MINING *company offices at Babbitt, April, 1920*

Pioneering with Taconite

The BIRTH of a MINNESOTA INDUSTRY

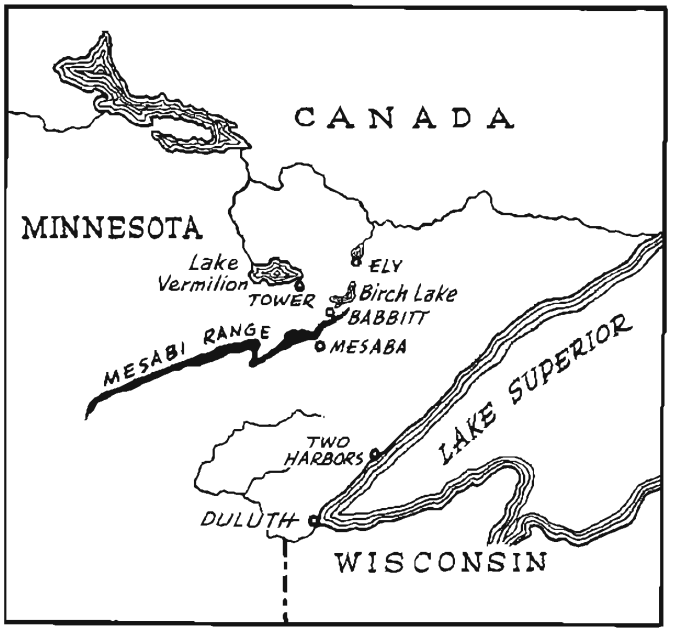
EDWARD W. DAVIS

THE REMINISCENCES here presented are drawn from a chapter which Professor Davis contributed to a mimeographed History of East Mesabi Magnetic Taconite *issued for limited distribution in October, 1948, by Oglebay, Norton and Company of Cleveland. In view of the greatly increased interest in the subject of this volume, it now seems appropriate to place before a wider audience a condensed version of Mr. Davis' narrative. Co-operating with him in making the material available for publication in* Minnesota History *were the company's president, Mr. H. S. Taylor, and members of the public relations staff of the Reserve Mining Company at Duluth.*

Until 1951, Mr. Davis was director of the Mines Experiment Station of the University of Minnesota, and thereafter he held a professorship in the school of mines and metallurgy. In June of the present year he retired and went to Silver Bay to serve as metallurgical consultant for the Reserve Mining Company. The great taconite plant which that firm is building in the new Silver Bay community is known as the E. W. Davis Works. Readers of this magazine will recall, in the Autumn, 1953, issue, a brief article by Mr. Davis on "Taconite: The Derivation of the Name."

MY CONTACT with the magnetic taconites of the eastern Mesabi Range began in the spring of 1913. I had come to the University of Minnesota to teach mathematics in the school of mines in the fall of 1912. At that time W. R. Appleby was dean of the school and John G. Williams, who represented mining interests in the Duluth area on the board of regents, was serving as regent-adviser to the school of mines.

Dean Appleby introduced me to Mr. Williams in the spring of 1913. When he learned that I was an electrical engineer, he told



MAP *of the Mesabi Range and the Babbitt area*

me about some magnetic iron ore found on lands he owned on the eastern end of the Mesabi. He said the ore could be picked up easily with an ordinary hand magnet, and added that a magnetic compass was so inaccurate that it was useless in the district. He thought perhaps I could devise an electromagnet that would separate the magnetic iron oxides from the silica. A short time later he sent me a few pounds of this ore, known as taconite, which had been secured, he said, from a place called Sulphur Siding, about fourteen miles east and north of the town of Mesaba in St. Louis County.[1]

Largely, I must admit, because Mr. Williams was a member of the board of regents, I took the small sample into the laboratory of the newly founded Mines Experiment Station and did a little work on it. I broke up the sample into small fragments and found that I could pick up practically every piece with a hand magnet. I tried breaking the pieces even finer and could still pick up nearly all the ore with a magnet. There was, however, a little sand that seemed to be nonmagnetic, and as I crushed the sample finer, the nonmagnetic material increased in quantity. I was never able, however, to make a concentrate containing as much as fifty per cent iron. I was sufficiently interested in the work to look up some information on magnetic separation, about which I knew nothing, and I learned that wet concentration of fine magnetic ore was in use to a limited extent.

In some notes made at the time I remarked that the ore was "very hard and extremely dusty, and some wet concentration method should be used." Later some tests were made using a hand magnet under water, and immediately much better results were secured. The first wet test on pulverized crude ore assaying 29.11 per cent iron, laboriously made in water with a hand magnet and many washings, produced a concentrate assaying 68.88 per cent iron and 3 per cent silica. This test was made in October, 1914.

When the results of the test were reported to Mr. Williams, he was much interested, and thereafter he and George A. St.

[1] Taconite is the name given to the sedimentary rock formation of the Mesabi Range. In general, its iron content is between twenty and thirty-five per cent. For an explanation of the word's origin see Mr. Davis' article entitled "Taconite: The Derivation of the Name" in *Minnesota History*, 33:282–283 (Autumn, 1953). *Ed.*

Clair, with whom he was associated in the ownership of the eastern Mesabi property, came every week or two to Minneapolis to see how the work was progressing.[2] The task of developing some type of equipment that would more easily wash the silica out of the ore was begun immediately, and as a result, the magnetic tube concentrator was devised. This consisted of a large C-shaped electromagnet, between the poles of which a glass tube about one inch in diameter and two feet long was supported at an angle of about forty-five degrees. Water flowed into the top and out the bottom of the tube through control valves. When the finely pulverized ore was placed in the tube, it immediately collected between the poles of the magnet. Moving the tube up and down a few inches and rotating it at the same time freed the silica, and the water then washed it downward and out of the tube, leaving the collected ore. This became the standard method of testing all small samples of magnetic ore, and the principle is still used with mechanical activating equipment in most ore-dressing laboratories.

It gradually became evident that while no coarse concentrate (the grains of which are about as large as the head of a pin) could be secured from this taconite, comparatively coarse tailing could be removed, thus reducing the bulk to be ground to −150 mesh for final concentration. This size measurement is obtained by using a screen with 150 wires each way, making 22,500 openings per square inch, and the resulting product is about as fine as flour. In its new plant at Silver Bay, the Reserve Mining Company will grind the ore to −10 mesh. At this size forty to fifty per cent of the taconite will be discharged as worthless rock containing practically no recoverable magnetic iron. The remaining ore must be crushed still finer (to −150 mesh) and concentrated again.

[2] For biographical sketches of Williams and St. Clair, with accounts of their mining connections, see the *History of East Mesabi Magnetic Taconite*, ch. 1, p. 8–13. The Minnesota Historical Society has a copy of this mimeographed volume. *Ed.*

EARLY IN 1915, Dean Appleby purchased a Dings belt-type high and low intensity magnetic separator. This machine worked only on dry ore, and only the low intensity magnet was used on magnetic taconite. I joined the staff of the Mines Experiment Station for the summer of 1915 and worked on the new Dings machine and on wet concentration of the fine ore. A few tons of taconite secured near Sulphur Siding and sent to the experiment station by Mr. Williams were used as a sample for test work during 1915. I have the records of the first test made with the Dings machine on ore crushed to four mesh and consisting of particles about three-sixteenths of an inch in diameter. The crude ore assayed 31.22 per cent iron, and the concentrate 33.66 per cent iron. The tailing assayed 3.88 per cent iron and represented 8.2 per cent of the weight of the feed (these are all soluble irons). Many tests were made on this machine by Henry H. Wade and myself during the summer of 1915 and later, but the highest grade of concentrate produced assayed only 49.72 per cent iron. This was on −100 mesh material—a screen with 10,000 openings per square inch.

PROFESSOR *Davis operating a magnetic tube concentrator at the plant near Babbitt, 1955*

The wet concentration results secured with the tube machine were so satisfactory that work was started on the development of a device that would handle larger quantities of ore and that could be considered a model for a possible commercial machine. This investigation resulted in the development of the magnetic log washer. The first machine of this type was built and put into operation early in 1915. It was essentially a trough five inches wide and twenty-four inches long, lined with copper. Beneath the copper sheet was an electromagnet, with one pole in the center and one on each side extending the full length of the trough. In the trough, two logs with small blades similar to those on standard log washers were mounted so they could rotate. This machine was set on an incline with the upper end above the water line, and the water overflowed a weir at the lower end of the trough. When fine magnetic ore was fed into the machine about sixteen inches from the discharge end, the magnetite collected on the bottom of the trough and was moved upward and out of the water by the action of the rotating log. The nonmagnetic material was carried by the flow of water to the lower end of the machine and flowed out over the weir.

The first test on this machine, made on January 20, 1915, using eastern Mesabi taconite crushed to —40 mesh, produced concentrate assaying 40.83 per cent iron. On January 28, working on —150 mesh ore, we produced concentrate assaying 60.44 per cent iron and tailing assaying 4.76 per cent iron. After Mr. Williams saw the machine in operation on February 8, he sent Dwight E. Woodbridge of Duluth to see it and to discuss with me the concentration of eastern Mesabi magnetic taconite. Mr. Woodbridge had been employed by Mr. Williams and Mr. St. Clair as engineer and consultant in connection with their taconite properties.

Mr. Woodbridge told me that forty tons of ore taken from two pits or shafts on Section 19, Township 60 North, Range 12 West, on the Mesabi in eastern St. Louis County had been sent to Moose Mountain, Canada, in 1914 and had been tested in a magnetic concentration plant there. The sample taken from one of the pits assayed only 11.42 per cent and that from the other assayed 36.02 per cent soluble iron. Fine grinding and wet magnetic concentration were used in the treatment of these samples. The results of the test showed that by crushing to 77 per cent —200 mesh, a final concentrate assaying 59.97 per cent iron was made.

The Woodbridge report, dated October, 1914, gives details of the tests made at Moose Mountain and goes into the construction and operating costs of a plant to treat this material. According to Mr. Woodbridge's estimates, the briquetted concentrate could be produced for a total cost of $2.87 per ton, and a plant to produce five hundred tons per day would cost about $450,000, including power equipment. The whole report is very optimistic.

Mr. Williams and Mr. Woodbridge had been involved earlier in financing some copper properties, and because of this, they were acquainted with Daniel C. Jackling. They contacted Mr. Jackling and interested him sufficiently so that he employed Walter G. Swart to investigate the Williams-St. Clair properties and report to him regarding the possibility of concentrating the ore from them. Mr. Swart, Mr. Woodbridge, and Horace V. Winchell, famed Minnesota geologist, arrived at the Mines Experiment Station on the University of Minnesota campus on June 16, 1915, and a concentration test was made for them on the little magnetic log washer. I remember the great interest and enthusiasm shown by Mr. Swart and Mr. Winchell on this occasion. The concentration of the magnetic taconite looked very simple to Mr. Swart, who was accustomed to the treatment of the much more complex western ore, and Mr. Winchell was full of information about the enormous extent of the magnetic taconite deposits of the eastern Mesabi. He told us that his father,

Newton H. Winchell, went up on the eastern Mesabi in 1875, pumped out the test pit originally made by Peter Mitchell in 1870, and put it down six feet farther.[3] He found solid magnetic taconite all the way, but no high-grade ore.

I remember what a great impression Mr. Swart and Mr. Winchell made upon me. These two and Dean Appleby made a grand trio. They were about the same age, the same size (slightly bulging), and all three were fine gentlemen in every sense of the word. They loved to eat and drink (in moderation) and tell stories of past experiences. I think the most entertaining evening I ever spent was with the three of them one night in 1915 at Schiek's Cafe in Minneapolis. Mr. Winchell told stories of his father's early experiences on the Mesabi while he was state geologist, and of his association with such pioneers as Stuntz, Mitchell, Longyear, and the Merritts. Mr. Swart recalled early days at Cripple Creek and Salt Lake; and Dean Appleby described his first visit to the Mesabi and the frontier town of Hibbing.

MR. SWART and the others went from the Mines Experiment Station to the range to look over Mr. Williams' property, and eventually Mr. Swart gave Mr. Jackling a glowing report of the whole project. As a result of this investigation, Mr. Jackling, with Charles Hayden and others, formed what was known as the Mesabi Syndicate. Mr. Swart was placed in charge of operations and was instructed to make a complete investigation of the property, build a pilot plant, and determine the technical and economic possibilities of concentrating eastern Mesabi magnetic taconite.

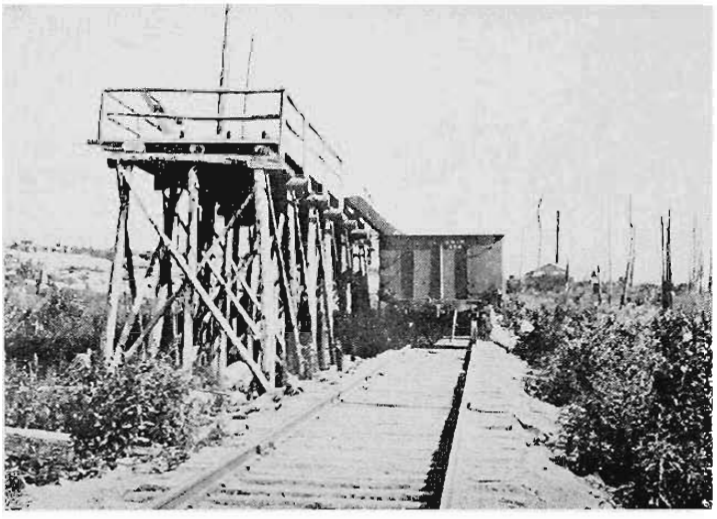
As his first assistant Mr. Swart employed Fred A. Jordan, who had been operating the Moose Mountain, Canada, iron-ore concentration plant, and who had earlier made some tests for us. When I first saw him, I thought Mr. Jordan was the homeliest man I had ever seen, but after I knew him better, I never thought of this. We became great friends and I admired him very much because he was so capable, industrious, and persistent. He was primarily a construction man and, secondarily, an operator. He had been an instructor at the Michigan College of Mining and Technology at Houghton and loved the university atmosphere. He liked to experiment and was always pleased to try something new.

When Mr. Jordan arrived at the Mines Experiment Station in January, 1916, Mr. Swart had already laid out a plan for the proposed expansion of the station's experimental work. As early as August, 1915, we had put into operation a magnetic log washer twelve inches wide and five feet long. Other equipment which Mr. Swart provided included a three-foot by eight-inch Hardinge ball mill and a five-spigot Richards-Janney classifier. Mr. Jordan went to work setting up this new equipment to make a flow sheet in which the ball mill discharged directly into the magnetic log washer. In the first test, the ore was ground to about thirty-five mesh and the concentrate produced from it assayed 37.55 per cent iron.

For a while after Mr. Jordan came to the station, I had little contact with him because I was teaching, but he and Mr. Wade worked together constantly. Among other things, by using screens with openings of different sizes, they divided a sample of crushed taconite into some twenty sized portions. They then spent weeks separating each of these into various magnetic fractions, mostly by hand on the dry Dings separator. We still have a case of exhibition samples showing these products.

More equipment was added under Mr. Jordan's direction, and eventually a closed-circuit flow sheet, using a Dorr classifier, was

[3] This pit is still visible on property now being mined by the Reserve Mining Company. A large slab of taconite removed from it will be fashioned into a monument for erection in the new town of Babbitt, located near by. Mitchell's exploring activities are described below on p. 275. A sketch of his career appears in *Skillings' Mining Review* for September 1, 1923. *Ed.*



ORE *loading equipment at Sulphur Siding, 1916*

put into operation. After this was installed, it was possible to produce concentrate approaching sixty per cent iron, but the feed rate had to be very low because, for one thing, flint pebbles were used in the ball mill.

In March, 1916, Ted B. Counselman, formerly an efficiency engineer at Morenci, Arizona, was employed by Mr. Swart and took over the test work. Mr. Jordan then went to Duluth to design and construct a pilot plant for the Mesabi Syndicate that was to have a capacity of about fifty tons per day. A location at Thirty-ninth Avenue West and the bay front in Duluth was selected for the plant. The site had been the property of an old lumber company and contained a good-sized brick building, which was enlarged by adding a wooden structure to form the pilot plant. I joined the staff of the Mesabi Syndicate on June 15, 1916, when the school year ended, and the following month the plant was ready for operation. Practically all experimental work on magnetic taconite at the Mines Experiment Station stopped temporarily at that time because most of the equipment had been shipped to Duluth.

THE ORE for the Duluth plant was mined from a location on the deposit known as the Sulphur Mine. This operation, which was the first taconite mine in the state, was directed by a man named Wallas. It was small, producing only about a hundred tons a day. A face, six feet to eight feet high, was developed and the ore was blasted down, using small holes made with air drills. Later a churn drill was used. The broken ore was loaded by hand onto small tramcars, which were pulled out of the pit, up a trestle, and dumped into steel gondola railroad cars.

During the period from 1916 through 1918, much work was done at the mine. When I first saw the property in 1916, it was practically impossible to travel about it except on the old Mesaba-Syndicate Trail, on the old logging railroad grades, or on the lines that had been cut by the surveyors. Several years earlier a fire had swept across the country, killing all the timber. Logging had started before the fire and, consequently, all the timber had either been burned or removed. The smaller trees blew down, and when I first saw the area it was covered almost waist deep with a tangled mass of small tree trunks. Surveying was most difficult in summer; in fact, it was found easier to do it in winter when snowshoes could be used. Tony Benson, later St. Louis County mine inspector, had charge of surveying. Aneroid barometers were used in making most of the contours.

The Sulphur camp, as I first saw it, consisted of four old log buildings which were used as the office, the engineering shack, the bunkhouse, and the cookhouse. They were all in bad repair and were put into usable condition during the winter and spring of 1916. A few hundred feet south of this group of buildings was an old log structure known as the barn, which was used as a storeroom and compressor house for the near-by mine. Between the camp and the barn ran a branch of the old Mesaba-Syndicate Trail, long since abandoned. This road ran the full length of the iron formation from Mesaba to the Dunka River; it was plainly discernible although somewhat grown over with brush. It crossed a small creek flowing between the camp and the barn just below the barn at a point where the water flowed over the taconite to form a shallow ford. The bottom of the creek was yellow-brown in color from limonitic deposits; hence the names Sulphur Creek, Sulphur Siding, and Sulphur Mine.

Just a few feet off the road and perhaps twenty feet from the ford was the test pit made by Peter Mitchell in 1870. He went on foot from Beaver Bay in search of iron for a group known as the Ontonagon Pool. He also went to the Tower area, but liked the ore he saw on the east Mesabi better and put down several pits there. At Sulphur Creek he put down a test pit which is supposed to have been the first on the Mesabi Range. Although he found only low-grade ore, he nevertheless acquired certain property in the neighborhood for the Ontonagon Pool. Later, in 1876, he sold this land to Mr. St. Clair, Mr. Williams, and Samuel Mitchell. Some prospecting and drilling was done in the area – by Oglebay, Norton and Company, among others – but only low-grade ore was encountered. The property had been practically abandoned for many years prior to the formation of the Mesabi Syndicate.

In the summer of 1917 another fire passed through the country and burned all the brush and down timber. This made exploration and surveying very much easier, for after the fire it was possible to walk about almost any place on the property. By burning away the overburden of moss and peat, the fire exposed great areas of taconite, and it thus was a godsend to the exploring and surveying crews.

During the summers from 1916 through 1918, a number of diamond drills were

LOG *bunkhouse and engineering shack at Sulphur Siding, 1919*

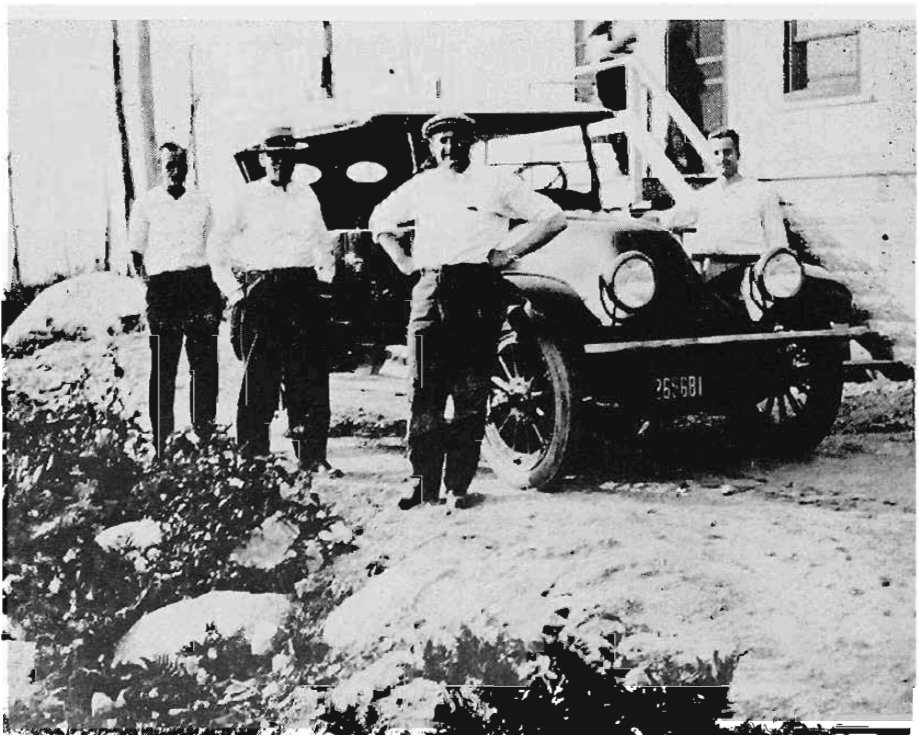
operating in the area, and Professors Frank F. Grout and T. M. Broderick of the Minnesota Geological Survey spent much time there. They described the work done then in a *Bulletin* published in 1919.[1]

Away back there in the woods, seventeen miles from Mesaba, the nearest town—which could boast only a railroad station and a store or two—a lot of things happened. During 1917 and 1918, there were from fifteen to twenty men in the crew at the mine. They were a sturdy, irritable, moody lot after living up there alone and isolated from the rest of the world, except for one train a week and a single wire telephone line that was usually out of commission. I remember our great excitement one day when Mr. Swart and two of the local crew came into camp in a Franklin that Mr. Swart supposedly had driven on the Syndicate Trail all the way from Mesaba. I think it was the only car that ever negotiated that road. A few days later, when the train came in, the Franklin was loaded on a flatcar for the return trip. As near as I could find out, the two men carried the car with Mr. Swart in it most of the way up to camp.

ORE PRODUCED at the Sulphur Mine was hauled to Mesaba over an old logging spur of the Duluth and Iron Range Railroad that ran through to the Dunka River. When the loaded cars reached the Duluth plant, the ore was dumped from a low trestle. It was picked up by hand and loaded into one-ton tramcars which were then hoisted and the ore dumped into a jaw crusher ten by twenty inches in size. The crushed product went through a set of rolls operating in closed circuit with a one-inch screen, and the resulting material then passed through a second set of rolls working in closed circuit with one-fourth inch screens of the Colorado impact type.

The bits of ore that were less than one-fourth inch in size went next to the storage bin. From there they finally were sent to a wet grinding plant consisting of an eight-foot by twenty-two-inch Hardinge conical ball mill which at first operated in closed circuit with an Akins classifier. This was later replaced with an Esperanza drag and then by a Dorr bowl-type classifier. I think this was one of the first bowl-type classifiers put into operation. The classifier overflow went to two magnetic log washers measuring two by fourteen feet each, and the

[1] See Frank F. Grout and T. M. Broderick, *The Magnetite Deposits of the Eastern Mesabi Range* (Minnesota Geological Survey, *Bulletins*, no. 17—Minneapolis, 1919). *Ed.*



WALTER *Swart,*
s second from the left,
c and his Franklin
c at the end of the trail

concentrate from them was pumped into wooden storage bins which were expanded as they filled up. The tailings from the plant flowed by gravity into a swamp at the edge of Duluth Harbor.

As it eventually worked out, the operation of the pilot plant was largely under my direction. The operations at the mine were under Mr. Jordan's direction, and Mr. Counselman worked as Mr. Swart's assistant in the Duluth office.

We were instructed to work out a flow sheet for a commercial plant to produce concentrate assaying sixty per cent iron. During the wartime summer of 1918, however, we were asked to produce as much low-phosphorus concentrate as possible and ship it to the Midvale Steel and Ordnance Company at Nicetown, Pennsylvania, for use in making steel for the noses of armor-piercing projectiles. From one location, Cliff Quarry on the formation east of Sulphur, concentrate could be made containing less than one one-hundredth of one per cent phosphorus. In all, approximately two thousand tons of sinter were shipped. The sintering plant was a homemade affair and its operation was very difficult. It was a cross between the Greenawalt and the Dwight and Lloyd systems; that is, three-foot-square pans were equipped with wheels and were then moved around an oval track.

In the Duluth mill we learned a lot of things about the concentration of magnetic taconite. We found out for certain that the rock was hard. We broke everything about the jaw crusher except the flywheel. The rolls wore badly; the shells became so grooved that the corrugations touched, and the circulating loads over the screens were excessive. The circuits were closed with dry-bucket elevators and these were very troublesome. Later, when the Babbitt plant was built, we vowed that it would not have a single elevator — and it didn't, except in the sintering plant.

The original dry cobbers were Ball-Norton machines. For the coarser sizes, these were not strong enough, and we had to rebuild and eventually completely redesign them. Mr. Swart brought from New Jersey the plan for cobbing out waste rock up to two inches in size. Later, I went to Mineville, New York, to see a dry cobbing plant in operation, but I couldn't see much of anything because of the dust.[5]

The production of waste rock to be used in making concrete was a basic consideration in all programs for a larger plant at Sulphur. Very elaborate tests were made to determine the amount of rock of varying sizes that could be produced at various iron assays. Complete cobbing characteristic curves were worked out and, eventually, formulas were developed that could be used to calculate the amount of rock that should be cobbed out to produce maximum overall profit. All this was done on the assumption that the rock could be sold at prices varying from twenty-five to fifty cents per ton. The sintered concentrate was to be sold as "Old Range Bessemer," and with the premium was priced at about five dollars per ton at the mines.

We had a lot of trouble with the grinding circuit in the Duluth mill. The ore was slime-free, heavy, and settled rapidly, and the Akins classifier broke down so often that we finally had to take it out. We got enormous circulating loads with the Akins, but the overflow was so erratic that we never knew what to expect.

All during the Duluth operation, we were striving to make a density classification. It was not until the last few months that we gave this up. In the meantime, J. V. N. Dorr, Robert McAffee, J. R. Ramsay, and A. L. Blomfield all came out to help operate the new bowl classifier, which was supposed to be the final answer to our classifier problems. It was, however, far from satisfactory, and finally Mr. Blomfield, who designed and built the first machine at the

[5] This was a dry plant. It was in charge of Joseph Linney, father of Robert Linney, who now is manager of operations for the Reserve Mining Company's plant at Silver Bay.

Golden Cycle plant in Colorado, went home in disgust. Although we used demagnetizer coils, I feel now that we were not getting proper demagnetization. We finally cut out the whole central portion of the bowl and used just a straight Dorr classifier with an enlarged overflow. When we finally learned to overflow at a density of about seven per cent solids, the outfit worked pretty well – at least it worked continuously.

As I think of the Duluth mill, it seems that most of the time we were either working with, or arguing about, the classifiers. When the classifier did not operate properly, it was hard to do much experimenting on any of the other equipment. The experts kept telling us that the classifier should operate at twenty to twenty-five per cent solids, and they produced data to prove it. But we could not hold it there for long, and when we used more water, the magnetic logs were flooded. The logs did not work very well anyway; their capacity was low. Then, for some reason, we thought we should make a log tailing containing one per cent or less of iron in the form of magnetite, while at the same time we made a ten per cent magnetic iron tailing in the dry plant. It was a long time before we learned the desirability of thickening the classifier overflow. Until this was done, we could not operate both the grinding circuit and the magnetic circuit efficiently.

I remember a man by the name of Dutton who had the agency in this country for the Grondal magnetic separators. He offered to put one in our plant alongside the magnetic logs. This was done and he got a man from Sweden to come over and help us run it. The visitor could not speak English, so we had a hard time discussing anything with him.

One afternoon Mr. Swart drove out to the plant and suggested that we take our Swedish expert up on the range and show him the mine. We tried to explain to him where we were going and he seemed to understand, so we all got into the car and started. It was in the fall, and after we got over the hill, it started to snow. The farther we went, the worse it snowed. We eventually got stuck and had a hard time pushing and pulling the car in order to turn it around so that it was headed back toward Duluth. We finally returned to Duluth wet and about frozen. Apparently the poor Swede never did know what it was all about, because he would never get into the car again. He always rode the streetcars, for he knew where they were going.

For test purposes, we had a three- by three-foot Oliver drum filter. It was supposed to take the log concentrate at about ten per cent solids and make a dry filter cake without overflowing. It did none of these things. When we finally put the log concentrate into a thickener, and fed the filter at fifty per cent solids, it did much better.

It seems strange now, as I look back at the Duluth mill, that although we had all the necessary equipment in our hands, we never got it working together in the right flow sheet. Three preconceived ideas, all false, caused much of the confusion. First, we believed that the classifier overflow should consist of twenty to twenty-five per cent solids; second, we thought the wet plant tailings should contain under one per cent of magnetic iron; and third, we believed there was a market for the rock cobbed out in the dry plant.[6] If I had been smart enough, I could have easily corrected two of these erroneous procedures myself, but the third was a management error.

We did, however, learn a few things. We found out how to magnetize and demagnetize the ore, but we never put this information to proper use and, therefore, never got the proper value from it. We learned that the size distribution of balls in the mill was critical, but discarded any idea of ball rationing because we thought small balls were far too expensive. We never considered any-

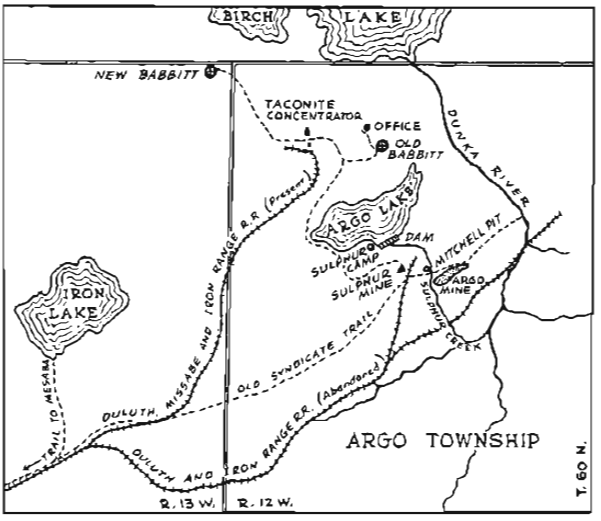
[6] Today we use seven per cent solids and four per cent magnetic iron, and we have learned that the rock cobbed out cannot be sold because it is too heavy.

thing but cast-iron balls. I remember making some tests that showed surprisingly good results with a synthetic charge using balls no larger than two inches in size. Although balls of this size are now being used, the tests were only of academic interest at the time. We developed the wet-drum cobber, but never though of a rubber cover. Therefore, we were so concerned about wear that we never used the cobber properly. We knew that the slime and the concentrate plugged up the filter cloth, but we never thought of removing the slime by classification. We investigated sintering very carefully and learned that we needed nine per cent moisture and seven per cent coal in the sintering mixture. We did not, however, recognize the importance of maintaining these proportions accurately and consistently. The value of coarse sinter returns was not recognized, but we did learn that the sinter should be cooled slowly and not quenched.

The cost of the Duluth plant and its three years of operation from July, 1916, to January, 1919, amounted to about five hundred thousand dollars. Perhaps this was a high price to pay for the information we gathered, but at least the money was not all lost.

ALTHOUGH I left the Mesabi Syndicate in December, 1918, to return to the Mines Experiment Station, I still acted as a consultant for the syndicate and spent much time at Duluth and Sulphur. During 1919 things were pretty dead, but in 1920 the decision was made to build a plant near the mine. The old Mesabi Syndicate, which had been organized to provide money for the experimental plant at Duluth, was dissolved and the contributors were given preferred stock in the Mesabi Iron Company. This was later recalled and common stock was issued in its place.

The first step toward building the new plant was the organization of a drafting crew, which was installed at Sulphur in a new building erected near the old office. Quite a study had been made of available



ARGO *Township and the Babbitt Area*

plant sites, taking into consideration water supply, tailing disposal, and mining locations. The selection of a mining location was comparatively simple. The quality of the taconite, the depth of stripping, and the accessibility to the railroad all pointed favorably toward an area just east of the old Mitchell pit.

The selection of a millsite was not so easy. Some half-dozen locations were studied and some were surveyed. In those days, we thought we had to have a good hillside location, and this was not easy to find near the mine. The Dunka River was accepted as the source of water, and a site for a dam was selected near a possible millsite several miles east of Sulphur on the old logging spur.

Mr. Jackling came up in his private car, named the "Cypress," and after looking over some of the proposed plant locations, immediately selected a new site on the north side of the formation, where the present mill buildings stand. Water was to be secured primarily from Birch Lake, about two miles away. A dam across Sulphur Creek and a pumping station at Iron Lake were to form auxiliary water supplies. A townsite was selected and the construction of a new office building was started in the early

spring of 1920.[7] To begin work the carpenters walked across the ice of a swamp and lake that had formed behind a small stripping dam across Sulphur Creek. The new town was to be called Argo, suggesting the story of Jason and the Golden Fleece, but postal authorities found another town of that name in the state.[8] The name was then changed to Babbitt, for Judge Kurnal R. Babbitt of New York City, who had been an associate of Mr. Jackling and Mr. Hayden and who had recently died.[9] I well remember Mr. Jackling's visits and how much impressed I was at first by his importance. He always had a secretary at his heels and a messenger to bring telegrams to him wherever he was. He criticized violently nearly everything he saw and was even critical of people, including Mr. Swart and Fred Jordan. Mr. Counselman and I didn't count.

The drafting crew, increased in size, was moved to Babbitt in 1920. George Des Brisay was in charge, but Ben Mitchell was sent from Salt Lake City, Utah, as a consultant by Mr. Jackling. As soon as the office was completed, bunkhouses were built for the crew. A large star-shaped eating house that could accommodate several hundred men also was erected. The railroad was extended across the formation to Babbitt, and actual construction on the new mill started in the summer of 1920. It was completed and the first sinter produced in July, 1922.

Fred Jordan not only supervised the construction program, but was also in charge of the operation of the whole project after it was completed. Bill Mudge was mine superintendent. He had about ten electrically operated churn drills and one two-yard steam shovel. The ore was hauled to the mill in side-dump cars, using steam locomotives. The stripping from the mine was used to build a dam across Sulphur Creek to impound water for the mill.

At that time, the town consisted of about fifteen houses, all on the old Babbitt site. Included were a bunkhouse for several hundred men, a store operated by a man from Moose Mountain named C. B. Marshall, a hospital with Dr. Paul D. McCarty in charge, a dormitory for about twenty-five men, and a sort of community hall, which was used as a church on Sundays and for dancing and moving pictures during the week.

I remember when the community hall was given its grand opening one Saturday night. The boys had organized an orchestra and the ladies had prepared a lunch. Mrs. Swart, who was a stanch Baptist, told all the women in camp that she did not want dancing since church services were to be held in the hall for the first time on the following day. But she forgot to tell my wife, who was a visitor, and she forgot to tell Mr. Swart. When the music started, Mr. Swart began dancing with Mrs. Davis and, of course, the whole crowd took it up. After a while, Mr. Swart looked up and said, "Where's Mrs. Swart?" Someone said she had gone home quite a while before. Mr. Swart grabbed his hat and left, but the dancing went right on.

Ted Counselman was in charge of the metallurgical operation in the plant, and shortly after the work started, he became the proud father of twins—the first white children born in the town of Babbitt. It was a great occasion. The Counselman mansion became something of a show place,

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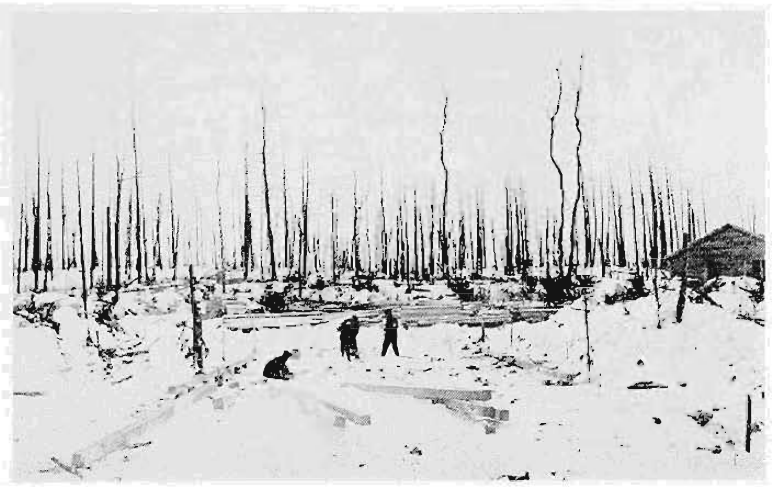
[7] This was the beginning of the old town of Babbitt on the south slope of the Granite Ridge. A valley to the north of the ridge is the site of the new town of the same name. Between them, on the north slope of the ridge, is the Reserve Mining Company's plant, on the same site as the original plant. *Ed.*

[8] The earlier village of Argo is in Winona County. The name has been used in St. Louis County to designate a lake south of the original townsite of Babbitt, the township in which old Babbitt is located, and a village on the Duluth and Iron Range Railroad. *Ed.*

[9] Judge Babbitt, who died on February 15, 1920, was general counsel for and a director of several mining companies. Before removing to New York in 1908, he practiced law in Colorado at Aspen, Cripple Creek, and Colorado Springs. *Who Was Who in America*, 40 (Chicago, 1942). *Ed.*



BUILDING *operations at Babbitt in February, 1920*

for the Counselmans not only had twins but a washing machine.

We had lots of excitement in Babbitt. There was the night when a couple of strangers stopped at the bunkhouse and started a card game. They were not doing so well and toward morning they held up the place. An old Swedish carpenter quietly got his rifle, and when the strangers left, he followed them outside. They began shooting at him with revolvers, but he calmly spotted one of them behind a log, shot right through the log, and killed the man. That was the first death in Babbitt. The other would-be robber then gave up.

During the construction period, Mr. Swart's only daughter, Molly, was married on the coldest day I remember up there. The temperature was twenty-five below zero, and a strong wind was blowing. It was one of the few days that winter when the steel construction gang did not work. The wedding was the first, and perhaps the only one, ever to take place in the old town of Babbitt.

But the prize story was one about Oscar Anderson. I was in on only a part of it, but that part is good enough because it shows the kind of people who spend their lives in these remote spots. Oscar was an old trapper who had lived near the Dunka River for many years. One day after a road from the Embarrass-Ely highway was put through to Babbitt, Oscar decided to take a trip. With some money obtained by selling his rifle, he was going to Faribault to visit his daughter, whom he had not seen for seventeen years. He had not been farther from the Dunka than Mesaba in that whole time. I rode with him on the bus as far as Duluth and left him at the station there with a ticket to Faribault clutched firmly in his hand. About a week later, I learned that Oscar was back in Babbitt, mad as he could be. It seems that he had spent all his money to go and see his daughter, and when he got to Faribault he found that she had been dead for eight years.

During the construction period, it was very hard to keep men in camp. The turnover was terrific – about twenty-five per cent each week. When the weekly train came in on Saturday, a hundred men would get on and another hundred new men recruited in Duluth would get off. Mr. Jackling was very abusive about this. I heard him say, "Give them strawberries and cream if they want it." It was bad. The work was behind schedule and was still slowing down when suddenly everything became calm and peaceful and the turnover dropped to comparatively nothing. We all kept our mouths shut and our fingers crossed, but Mrs. Swart somehow discovered the reason and immediately notified the authorities in Ely. They went over to the mouth of the

Dunka, chased two Finlanders and their flock of girls away, destroyed the liquor and gambling equipment, and burned the cabins there. After that, the turnover went back to normal. I'll bet you can still follow the trail the men made to the Dunka. It was four feet wide and packed hard as a pavement.

IN THE early spring of 1921, when the Babbitt plant was about half finished, I received from Clement K. Quinn and Company, sales agents for the Mesabi sinter, an ore sales book showing the grade of ore the Mesabi Iron Company would have available. I was much surprised to find that Mesabi sinter was being advertised for sale at an analysis of sixty-four per cent iron and nine per cent silica. We had never made any concentrate of that grade, let alone sinter, and the plant under construction was not designed to produce sinter averaging better than sixty-one per cent iron and fourteen per cent silica.

I immediately went to Babbitt and questioned Mr. Swart. He informed me that an investigation of the market for iron ore showed that it would be necessary to get the silica down to nine per cent in the sinter. I told him I knew of no way to do this, but he said that they would have to reduce capacities, grind finer, and make this grade.

The Babbitt plant was designed to produce about five hundred tons of sinter a day. I have definite records of the first few months' operation, because the university and I were sharing a royalty of one cent per ton for the magnetic separators. The figures are as follows: September, 1922 — 5,807 tons; October — 4,369 tons; November — 499 tons; December — 6,755 tons. I have no record of the analysis, but would expect it to be between sixty and sixty-one per cent iron. The struggle to make a higher grade product than the plant was designed to produce was largely responsible for the low production rate.

Of course, other difficulties occurred. In the quarry, the rock broke into large pieces and much mudcapping was required. In the crushing plant, the gyratory crushers gave constant trouble, principally because the shafts broke. In the roll plant, the dust was terrific, and constant attention was needed to keep the roll shells from corrugating. In the fine-grinding plant, the pipe launders got out of line and the couplings broke. In the concentration plant, the wet cobbers frequently became grounded, and pieces of wood and other foreign materials bent the copper spirals in the magnetic log washer. Filter cloths had to be changed almost continually because they clogged up with slime, and the plan of mixing the sintering fuel in the filter was found to be very questionable. The inclined Dwight and Lloyd sintering machine broke down almost daily, and the dust loss through the fan was excessive.

The plant was built with the idea that the coarse rock consisting of particles up to two inches in size, cobbed out in the roll plant, would be sold for making concrete at an average price of twenty-five cents a ton at the mine. It was soon learned that the rock was so heavy — about one and one-half times the weight of gravel — that no one wanted to use it. Consequently, this source of revenue vanished. The plan had been to cob out a third of the rock at a magnetic iron assay of ten per cent. This cobbing continued all during the operation of the plant, but since the rock could not be sold it represented a net loss of iron units and money.

I have always felt that the failure of the Babbitt plant to continue in operation should be blamed, in the last analysis, on bad judgment. Certainly there were mistakes in the flow sheet, in the plant design, in the equipment, and in the operating methods, but these could have been ironed out and many of them are to be expected in any new plant. The one really bad mistake, however, was our failure to realize that our final concentrate would have to contain not more than nine per cent silica. Mr. Swart

was new in the iron ore business – as new as I was – but he was in constant touch with the Duluth crowd and various consuming organizations. Fred Jordan had actually been making and selling Moose Mountain briquets. Nevertheless, the nine per cent silica requirement was not recognized until the plant was half completed. The plant did produce sixty per cent sinter with fifteen per cent silica quite easily. The secondary crushing equipment could have been redesigned or changed. Coarse cobbing could have been eliminated, and the sintering machine could have been rebuilt. With these changes and more operating experience, I believe sixty per cent iron sinter could have been made for three dollars per ton.

If Mr. Hayden, who was a director in many large companies, had had greater faith, I am sure that he could have disposed of the sinter for enough to cover expenses. The plant could then have remained in operation long enough to develop a new flow sheet to produce sixty-four per cent iron. Mr. Hayden, however, took the position that he had done all he could properly do in providing the money. It was now up to the management to begin paying dividends. There was only one answer to that, and the plant was shut down so fast that newly delivered supplies were not even taken into the warehouse from the loading platform.

Mr. Swart was a grand person, but he was a born optimist. He mortgaged everything he had – even his life insurance – to buy Mesabi Iron Company stock at eight dollars a share. (This stock is now selling for more than forty dollars a share.) Mr. Hayden turned over a thousand shares each to Mr. Jordan, Mr. Counselman, and myself. We thought it was a gift for meritorious service or something similar, until we began to receive bills when the plant closed down. Fred never did pay. He was working for the Youngstown Sheet and Tube Company at the time he died. He was exactly Mr. Swart's age, but seemed much younger.

So ends the first chapter in the history of taconite development. Now – thirty-five years later – the second chapter is being written at Babbitt and Silver Bay.

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TACONITE
plant at Babbitt about 1923