now generally used throughout the Missouri lead-fields would, on a somewhat smaller scale, fit the known local conditions in this state.

The smelting of the zinc-ores is a more elaborate process than that of lead. If it is to be accomplished profitably and with a saving of the valuable by-products it requires large investment. The old and common process of spelter-making with hand-rake reverberatory furnace for driving off the sulphur, and with coal-fired Belgian retorts for saving the metal, is not to be recommended, except where the proper fuel is abundant and cheap, and even then the loss of the sulphur is serious. The question of spelter-manufacturing in the Dubuque district has not been agitated for reason of the fact that the zinc sulphide-ores have not been as yet extensively mined. Very considerable bodies are now being exposed and it is merely a question of time when the subject will have to be passed upon. All indications point to the probability of the zinc blende mines becoming a notable feature of the region.

With the inevitable uncovering of large bodies of low-grade and complex ores it becomes necessary to concentrate and separate the metallic minerals before the ores are smelted. In the Dubuque region there are four principal classes of ores. These ores graduate into one another to a greater or less extent. They comprise the normal lead-ores (galena), dry-bone ores (smithsonite), mixed bone- and jack-ores, and mixed jack- and pyritiferous jack-ores (blende). The lead very rarely occurs in any considerable amounts so closely associated with the zinc minerals as to need separation by milling. The greater part of the lead-ores are very pure and only need to be washed free from the soft earth to be ready for charging in the furnace. In the general downward migration of the ore-materials there has been a marked concentration of the metallic sulphides in the zone above permanent water-level, which fact accounts partly for its freedom from impurities. The mineral is of nearly theoretical purity, ores from the Karrick mine assaying 86.43 per cent lead. It

does not contain silver in more than a trace, although some of the ores from the Illinois field are said to yield silver enough to notably influence the price of the ores.

Whenever lead-ore occurs mixed with those of other metals, as at the Ahern mine of the Dubuque Lead Mining company, where it, together with marcasite, filled solution-cavities in a blue dolomite, and at the Pike's Peak mines, where some of the lead-ore is in intimate association with both blende and marcasite, it is readily removed owing to its high specific gravity. As this is between 7.4 and 7.6 the galena comes down on the screens of the first jig. Very little lead-ore has been yet jigged at Dubuque. It is commonly passed through the log-washer only.

The dry-bone ores, proper, occur, as does the galena, mainly in the upper weathered parts of the rock-section. They are commonly hand-sorted, washed with log-washers, and hand-picked. To a limited extent they are now being milled, and a considerable proportion of the ores of the region are marketed direct. Dry bone assumes a wide variety of forms from the clear translucent stalactitic variety, through honeycomb bone, to rock-bone. Analyses of the ores from the Cripple Creek mine yielded 47.3 per cent of metallic zinc, and 2.1 per cent of iron. The latter is in the form of the oxide as ochre or ochrous clay mixed with ore, and is completely removed by the washing.

The mixed bone- and jack-ores occur at and about ground-water-level. At the present time they are the ores most extensively mined. The iron exists partly as the sulphide and partially as the oxide. In milling the former is not completely separated. Nor is it possible to make a complete separation of the bone and jack, on account of the small difference in specific gravity.

The blende and blende-marcasite ores occur below water-level; these are the ores which will be most largely mined in the future.

The principal mill of the district is that of the Dubuque Ore Concentrating company. This custom-mill has a capacity of fifty to eighty tons in ten hours, the amount depending somewhat on the character of the ores. The ores are passed first through a 9x15 Blake crusher, then through 14x20 rolls, are elevated and

then sized by means of a trommel-screen having half-inch round holes. The over-size from the screen goes to a second pair of rolls and back to the elevator. The undersize passes to a five-cell Cooley "rougher" jig, with 26x36 plungers, and 24x36 inch screens, which are grates with three-sixteenths-inch holes. The eccentrics are driven at 140 revolutions a minute and have a stroke of $\frac{3}{8}$ to $\frac{3}{4}$ inch. The tailings here are hoisted and laundered away. The middlings are drawn and re-ground by a third set of rolls. The re-ground material, with the fines which passed through the screens, is elevated and run over a second, six-cell, "cleaner" jig, with plungers and screens 24x36 inches. The screens are 4; 6; and 8-mesh. The eccentrics of the first three plungers make 200 revolutions a minute. The last three are driven 225 revolutions per minute. This plant uses 400 gallons of water per minute, a part being caught in a pond and run through in a circuit. The power for such a plant is properly about 45-H. P.; but in this plant both engine and boilers are considerably in excess of this. In running, two men are required in the jig-room, one at the engine, and two to three at the crusher.

Although the mining of iron-ores has never attained the position of an important industry within the limits of Iowa deposits of this metal attracted the attention of the first French explorers of the Upper Mississippi region. Jesuit maps published as early as 1672 locate "Mines de Fer" in the driftless area around the mouth of the Wisconsin river. Joliet's map of 1674 seems to indicate similar deposits on both sides of the great river at this point.

Until quite recently little use has been made of any of the iron-ores of the state. Owen,¹⁸⁵ while examining the mineral deposits of the Dubuque district, considered that large bodies of iron-ores occurred in this region, as extensive as those of Tennessee.

In 1857 Worthen reported good iron prospects in Henry county.¹⁸⁶ These were of Carboniferous age. Whitney¹⁸⁷ mentioned a number of workable iron-ore deposits in the northeastern part

¹⁸⁵Twenty-eighth Cong., 1st Sess., Sen. Doc., Vol. VII, No. 407, p. 52, 1844.

¹⁸⁶Rept. Geol. Surv. Iowa, Vol. I, p. 213, 1858.

¹⁸⁷Ibid., p. 420.

of the state. White¹³⁸ noted a number of possible localities that might prove valuable in time.

Of late years there has been some new development of hematite and limonite ores in Allamakee county. These deposits were fully described by Calvin¹³⁹ in 1895.

In the normal course of national development the use of large fuel supplies belongs to a period when a country has become thickly populated, when the arts and manufacturing enterprises have attained great importance, and commerce has assumed large proportions. In America, however, mineral coal as a fuel appears to have been known at a very early day. How long before the advent of the European it was used is largely a matter of conjecture. Strangely enough its discovery belongs to the interior of the continent rather than to the Atlantic sea-board, where the first permanent European settlement took place, where it is now so extensively mined, and where it is known to be so widely distributed. In the Continental Interior the discovery of coal antedates that of the East by at least half a century; while in a limited way to be sure, its use by the Indians is now known to go back to a still more remote period.

Heretofore the discovery of coal in America has been dated back only to the beginning of the Eighteenth century. The earliest record in Pennsylvania is 1704, twenty years after the privilege of colonization was granted to Penn. Anthracite was not known in the Wyoming district of Pennsylvania until 1766; and its discovery in the Lehigh valley took place 25 years later. Virginia coals were mined for the first time near Richmond, in 1750; and at the close of the Revolutionary war they were shipped for the first time from that district to Philadelphia, New York and Boston.

In this country the earliest definite mention of the existence of mineral fuel in the form of coal appears now to be in the Upper Mississippi region. Jesuit missionaries, in the Assiniboine land, then in what is the state of Minnesota of today, make record of the occurrence of coal as early as 1659. In describing the Poulak (Assiniboine tribes) this statement occurs: "Comme le bois est rare & petit chez eux, la nature leur a appris

¹³⁸Geology of Iowa, Vol. II, p. 336, 1870.

¹³⁹Iowa Geol. Surv., Vol. IV, p. 97, 1895.

à faire du feu avec du charbon de terre, & a couvrir leurs cabanes avec des peaux." * * * * ¹¹⁰ It is also quite possible that the Ioway Indians of the northern prairies also made use of the lignite deposits of the region such as are found, for example, in Brown county, Minnesota, near the headwaters of the Des Moines river, and on the Big Sioux river in Plymouth county, Iowa.

When La Salle established in 1680, Fort Crève Cœur on the Illinois river, near the present site of Peoria, large coal-beds were discovered. Father Louis Hennepin, who was associated with La Salle at this time, states, in the journal of his travels, that at the place mentioned mineral coal exists. In an English edition¹⁴⁰ of his map of the Upper Mississippi region the location is clearly represented. That he was not mistaken is amply shown by subsequent developments.

In his letters regarding the natural productions found along the Illinois river, issued a few years later, La Salle also mentions the fact of the occurrence of coal at Crève Cœur. In a recent reprint of these letters by Margry,¹⁴² among other instructive statements the following paragraph has a special interest in this connection: "Il y a aussy quantite d'ardoisieres et charbon de terre; quatre lieues plus bas, a droite, on trouve la rivvere des Pestigouki dans laquelle j'ay trouve un morceau de cuivre et une espece de metal que j'envoyay, il y a deuxans, a M. de Frontenac dont je n'ay point en de responce, et que je croy de la bronze, si elle se trouve en mine."

Still another very early reference to the occurrence of coal in the Upper Mississippi valley is that of Le Gardeur de l' Isle, who writes in 1722 from Fort Chartres, near Kaskaskia, that he accompanied one Renault to the Illinois river to look after copper and coal mines.¹⁴³

An Englishman, Capt. Phillip Pittman, who visited the Mississippi valley soon after the Peace of Paris, astutely infers

¹⁴⁰Relation de ce qui s'est Passé de plus Remarkable avx missions des Pères de la Compagnie de Jesus en la Nouvelle France, en années six cent soixante envoyée au R. P. Clavde Bovcher, A Paris, Sebastien Cramoisy, MDCLXI. "As wood is scarce and very small with them nature has taught them to burn coal in its place, and to cover their wigwams with skins."

¹⁴¹New Discovery of a Vast Country in America, etc., map, London, 1698.
¹⁴²New Discovery of a Vast Country in America, etc., English ed., map, London, 1698. Mém. et doc. pour servir la l'histoire des origines Francaises des pays outremere; t. II, Lettres de Chavalier de la Salle et correspondance relative a ses entreprises, (1676-1685), p. 175, Paris, 1879.

¹⁴³Coll. Wisconsin State Hist. Soc., Vol. XIII, p. 275, 1888.

from the great pieces of coal which he found constantly on the sand-bars up the river that there were coal-mines on the upper parts of the great stream.¹⁴⁴

The French early knew of the coal which outcropped on the Missouri river a few miles above its mouth, at a point which they named La Charbonnière. Lewis and Clark make mere reference to it:¹⁴⁵ "At the distance of a few miles we passed a remarkable coal hill on the north side called by the French La Charbonnière."

Lieut. Z. M. Pike, on his trip to the sources of the Arkansas river, first passed up the Missouri and Osage rivers. "Six miles below St. Charles, on the south side, in front of a village called by the French Florisant, is a coal-hill, or as it is termed by the French, La Charbonnière. This is one solid sandstone hill which probably affords sufficient fuel for all the population of Louisiana."¹⁴⁶

Long on his expedition from Pittsburg to the Rocky mountains, in 1819, also visited Charbonnière.¹⁴⁷ He also noted other coal deposits in going overland in a direct line from the mouth of the Missouri river to Council Bluffs. "The Chariton river originates near the De Moyer river of the Mississippi and traverses the region which is of great importance both on account of the fertility of its soil and its inexhaustible mines of coal.

* * * These extensive beds of coal will be considered of great value and the necessities of the inhabitants will lead to their early exploration."¹⁴⁸

The first distinct mention of the occurrence of mineral coal in Iowa appears to be that of Featherstonhaugh,¹⁴⁹ who, in 1835, descended the Mississippi river in a canoe, from Dubuque to St. Louis. At the mouth of Rock river, on both sides of the Mississippi, he reports the occurrence of bituminous coal deposits.

The same year Albert Lea investigated for the Federal government the resources of the Black Hawk Purchase,¹⁵⁰ comprising

¹⁴⁴Present State of European Settlements on the Mississippi, etc., p. 7, London, 1770.

¹⁴⁵Hist. Exped. Lewis and Clarke to Sources of Missouri, etc., during years 1804-6, Vol. I, Philadelphia, 1814.

¹⁴⁶Explorations to Sources of Mississippi, etc., during 1805, 1806 and 1807, pt. II, p. 126, Philadelphia, 1810.

¹⁴⁷Exp. Pittsburg to Rocky Mts., etc., Vol. I, p. 70, 1823.

¹⁴⁸Ibid., p. 97.

¹⁴⁹Rept. Geol. Reconnaissance, etc., to Coteau du Prairie, p. 129, Washington, 1836.

¹⁵⁰Notes on Wisconsin Terr., particularly with Reference to Iowa Dist. or Black Hawk Purchase, 53 pp., Philadelphia, 1836.

the present eastern Iowa, and noted the occurrence of coal in many places. In the Des Moines valley he records large coal deposits existing between the mouth of that river and the Raccoon forks.¹⁵¹

When Owen,¹⁵² in 1839, visited Scott county, he found coal outcropping along Duck creek four miles northeast of Davenport, and he records the results of a chemical analysis of a sample collected there.

The Federal census for the year 1840 shows that 400 tons of coal were mined in Iowa during that year. This date may be regarded as marking the beginning of the commercial mining of mineral fuel in the state and the birth of one of her most important industries. Before this time, and also for a decade or two afterward, wood was so plentiful and so cheap that in this thinly populated region there was little demand for any other fuel. From the date mentioned there was a steady increase in the coal production of the state until it attained the present large proportions.

In his "Remarks on the Geology of the Upper Mississippi" Nicollet¹⁵³ says that shallow coal-basins frequently occur in Missouri and the south part of Iowa territory."

At the fifth meeting of the American Association for the Advancement of Science, in 1851, Owen read an "abstract" of his later report, in which he gives the first comprehensive view of the extent of the coal deposits of Iowa and Missouri. Among other important observations he notes that the coal-field of the states mentioned is a large, more or less circular basin, having an area of about 35,000 square miles. It is subdivided into three members, the lower one of which is stated to be composed of limestones chiefly and to have a thickness of perhaps 100 feet; the middle one, mainly comprising shales, has a thickness of about 75 feet; and the upper silicious sequence has a thickness of about 100 feet. The second, or middle member, is the coal-bearing portion, the individual coal-seams having a thickness of from a few inches up to four or five feet.

¹⁵¹Ibid., p. 25.

¹⁵²Twenty-eight Cong., 1st Sess., Sen. Ex. Doc., No. 407, p. 53, 1844.

¹⁵³Am. Jour. Sci., (1), Vol. XLI, p. 181, 1841.

Owen's final report¹⁵⁴ on the geology of this region surveyed in several previous years, shows a fine cross section along the Des Moines river, in which numerous coal seams are displayed. Some coal out-crops are also noted on the Missouri river in the southwestern corner of the state.¹⁵⁵

During the years 1855-1857 Hall, Whitney, and Worthen examined a large number of coal deposits in different parts of the state. Hall¹⁵⁶ gave a general account of the geology in which the coal measures are briefly mentioned. Whitney¹⁵⁷ described the chemical composition of the coals. Worthen¹⁵⁸ reported upon a trip up the Des Moines river; and on some of the counties in the southeastern part of the state.¹⁵⁹

A decade later, White and St. John made a reconnaissance of all the coal-producing counties of the western half of the state.¹⁶⁰

In 1879 a state bureau of mine inspection was established by act of the legislature. Since that time there has been kept a fairly complete record of the industrial features and development of coal-mining in the state.

During recent years a large number of articles have appeared relating directly to the geology and mining of coal. In the county reports of the present State Geological Survey have been given full details of the occurrences of coal and of the mines in operation. Two special reports on the coal deposits of the state have also been issued. The detailed history of coal mining in each of the various counties of the state has received the attention of Lees.¹⁶¹

¹⁵⁴Rept. Geol. Surv. Wisconsin, Iowa and Minnesota, p. 105, 1852.

¹⁵⁵Ibid., p. 133.

¹⁵⁶Rept. Geol. Sur. Iowa, Vol. I, p. 123, 1858.

¹⁵⁷Ibid., p. 397.

¹⁵⁸Ibid., p. 147.

¹⁵⁹Ibid., p. 183.

¹⁶⁰Rept. Geol. Sur. Iowa, Vols. I and II, 1870.

¹⁶¹Iowa Geol. Surv., Vol. XIX, p. 525, 1909.

