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# THE 1949 DISCOVERY OF THE GRACE MINE IRON DEPOSIT<sup>1</sup>

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by Heyward M. Wharton<sup>2</sup>  
Missouri Geological Survey

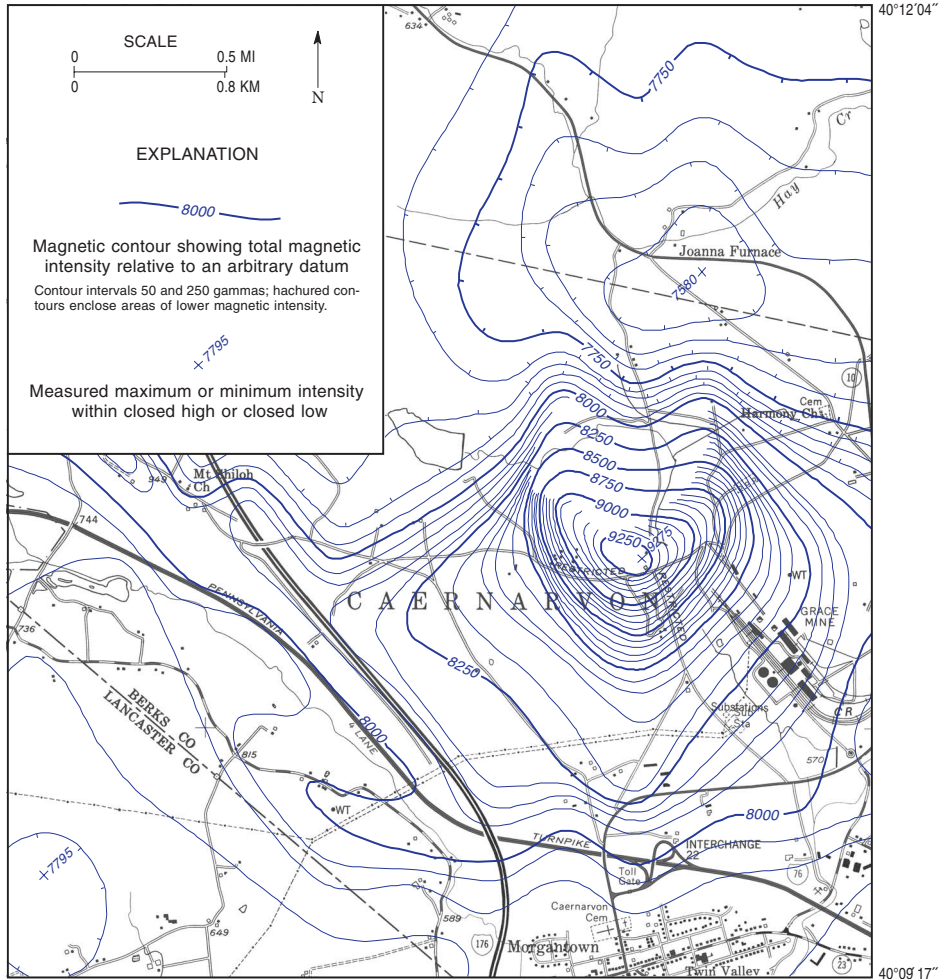
**BACKGROUND.** Donald M. Fraser, the Chief Geologist at Bethlehem Steel, was credited with the discovery of additional iron ore at the company's historic Cornwall mines near Lebanon, Pa., by means of ground magnetic surveys. Then, in 1948, the company's Geology Department contracted with Aero Service Corporation in Philadelphia to make aeromagnetic surveys of the major lower Mesozoic basins in Pennsylvania, because these were known hosts for several important Cornwall-type iron deposits. Technical equipment for airborne magnetometer surveys had been developed by Gulf Research and Development Company, just before World War II, and improvements were made during the war through research for the U.S. Navy, which was interested in antisubmarine detection. An Aero Service geophysicist, William Agocs, was assigned to Bethlehem Steel to help evaluate the numerous magnetic anomalies shown on the new aeromagnetic maps. Two of the most promising anomalies were near Morgantown, Berks County, and at Pine Swamp, near Warwick, Chester County. An aeromagnetic map of the Morgantown anomaly is shown in Figure 1. The map is one of the products of aeromagnetic surveys flown in 1957 by the U.S. Geological Survey in cooperation with the Pennsylvania Geological Survey, nine years after the initial surveys for Bethlehem Steel.

Aeromagnetic surveys were a tremendous advance over the traditional ground magnetic surveys. They could cover large areas quickly and at modest cost, with no need for permission from landowners. They could also cover very rough terrain without difficulty. The aeromagnetic surveys not only were important for discovering buried mineral deposits but also were helpful in mapping subsurface geology and structure, thereby becoming a standard and useful tool

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<sup>1</sup>Modified from Wharton, H. M., 2002, Recollections of the discovery in 1949 of the Grace mine iron deposit at Morgantown, Berks Co., Pa.: Friends of Mineralogy, Pennsylvania Chapter, Newsletter, v. 30, no. 4, p. 3–8.

<sup>2</sup>Retired.



**Figure 1. Portion of an aeromagnetic map of the Morgantown area showing the anomaly at the Grace mine iron orebody. Contours from Bromery and others (1959). Base map modified from U.S. Geological Survey Morgantown 7.5-minute topographic quadrangle map, 1956, photorevised 1969 and 1975.**

for both oil and mining companies. The Grace mine anomaly, identified in 1948, was the first instance of an ore discovery resulting from an airborne magnetometer survey (Sims, 1968, p. 109).

**DRILLING THE MAGNETIC ANOMALY AT MORGANTOWN.** Land acquisition for areas covering the most promising anomalies was quietly undertaken by Bethlehem Steel. The first core drilling rig was

delivered to the Morgantown site on September 1, 1949 (Bingham, 1957, p. 45). My job was to “sit” on the rig and log the drill cores. I rented a room in Honey Brook, a few miles from Morgantown, so as not to attract attention. There was a lot of speculation by local residents after the purchase of groups of farms in the area, and, later on, after visits to the drill site by newspaper reporters and others trying to find out what the drillers were up to. We were careful not to divulge anything. When the job began, there was a single daylight shift at the drill, but progress was slow, often due to mishaps. The drill hole collared in Triassic red beds, sandstones, shales, and conglomerates of the Brunswick Formation, and later reached the basal Stockton Formation (Sims, 1968, Table 2, p. 111). Many drill cores contained disseminated pyrite, which helped to keep us interested as we did the logging.

People in the Bethlehem office soon became nervous, wondering if the anomaly might not actually amount to anything important, so a second shift was added at the drill site to speed things up. Another geologist came down from Bethlehem to log core during the day shift, and I took over from around 4 p.m. to 11 p.m. Finally, on December 19, 1949, iron ore was hit at a depth of 1,524 feet. I was at the rig that afternoon, and the drillers and I could see that something was up when the drill cuttings suddenly changed color from red to black. However, I waited to see the drill cores, to be really sure it was iron ore, and then drove to Reading in order to assure some privacy while phoning Donald Fraser at his home. Donald Fraser, George Adair (a senior geologist), and a couple of Bethlehem Steel vice presidents drove down to the drill site, arriving about midnight with a bottle of bourbon. We were all pretty excited! Even at this point, the experienced geologists at Bethlehem Steel were quite sure a major iron deposit had been discovered.

**GEOLOGY AND ORE GENESIS.** The Triassic red beds at the Morgantown site were deposited on an ancient erosion surface formed on folded Cambrian strata; the contact represents a profound unconformity, and also marks the top, or hanging wall, of the orebody. The iron ore was dominantly magnetite, which accounts for the prominent magnetic anomaly (Figure 1). The main accessory minerals were pyrite, chalcopyrite, and, locally, pyrrhotite. Less common were sphalerite, marcasite, galena, hematite, digenite, and goethite (Sims, 1968, p. 116–117). The magnetite mineralization replaced a large wedge of impure Cambrian limestone already altered to calcium and

magnesian silicates by contact metamorphism from a thick, subjacent intrusive sheet of diabase (Sims, 1968, p. 122–123).

Sims (1968) contended that after cooling and crystallization of the diabase, the altered limestone was invaded by mineralizing solutions, presumably from the same magma chamber that yielded the earlier diabase intrusive. Along with the introduction of magnetite and its accessory minerals, the silicate minerals in the altered limestone were hydrated and converted to serpentine, talc, chlorite, and tremolite, the main gangue minerals. The No. 1 drill hole cut over 400 feet of ore, followed by about 25 feet of weakly mineralized limestone, and, finally, about 20 feet of nearly pure tremolite in contact with the thick (up to 1,200 feet) diabase sheet (Sims, 1968, Figure 6, p. 121). Sims (1968) has a summary description of the drill cores (including assays and mineral contents), a geologic map of the mine area, a block diagram, and a plan map of the orebody.



**Figure 2.** The No. 2 drill hole at the Morgantown site. For scale, note the figure on the tripod platform.

### **DISCOVERY LEADS TO GRACE MINE DEVELOPMENT.**

The No. 2 drill hole (Figure 2) was spotted about 1,000 feet south of the No. 1 discovery hole. Surprisingly, it was a blank hole, due to the abrupt termination of the orebody in that direction. In the meantime, several truck-mounted drills were moved into the area. One or another of the drill holes was purposely drilled through the diabase to see if iron ore occurred along its lower contact. Bingham (1957, p. 45) stated that by January 1951, the orebody had been delineated by 17 drill holes, averaging 2,200 feet deep; mine development was then initiated. The new operation was named the Grace mine

in honor of Eugene C. Grace, the chairman of Bethlehem Steel at the time and an enthusiastic supporter of the company's exploration program. Bingham (1957, p. 47–48) added that the mine, having been designed to produce 9,600 tons per day of crude ore grading 42.5 percent iron, would yield about 5,760 tons per day of iron ore pellets, averaging 65 percent iron. Design capacity of the mine and plant on a yearly basis were, respectively, 3 million tons per year (t/yr) of crude ore and about 1.5 million t/yr of iron ore pellets. Mine production began in 1958, and the maximum annual production of crude ore from 1958 through 1964 was 2,911,054 tons of iron ore in 1962 (Sims, 1968, Table 1, p. 110).

Sims (1968, Figures 3 and 4, p. 113–114) reported that the orebody is roughly tabular, about 3,500 feet long, 700 to 1,500 feet wide, and from less than 50 to over 400 feet thick, and ranges in depth from 600 to 2,200 feet below sea level. It was estimated to contain about 118 million short tons of ore (Eben, 1996). The ore was concentrated using magnetic separators, then pelletized for shipments to one or another of the three nearby Bethlehem Steel plants. Tailings from the magnetic separators were treated in a pyrite flotation plant, and the pyrite concentrate was then shipped to Bethlehem's Sparrows Point, Md., sulfuric acid plant. Copper, cobalt, and gold were recovered from Cornwall ores, but only copper was recovered from Grace mine ores because of their lower contents of cobalt and gold (S. J. Sims, written commun., 1992).

**GROUND CHECKING PROMINENT AIRBORNE MAGNETIC ANOMALIES: A NEAR MISS.** Personnel from the Cornwall Mines Division took over the drilling program at Morgantown after a couple of months, and I was assigned to assist a senior geologist, Dick Lake, in field checking some of the other anomalies on the new aeromagnetic maps. We started near Gettysburg and worked back toward the office in Bethlehem. One of our last projects, before I left to attend graduate school in September 1950, was a ground magnetic survey of the major Pine Swamp anomaly near Warwick, Chester County. We used a Hotchkiss Superdip instrument (Figure 3) and made a series of north-south traverses covering the anomaly. It was later drilled by Bethlehem Steel, and an iron deposit was discovered, but I was told that the deposit was not considered economic to mine. In a geophysical investigation, Gedde (1965, p. 46) estimated the volume of an iron deposit necessary to form the Pine Swamp anomaly, which converts to approximately 30 million tons of potential iron ore. The iron mineralization at Pine Swamp replaced the Precambrian Franklin Mar-



**Figure 3. The author with the Hotchkiss Superdip instrument at the Pine Swamp anomaly, near Warwick, Pa.**

ble, as at the nearby French Creek mine. The Pine Swamp locality is near the formerly important Jones, Hopewell, and Warwick mines, but it was not mined in conjunction with those older mines because it was deeply buried, like the Grace mine orebody, and had not been detected.

**SUCCESSSES CUT SHORT.** The Grace mine had a long and productive life and was an important contributor to the regional economy. Employment peaked at 1,100 workers in the early 1970s (C. F. Eben, written commun., 2002). A photograph of the surface plant gives some idea of the size and scale of the operation (Figure 4). Production began in 1958 and was suspended in 1977 due to depressed conditions in the U.S. steel industry and the fact that underground mining was much more expensive than the increasingly important open-pit operations. Barnes and Smith (2001, p. 19 and 24) reported that at the time of closure a zone of ore 480 feet thick and richer in copper had been outlined by drilling to the northeast. A total of 45 million tons of crude ore was produced at the mine, which compares favorably with the total of 106 million tons of iron ore produced at the Cornwall mine between 1742 and June 30, 1973.

Closure at Cornwall, like that at the Grace mine, was premature. Serious flooding of the mine workings at Cornwall resulted from the heavy rains accompanying tropical storm Agnes in 1972, and it was decided to cease operations at the mine.



**Figure 4. The Grace mine surface plant in 1977. Photograph contributed by S. J. Sims.**

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## ABOUT THE AUTHOR

*Heyward M. Wharton is an economic geologist. His first job was with the Bethlehem Steel Company in early 1948. In addition to his assignments in Pennsylvania, the job included work in West Africa and Brazil. In 1955, he worked for the New Jersey Zinc Company in Colorado doing uranium exploration and mining. Next he worked for Union Carbide Corporation doing general exploration in the western part of the country. At the end of 1965, he was employed as an economic geologist by the Missouri Geological Survey in Rolla, Mo. He retired in June 1988, after nearly 23 years of service.*

*Some of Heyward's forebears in Philadelphia had important roles in Pennsylvania's mineral industry. His great-grandfather operated iron furnaces in Adams County during the Civil War period. Heyward is distantly related to Joseph Wharton, the Quaker industrialist who founded the Wharton School at the University of Pennsylvania. That gentleman was an important manager and innovator in the United States zinc and nickel industries. Joseph Wharton was the primary operator of the Gap nickel mine. He was also a director and stockholder of the fledgling Bethlehem Iron Company that later became the giant corporation.*