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ORE AND ORE MINING IN LAWRENCE COUNTY.

BY JAMES E. LAWTON, C. E.

(READ AT JACKSON MEETING, JUNE, 1885.)

Lawrence is the most southern county in Ohio, and the centre of the Hanging Rock iron region. It was one of the pioneer sections in the manufacture of iron in the State, its first furnace (Union) being built in 1826; and since that time, there has been built and operated some twenty blast furnaces in the county. With but few exceptions, and these only in part, all these furnaces have depended upon and used only native ores in the manufacture of their product. The pig iron made from these native ores bears a very high character, celebrated for casting purposes where great strength is required, and was largely used by the Government during the late war, in the manufacture of ordnance.

The physical formation of the county is such as to make free-level mining possible in all cases, being a succession of high hills and deep hollows.

The uniform and gentle dip toward the east, makes the tracing of the strata quite simple, but being so slight, this general dip is quite often overcome by local dip, so that it is not much of a faction in calculating for drainage in mining operations. The

ores used in Lawrence County are the several seams of block found below the Ferriferous Limestone, the kidney ores, which are found in the shales between the various coal seams above the Ferriferous lime and the limestone ore. The block and kidney ore are only valuable locally, being quite variable in quality and quantity, often quite lean and silicious and generally used only as mixtures with the limestone ore. The limestone ores, however, is more regular as to quantity and quality and more largely used than any or all the other seams.

It is found over-lying the ferriferous limestone, so called for that reason, about fifteen feet below the No. 5 (Lower Kittanning) coal, here known as the New Castle.

This ferriferous limestone with the ore which it carries, is one of the most persistent formations known to this section, and is for this reason much used as a horizon in geological research.

There are in the limestone ore three benches or members which may be described as follows: First the vein—always red on the out-crop, because oxidized by exposure to air and water, and commonly blue or gray under heavy cover.

This is not, however, always the case, as we frequently find the vein to be red in color, and exactly similar to that found at the out-crop, quite a distance under ground and sometimes in the centre of large hills, so caused, I suppose, by the action of air and water which pass through fissures in the limestone known as "lime-breaks." The thickness of the vein varies from nothing to eighteen inches, with an average probably of six inches. When red it quite frequently "sticks" to the limestone, sometime with no division between.

Sometimes it can be shot or wedged off the limestone and comes off clear, and in places there is found an inch or two of soft muck between ore and lime. The blue ore frequently sticks, but the grey never does.

Second, a layer of "kidneys" from six inches to two feet above the vein in the slate, which overlies it. These are often found from three to six inches thick, and when present at all, usually as regular as the vein itself.

Third, above the vein and lower bench of kidneys, and from three to six feet above the limestone, there is another bench of kidneys, commonly called the "sand kidneys," larger than the lower bench. They are sometimes found as large as flour barrels.

These top kidneys are more scattering and irregular than the lower deposits, and are often left in or above the roof of the mine, as they lie so high that it will not pay to work after them, especially as the taking down of so much top and the consequent approach to the No. 5 coal makes the roof quite dangerous.

The kidneys, like the vein, are red close to the out crop, but always grey under heavy cover. The vein and kidneys are alike rich in iron, mined and used together, and together constitute the limestone ore, with a total average thickness of not to exceed ten inches, as often one and sometimes all the members of the formation are wanting. In some parts of the county the sandstone lies close enough to the limestone to form the roof of the mine, but usually the clay slate which begins on top of the ore vein extends up to the bottom of the No. 5 coal.

This overlying is a kind of fire-clay, and is a material very hard to keep up in mining, being full of "horsebacks" and smooth seams, and especially treacherous as a top as you approach the coal above.

The block and kidney ores are all mined or procured, rather, by "benching" or "stripping," that is, by removing the clay, shale or rock from the ore at the outcrop, and then taking up the ore. From the rapidly increasing thickness of the cover in the bluff hill and the consequent increase in cost of getting the ore, and the fact that many of the ores deteriorate in quality as they leave the out-crop—all these causes limit the area of benching to only a few feet along the margin of the out-crop.

The limestone ore at first was obtained, and to some extent is even at the present procured in the same way, and of course so long as a sufficient quantity could be got on the out-crop, it was the best way and decidedly the cheapest, and the fact that all the furnaces in the county have large tracts of land and consequently large areas of out-crop, accounts for that being the principal system used in getting ore, up to a comparatively recent date. Another reason is, for practicing this system of mining, that the red ore on the out-crop is softer and better adapted for use in charcoal furnaces than either the grey or blue which are usually found when mining deep under cover.

In this county, near the furnaces, the "benches," where the dirt and rock have been removed and wheeled or cast down the hill from the ore level, present the appearance of huge wagon roads, so regular lies the ore and so completely has it been taken from the out-crop. When a sufficient quantity of ore could not be obtained by benching, and the stripping became so heavy that it could not be dug profitably in that way, it became necessary to go under for it. Small entries were then put in different distances depending largely on the quality and thickness of the ore found. As in many cases nothing was paid for yardage these entries were very crooked, the best ore being followed as the entries were driven in. Rooms were turned off the entries at irregular distances, usually about thirty feet apart

and generally widened toward the crop. The width and length of the room depended very much on the thickness of the ore, freedom from water and strength of the roof.

A "rib" usually ten feet wide was drawn back to within four or five yards of the entry, leaving a "stump" to hold it up. The whole entry was worked in that way, and as many of the "stumps" drawn as circumstances would admit without endangering the roof.

As in benching, large quantities of ore was left in the "buck-walls" or divisions between benches, and in many cases, covered up deeper than before, so by these small entries and "gouges" much ore is left in the hill and lost, and the system results, finally, in a fringe of short workings all round the out-crop, and that too, in the best places, as the men are well posted as to where the best ore is, and are usually allowed to dig where they please, being paid so much per ton for the ore they dig. The price paid for digging varies greatly, rises and falls with the prosperity and depression of the iron business, sometimes as low as 75 cents, and again as high as \$3.00 per ton of 2,268 pounds.

In the little entries and "gouges," above described, no system of ventilation is used.

The distance driven into the hill varies from one to fifty or sixty yards. At most of the furnaces an effort has been made of late years to have a more regular system of mining than this. Single entries are then driven eighty to one hundred yards apart, parallel, and with rooms turned off both sides and driven to meet, and with cross entries at necessary distances to secure proper ventilation.

The necks of the rooms are driven entry width for five yards, and then widened usually toward the out-crop, so as to give a "breast" of twenty feet, which width is kept up the full length of the room, commonly forty or fifty yards.

A "rib" ten feet wide is then drawn back to within five yards of the entry, leaving, as the mines are turned, ten yards apart, an entry stump fifteen feet by thirty. Finally these pillars are drawn out, and thus all the ore is secured.

If intended to stand for a long time the entries must be timbered and "lagged." Timbers are used about six inches square, doubled, notched and lagged with poles. The rooms also have to be posted with props about two feet apart along the road, and when required in the wing of the room. The ore and what slate can not be stowed back or "gobbed" in the rooms, has to be hauled out by man power, as the entries are only four feet high and the rooms are only large

enough to get the ore. In working rooms it is found necessary to bring out about as much slate as ore in addition to the ore. In driving entries, of course all the slate has to be hauled to the outside. In the last few years some operators have put in mines with gangways large enough for mules and have rooms turned only off cross entries and ventilated by furnaces. The men, however, much prefer to work in the little "push entries," where, being nearer the out-crop, the cutting is easier and little or no powder is necessary.

For this reason it has been found difficult to fill up these larger mines at the price now paid for digging, and test to a full extent the advantage gained, if any, over the old plan of working.

The vein worked being so thin, and the value of iron so low, make cheapness the main and absolutely essential thing. One firm has tried, on quite a large scale, too, the long wall system. It was fairly successful, but the slate roof was not found to be of such a character as to give the best possible results of the system, as the roof would break off against the "solid" and not give "squeeze" enough to be of much benefit in mining.

The Harrison Mining Machine has been used by some parties and was found to be of great advantage, but the very depressed condition of the iron business, the introduction of steel in place of iron in many branches of manufacture, and the general "hard times," have very much militated against costly experiments and the introduction to any great extent of improved and approved appliances. In my opinion the plan of mining that would give the best results possibly in this section would be to drive a series of entries to the far boundary of the territory to be worked out, using the Harrison or some other mining machine worked by compressed air, for undercutting and ventilation while driving the entries. Then join the entries by a cross entry and work back the wall face so obtained until the whole boundary is worked out. By this plan much posting would be saved and if sufficient speed was attained it would not be necessary to timber the gangway.

This plan, or some other modification of the long wall system will have to be adopted here at some time, to obtain the immense boundaries of ore which remain almost untouched and which it is impossible to procure by systems now most generally used here.