A STUDY OF THE CRANBERRY ORE BELT

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by

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PREFACE

The purpose of this study of the Cranberry ore belt was made to learn more about the findings of previous investigations; to examine the results of testings done on the magnetite from the Cranberry area; to study more carefully the available land grants, charters, deeds, and personal papers connected with the operations; to review the operation of the iron production of the region from colonial days until cessation of operations in 1930; to explore information of the expanse of the ore deposits prevalent; and, to record some of the personal knowledge about the Cranberry ore belt known only to those elderly persons yet living who helped to make this interesting chapter in the history of western North Carolina and east Tennessee.

The study was undertaken at the personal suggestion of Dr. D. J. Whitener of the Appalachian State Teachers College, Boone, North Carolina, who recognized better than the writer that this ore belt merited more study with the possibility of forming some conclusion as to the probability of any future utilization of the minerals of the region.

Due to the nature of the study the materials treating it are very restricted. Much of the information is from reports made by persons of some renown in historical and geological fields, some of it is from the elderly people of the area who helped with the operation of the Cranberry mine, and some of it is from the personal experience of the writer who was fortunate to have lived his entire life about ten miles from the mine.

The writer expresses his sincere appreciation to those persons in the area who assisted greatly in sharing information, especially to S. H. Odom, superintendent of the mine during the latter years of its operation; to James M. Bowlick, father and companion of the writer and laborer at the mine for many years; to Joseph David, geologist for the United States Bureau of Mines during the schedule of diamond-drill testing from 1943 until 1946; and, to all those from whom the writer learned about the Cranberry ore belt, directly and indirectly.

Finally, the writer's sincerest thanks go to the Advisory Committee, Dr. J. D. Whitener, Dr. J. C. Yoder, and Dr. Lee F. Reynolds, for the generous cooperation extended so unsparingly during the prosecution of this study.

Elk Park, North Carolina C. A. Bowlick

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THE HISTORICAL ASPECTS

It may be helpful in a study of the Cranberry ore belt to examine the history of the region. Since the mining of the ore was done mainly in the western part of North Carolina and the smelting in east Tennessee, both of these areas will be considered.

The land of this region was included in a grant made by Charles II of England to eight of his friends in 1663, the most active of whom was Anthony Ashley Cooper, later Earl of Shaftesbury. John Locke, the former tutor to the king, worked out a highly elaborate model state with a feudal hierarchy, but it was not adaptable and was never put in actual operation. Proprietary rule in the Carolinas came to an end in 1729.[1]

The Catawba Indians held the territory to the crest of the Blue Ridge. Many finished and unfinished arrowheads, pipes, stone hatchets, pots and other relics found here offer proof that the Indians roamed freely the mountain valleys. Numbers of mounds have been found, but only Indian relics of the common type have been discovered.[2] About a mile above Heaton, North Carolina, on Curtis Creek, is a cave in

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[1]H. U. Faulkner, American Economic History (New York: Harper & Brothers, 1929), pp. 54-55.

[2]J. P. Arthur, History of Western North Carolina (Raleigh: Edwards and Broughton, 1914), p. 14.

which Indian relics, including two round-shaped clay pots and some leg bones were found a few years ago. One of the pots held about four pints and the other ten. The lesser one had been placed bottom up inside an opening just large enough to admit a small man. The other one was over it. The bones were discovered in a larger compartment of the cave, however, the opening was too small to enter. Exploration was done by using a flashlight and viewing the skeleton from the outside. Nearby in another part of the cave was a long clay jar-like vessel wedged between two slanting rocks. This was not recoverable due to the distance it had rolled before becoming wedged in the crevice. Many smaller relics have been found in the vicinity of this cave, especially they have been seen on a plot of nearly level land a half mile away. The clay pots were carried to the store of the Cranberry Iron and Coal Company at Cranberry where they were displayed for several days. Later Emmett Monday sold them to the superintendent of the Cranberry Mine.[3]

Although the mountains of the area were not settled during colonial days, except the ridge between the Toe and Watauga rivers, the people who did cross the Blue Ridge lived under colonial laws and customs, or descended from the pioneers who did.[4] For a century and a half the English were confined to the Appalachian coast district. Their

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[3]Explored by the writer with Emmett Monday about 1925.

[4]J. P. Arthur, op. cit., p. 60.

fringe of the continent was more like the European homes of the colonists than any other part of America. The rugged Appalachians, singularly impassable for such low mountains, kept the settlement from scattering too widely. This compactness influenced the development of a less dependent quality among the people and probably influenced the industry of the region.[5] The foothills were settled early in the history of the state, and there was a sparse population of the eastern slopes of the Blue Ridge long before anyone ventured to establish a home in the mountains beyond the barrier, the first permanent settlers west of the Blue Ridge not appearing until after the Revolutionary War, in the course of which the Indians were partly subdued. As time passed the restless drifting of people who had come to America in search of homes brought one and another to the mountains. These settlers did not realize their ambition, but many of them found a home according to the modest standards of the time.[6]

The forest trails became the highways for the white settlers to travel. The same type of people who settled Virginia and the eastern part of the Carolinas peopled the western mountains, English predominating. Eventually there drifted down from Virginia large numbers of Scotch-Irish who, after the events of 1730, came in such large numbers

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[5]W. M. West, The American People (New York: Allyn & Bacon, 1928), p. 8.

[6]Margaret W. Morley, The Carolina Mountains (New York: Houghton Mifflin Company, 1913), p.138.

to the New World. Also, after 1745, many Scotch Highlanders came to the mountains. So many of these staunch people came to western Carolina that they have given the dominant note to the character of the mountaineer.[7] In all the region there was little aristocracy, few large proprietors, few gentry, few servants, and almost no slaves. Nearly every male settler was a free proprietor working his own land and using products of his own labor. There were fewer schools and clergy than in the eastern part of the colony; and the hard conditions of life, with constant contact with the savages, developed a rudeness of manner and a ruthlessness of temper which were characteristic of the frontier. Both for good and bad, these conditions tempered the frontiersmen into the first true Americans.[8]

Although early isolation prevented free communication with other inhabited parts of the colony, these settlers established themselves and met the frontier hardships bravely. Similar problems developed similar ideals, viewpoints, and attitudes.[9] Self-reliance, sturdiness of character, sterness of belief, deep religious feeling, and truly democratic attitudes proved to be some of the more worthy characteristics of the mountaineer of western North Carolina. The several nationalities

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[7]Ibid., p. 141.

[8]Ellen Semple, American History and Its Geographical Conditions (New York: Houghton Mifflin Company, 1933), p. 72.

[9]Loc. cit.

soon merged into oneness and intermarriage became very prevalent.[10]

When the first Continental Congress began its sittings the only frontiersmen west of the mountains and beyond the limits of continuous settlement within the original thirteen colonies were the two or three hundred citizens of the Little Watauga Commonwealth, and a commonwealth it was being beyond the jurisdiction of any government except the consciences of the inhabitants. The building of the commonwealth by John Sevier and James Robertson gave a base of operations and furnished a model for similar commonwealths to follow.[11]

In 1763, a royal proclamation forbade English colonists to settle anywhere west of the mountains. The English government dreaded Indian wars that were certain to follow the advance of the frontiersman, and it was also influenced by rich commercial companies which desired to retain the vast Mississippi valley as a fur trading preserve. Even had England remained the possessor, this attempt to prohibit settlement of the region was doomed.[12] The restless farmers of the Appalachian valleys had begun to feel crowded, and it was impossible to hold back the land-hungry settlers impatient to escape the restrictions of the more conservative eastern counties. During the year of the Proclamation the first settlers pushed forward and established themselves on the

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[10]Theodore Roosevelt, The Winning of the West (New York: G. P. Putnam's Sons, 1899), I, p. 105.

[11]Theodore Roosevelt, op. cit., III, pp. 276-280.

[12]W. M. West, op. cit., p. 169.

upper Yadkin river; six years later Robertson and Sevier led a band of Virginia frontiersmen into the Watauga valley and planted a settlement which by 1772 comprised thirteen stockaded forts.[13] Disputes between Virginia and North Carolina over jurisdiction led finally to a meeting of representatives from the thirteen forts. These representatives drew up the first written constitution adopted west of the mountains by American-born frontiersmen, known as the "Articles of Association." It provided, among other things, for manhood suffrage and religious freedom.

For six years the Watauga settlement retained an independent government. In 1778, after the Revolution had reformed North Carolina, the group of Watauga settlements recognized the authority of that State and became Washington County.[14]

In 1784, North Carolina ceded her lands west of the mountains to the Congress of the Confederation, but that dilatory body never accepted the grant. Accordingly, the Westerners complained bitterly that North Carolina had cast them off; and, in August 1784, a convention of forty delegates declared that district an independent state. A constitution was adopted and very soon a complete State government met with Sevier as governor. It was named Frankland, the land of the free. But now North Carolina repealed her cession; and, after some years of struggle, she succeeded in reestablishing her authority. Nevertheless, from 1790 until

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[13]H. U. Faulkner, op. cit., p. 170.

[14]W. M. West, op cit., pp. 171-172.

1796, when these settlements were incorporated into the State of Tennessee upon its admission into the Union, North Carolina took a more generous view of the West.[15]

The earliest grants secured for lands in the region were by John McKnitt Alexander and William Sharpe for acreages in the Cranberry and Toe River valley vicinity. Alexander lived in Mecklenburg county and was secretary to the convention that drew up the Resolves of May 1775. He was a close friend of colonel Waightstill Avery who at the time was practicing law in east Tennessee and western North Carolina. Sharpe was one of the leading men of North Carolina, having served as aide-de-camp to General Griffith Rutherford in the Indian wars, as a commissioner to make a treaty with the Indians at Long Island of the Holston, as a member of the Constitutional Convention in 1776, and in the Continental Congress.[16]

These men secured four grants dated December 10, 1778. One tract lay at the mouth of Rock Creek, near the present site of Bakersville, North Carolina, and the last tract on the side of the Yellow Mountain near the Cranberry ore belt. It appears probable that they were more interested in minerals since only two of these tracts would be considered good for agricultural purposes, and the other two having no value except

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[15]Ibid., p. 180.

[16]John H. Wheeler, Historical Sketches of North Carolina (Philadelphia: Lippincott, Grambo Company, 1851), p. 78.

for the mineral ores on them. The outcrops of iron, mica, or other mineral might have attracted their attention to the region. It would appear that they never planned to live on the land.[17]

Probably the first grant taken out by a resident of the area was the one secured by a man named Samuel Bright on March 5, 1780. It was for 360 acres of land lying in the valley of the North Toe River. Bright was a loyalist and lived about three miles from McKinney Gap. Bright's Trace took its name from him. It appears that he was in league with the Indians and had probably lived with them before the Revolution. He served as a guide for parties crossing the mountains, and he went west some time before 1800 with a family by the name of Grant. It is thought that these were the ancestors of Ulysses Simpson Grant, eighteenth President of the United States.[18]

Not long after Bright's grant was issued, others were taken out by William Wiseman, William Davenport, William Davis, and William Pendley. Wiseman, Davis, and Pendley were co-adventurers who left London together as boys and remained together thereafter. They landed in New England, made their way south, lingered for awhile on John's River, became guides to hunting parties going into the mountains, and Wiseman became a soldier in the Revolutionary War. They later took up land in the North Toe

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[17]Loc. cit.

[18]John P. Arthur, History of Watauga County (Richmond: Everett Waddey Company, 1915), pp. 54-55.

River valley where Wiseman became the first magistrate of the area.[19]

About 1780, Reuben White took out a claim for the one hundred acres of land supposed to cover the Cranberry ore belt, and Waightstill Avery received four small grants surrounding White's tract.[20] In addition to these Avery procured hundreds of 640-acre sections of land covering all the North Toe River valley from its head to Toecane, North Carolina, and grants along Squirrel, Roaring, Henson, and Three Mile creeks, the lower valley of the South Toe and Linville rivers.[21]

In 1795, William Cathcart took out two large grants, one known as the 99,000-acre tract and the other as the 59,000-acre tract. These grants covered mainly all the lands now comprising Avery and Mitchell counties, except some land along the Blue Ridge, and embraces the lands theretofore granted to Avery. Later Avery devised all this land to his son, Isaac T. Avery, whereupon a controversy arose between the father of John Evans Brown, agent for the claimants under the Cathcart grants, and Avery. This resulted in the execution of compromise deeds in 1853. Isaac T. Avery received a quit claim to about 50,000 acres of land so as to include some of the lands described and the Cranberry ore belt.[22]

There were three forges for the manufacture of iron in what was

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[19]Loc. cit.

[20]Cochrans v. Improvement Company, 127 North Carolina, p. 387. Dugger v. Robbins, 100 North Carolina, p. 1.

[21]John Preston Arthur, op. cit., p. 264.

[22]See Appendix for copy of deed.

then Watauga County, North Carolina. These were Cranberry, Toe River, and Johnson. The first grew out of the discovery of the Cranberry metallic ore by Joshua, Ben, and Jake Perkins of Tennessee. They had attempted to remove the new flax shirt from a man named Wright Moreland during a feast and frolic following a log-rolling at Crab Orchard in Tennessee. The scuffle resulted in sufficient injury to Moreland to arouse his anger and cause him to procure warrants for the three men. They escaped into North Carolina, however, where they lived on the wooded part of the Hump Mountain, supporting themselves by digging wild ginseng that grew in the area. While searching for this herb along the east slope of the Hump Mountain they discovered the outcrops of the iron ore of the Cranberry belt.

Before coming into the Carolina hills to escape the sheriff, the Perkinses had worked at the old Dugger forge on Watauga River about four miles above where Butler, Tennessee, once stood. (Watauga Lake now covers the old site of Butler and the place where the old forge was located.) This experience assisted them in constructing their forge about halfway between Cranberry and Elk Park, a short distance on the Boone roadway, and equipping it with a water trompe, furnace, goose nest, hammer, and other items necessary for manufacturing iron from the ore. This was in 1821. Soon after they began their forge Abraham Johnson, agent for John Brown, land speculator, built a forge on the left bank of Toe River about three-fourths mile above the mouth of White Oak Creek and near the mouth of Cow Camp Creek. Some of the ore for his forge came from a nearby

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[23]John Preston Arthur, loc. cit.

deposit, but most of it was hauled in wagons from the Cranberry vein. After the construction of forges at these two places a William Buckhannon had a forge about one-half mile above the present location of Minneapolis, North Carolina. This forge was built by a man named Calloway.[24] He had little or no ore nearer than the Cranberry vein and had to draw most of his supply from there.[25]

After the Perkinses had worked at the Cranberry deposit for some time they are reported to have applied for, and received, a grant from the State of North Carolina for three thousand acres of land because they had mined and forged three thousand pounds of iron from the Cranberry vein. Soon thereafter John Brown, who kept a close watch for squatters and trespassers on the Tate and Cochran lands, though then claimed by him under a junior or Cathcart grant, convinced the Perkinses that he held a superior title to theirs for the Cranberry property. As a result they purchased his title to the land and then sold it to Abe and William Dugger who had also come from the old Dugger forge near Butler, Tennessee. The Duggers operated the mine on the Cranberry lands until Abe's death, who, being offended with his son, George, for having married Carolina McNabb, left his interest in the property to his daughters, Mattie, Nancy, and Elizabeth, leaving George only fifty acres of land about one-half mile below Banners Elk, North Carolina, at the southern foot of the

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[24]Interview with Mrs. Ruth Calloway, Newland, North Carolina, February 12, 1955.

[25]John Preston Arthur, op. cit., p. 265.

Beech Mountain.

John Hardin became Mattie Dugger's guardian, she being unmarried, and took over the mine about 1850. He retained control of it until some time during the Civil War. With him was Peter Hardin, then a boy of twelve years, who remained with the mine longer than any other person. Peter was the son of a Creek Indian whom Nathaniel Taylor of Elizabethton, Tennessee, had brought with him from the Battle of the Horse Shoe in 1814.[26]

Some time between 1865 and 1868 a man named John Stacy came to Cranberry from South Carolina. It is known that he hauled ore from the mine at Cranberry to the forge in a wagon drawn by a yoke of oxen. It is probably true that he hauled much of the charcoal from the several pits in the section to the forge for smelting the ore.[27]

Jordan Hardin, son of John Hardin, assumed operation of the mine during the Civil War and worked forty to sixty men making iron for the Confederate government. This iron was hammered into bars for the manufacture of axes, and was hauled to Camp Vance below Morganton, North Carolina, by Peter Hardin in a wagon drawn by four horses. He made one trip each month, summer and winter.[28]

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[26]John P. Arthur, op. cit., p. 265-266

[27]Interview with Professor Starr Stacy, Appalachian State Teachers College, Boone, North Carolina, February 9, 1955. John Stacy was Professor Stacy's grandfather.

[28]John P. Arthur, loc. cit.

The Reuben White tract of land had in the meantime passed by a succession of conveyances to William Dugger who sold his interest to Robert F. Hoke, C. C. Hutchinson, and a man named Sumner. Dugger and Brown had entered into a written contract to hold one-half of one-fourth each of the mining interest in all the Dugger land outside the White tract. However, before Dugger conveyed the land to Hoke, Hutchinson, and Sumner, he had contracted to sell to John Hardin, Thomas Miller, and another, and had placed Hardin in possession so that the Hoke purchase was from Hardin, and associates, taking the legal rights from Dugger. Thereupon, Judge A. C. Avery, acting as executor for his father's estate, gave notice to Hoke and Company of the equitable claim of Brown and Avery in three thousand acres of land embracing the ore bank at Cranberry before they bought it from Dugger. In the ensuing litigation Avery compelled Hoke and Company to pay between $15,000 and $20,000 for the Brown and Avery claim in the Cranberry property.[29]

Thomas Carter, who had operated a plant at Linville Falls, North Carolina, for making guns during the Civil War, and General Robert F. Hoke obtained an interest in the Cranberry mine and forge. Carter had an equitable contract for a part interest held under bond for title by Hardin, Miller, and others, which led to the litigation of 1867

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[29]Ibid., pp. 415-416

in which the plaintiff agreed to convey his interest in the Cranberry ore belt to General Hoke, and others, for the sum of $44,000. When he tendered a deed he was given a draft on a New York bank. The draft was protested and never paid due to the fact that the funds for its payment were to be derived from the proceeds of the sale of the same property to another party by Hoke, and associates. Carter had defeated the sale, and upon these facts a receiver was appointed and the sale of the property enjoined. At the spring term of the Superior Court of Madison County in 1869, Hoke moved to dissolve the injunction and terminate the receivership. Upon hearing of this motion it appeared that Hoke, and associates, had affected another sale of the property to the Russells, and associates for $50,000. They claimed to be innocent buyers without notice, however, and Judge Henry granted the motion. An appeal to the North Carolina Supreme Court continued the injunction against the sale until Carter had received payment and the innocence of the Russells firm established. Not long after this Hoke compromised with Carter and a title to the property was affected as far as Carter was concerned.[30]

The interests of the original purchasers of the White and Avery tract on which the Cranberry ore bank is located, as well as interests to adjacent lands under a forge grant (junior to the 59,000-acre tract

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[30]Thomas D. Hoke v. Robert F. Hoke, et al., 64 North Carolina, p. 348.

of 1796), were sold for partition under a decree of the State Supreme Court in Morganton, North Carolina, before the Civil War, and was bought by William Dugger. He subsequently paid the purchase price and received a decree that James R. Dodge, Clerk of the Supreme Court of North Carolina, should make him a deed to the land. Before receiving the title Dugger entered into an agreement with Isaac T. Avery and John Evans Brown that the three should have a one-third interest in all the minerals of the White Ore Bank Tract. This agreement seems to have been registered; and, the Civil War coming on, the sessions of the State Supreme Court in Morganton were abolished. Colonel Dodge, the clerk of the court, died without having made a title to the land to Dugger. Judge Avery later secured, with the help of Honorable B. F. Moore, an ordinance of the Convention of 1866 authorizing the presiding Clerk of the Supreme Court of North Carolina in Raleigh to execute the title for the property to William Dugger. However, in this title the clerk failed to mention the equitable agreement among Dugger, Avery, and Brown, leading into the aforementioned litigation.[31]

After Hoke and Company sold the property soon after the Civil War it remained under the control of Peter Hardin who remained overseer for several years. He was permitted to mine, forge, and sell iron from

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[31]John P. Arthur, op. cit., pp. 417-418.

the Cranberry mine and operate a small sawmill on the property.[32]

In 1876, the ore bank was purchased by the Cranberry Iron and Coal Company, and in 1882 it was connected with Johnson City, Tennessee, by railroad. When the company began to construct the railroad, Peter Hardin kept the store at Cranberry and was the postmaster there, keeping all the accounts for the employees although he could not read and write.[33] His wife, the former Charity Greenlee, and her daughters did the clerical work for him. She was a full-blooded Negro and had been a slave for John Greenlee. It was from him that she took her surname.[34]

In 1884, a small blast furnace was built and smelting of the ore begun. Later, in 1900, this furnace was abandoned for a larger one in Johnson City, Tennessee, which had been built and was being operated by the Cranberry Furnace Company. The smelting operations at Johnson City used all the ore mined in the Cranberry ore belt after 1900, and the manufacturing of iron was continued there periodically until 1930.[35]

The Cranberry Furnace Company, a subsidiary of the Cranberry Iron and Coal Company, was chartered in 1901 by the State of New Jersey where the main offices were located. This charter was amended in 1939 to read The Tennolina Company.[36]

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[32]Interviews with the writer's father, J. M. Bowlick, who worked for Peter Hardin.

[33]John P. Arthur, op. cit., p. 267.

[34]Interviews with Mrs. James M. Bowlick and Mrs. R. N. Cardwell, ages 73 and 74 respectively, January 18, 1955.

[35]M. H. Kline and T. J. Ballard, Cranberry Magnetite Deposits (Washington: Department of the Interior, 1948), p. 5.

[36]See Appendix for copy of the charter.

Since 1884 the mine produced about 1,250,000 tons of commercial ore, and for the four years from 1917 through 1920 the annual output averaged sixty thousand tons. According to a report by S. H. Hamilton, mine geologist for the Cranberry Iron and Coal Company, the total production of all the ore from workings in the Cranberry ore belt from 1882 until the close of operation in 1930 amounted to 1,500,148 tons. This included ore mined at the Cranberry, Wilder, and other openings.[37]

After cessation of the mining operations the concentrator plant at Cranberry was dismantled, so was the furnace at Johnson City. All rails and machinery were removed from accessible parts of the mine. A large part of this material was sold for scrap iron.[38]

At the present time the mineral rights on sixteen hundred acres of land, along with the surface rights on twenty-four acres, are owned by the Tennolina Company of Philadelphia, Pennsylvania. This area contains all the major mine openings of the Cranberry ore belt. The remaining surface rights were sold to John A. Taylor of Spruce Pine, North Carolina, who has conveyed two hundred seventy-four acres to the Mead Corporation of Sylva, North Carolina and Kingsport, Tennessee. The timber and pulp wood have been mainly removed by the Mead firm. Taylor has sold several small tracts, lots, and dwellings to individuals.

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[37]M. H. Kline and T. J. Ballard, loc. cit.

[38]Interview with W. H. Whisman, Vice President, East Tennessee and Western North Carolina Railroad Company, Johnson City, Tennessee, November 13, 1954.

Much of the property, however, remains in his possession, especially the orchards the Cranberry Iron and Coal Company had planted and the farm operated along with the mining and manufacturing of the iron in the Cranberry ore belt.[39]

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[39]Interview with John A. Taylor, Spruce Pine, North Carolina, December 20, 1954. Also, personal knowledge of the writer.

CHAPTER II

REVIEW OF THE HISTORICAL LITERATURE

Dr. George Troost, State Geologist of Tennessee, in his fourth report in 1837, spoke of the Cranberry ore deposit as follows:

> The iron ore of the primordial formation is generally that which is called magnetic iron ore. Immense quantities of this ore are found in the northeastern parts of the United States. And not to speak of the vast deposits of this ore in similar formations in Washington County, Missouri, which have formed these fifty years one of the wonders of the west, nor those of Elba, which produced most of the iron used by the Romans, and the mines of which are considered yet inexhaustible. I must mention one situated near the limit which separates the State of Tennessee from North Carolina at the foot of Roan Mountain in Carter County. It seems to be an extensive vein of rich magnetic iron ore, similar to that of some parts of Sweden, and is accompanied with the same minerals as the Swedish ore, namely, a variety of pyroxene salite or malacolite.

Again in 1854 the existence of iron ores in parts of North Carolina was referred to by Whitney,[1] but the ores were not discussed. He stated that iron ores could be found in the metamorphic rocks in the western part of the State, but declared them too remote to be of much marketable value. They were considered by him to be of value only to local forges. The Census of 1850 reported but four hundred tons of iron as being produced in the State that year.

The first systematic account of the iron ores of North Carolina

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[1] J. D. Whitney, Metallic Wealth of the United States (Philadelphia: Bureau of Mines, 1854), p. 474.

was made by Kerr[2] who discussed the deposits by districts and described them in some detail, illustrating his work with several tables and maps. He briefly described the ore bank at Cranberry, stating that the country rocks around the deposit are hornblende, slate, and syenite, gray gneisses, and gneissoid slates. At the time he described the deposit the mine had not been opened, the ore was being taken from the loose masses only, which were scattered over and through the soil covering the vein. The assayer recognized the ore as being the finest he had ever analyzed. In regard to quantity Kerr believed the deposits exceeded those of Missouri or Michigan, and equal to anything in the Champlain region. He gave no details about the vein, merely saying that all the epidote was not confined to a single stratum, or part of the ore bed, but that it was mixed to some degree with the pyroxenic rocky gangue which mostly occurred toward the western side of the deposit.

Other ore deposits similar to those at Cranberry were reported to be in the northwest, west, southwest, and southeast of that at Cranberry, It was further stated that most of these were known by the outcrops only and he did not surmise as to the size of any of these.[3]

In 1876, in a report by S. T. Abert to the Chief of Army Engineers, attention was called to the construction of a railroad from

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[2] W. C. Kerr, Report of Survey of North Carolina (Raleigh: Division of Geology, 1875), pp. 217-271.

[3] Ibid., p. 266.

Johnson City, Tennessee, to Cranberry, North Carolina, in order to tap the ore at Cranberry for the use of the furnaces in Tennessee. He stated that not more than 50,000 tons of iron ore had been taken from the vein in the vicinity of Cranberry, and advised further exploration. He also mentioned the occurrence of other ore beds and of a titaniferous ore on Rock Creek.[4]

In 1883 and 1884 Smock mentioned the existence of magnetite in western North Carolina.[5]

J. W. Swank, in his Mineral Resources of the United States for 1885, made definite mention of the ore bank at Cranberry and declared it had been worked for one hundred years to supply bloomeries in the neighborhood. He stated that preparations were being made to ship the ore to distant points and smelt some of it in a small charcoal furnace that had been built near the mine. He mentioned this ore to be superior in adaptability for the manufacture of steel. The analyses appearing in his report tend to show the maintenance of character the ore possessed.[6] Again, two years later, he referred to the Cranberry ore as being well adapted for steel making by the acid process, and stated that similar ores were found in the western part of the State.[7]

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[4] S. T. Abert, Examination of Catawba River from South Carolina to Old Fort, North Carolina (Washington: United States Army Report for 1876), pp. 367-376.

[5] W. S. Bayley, Magnetic Iron Ores of East Tennessee and Western North Carolina (Washington: Bureau of Mines, 1923), p. 26.

[6] Loc. cit.

[7] Ibid., p. 27.

The Census Report on the Mining Industries of the United States beginning with July 1, 1886 contained a brief description of the ores of all the mines in North Carolina and reports of analyses. This gives us the earliest details of the mines and contains the most detailed analyses of the ores that had been published up to that time. This account was also written during the period of vigorous magnetite exploration and contains much information that would otherwise have remained unknown. In the report, for instance, are accounts of many deposits then exposed which have since been covered with debris and are no longer available for study.[8]

On a trip across the State of North Carolina, N. L. Britton made a visit to the Cranberry mine in 1887 and reported the ore to be in rocks of about the same age as those in which the New Jersey deposit is found. He described the ore as being in a bed at least one hundred feet thick and self-fluxing. It was supposed that the self-fluxing resulted from the presence of so much dark-colored pyroxene. He also said that this was associated with some epidote and insignificant amounts of white quartz and calcite, together with bands of feldspathic rock. The strata, he affirmed, to be much contorted.[9]

In 1888, John Birkinbine wrote of the magnetites of western North Carolina, mentioning the fact that the first iron ores found in

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[8] Loc. cit.

[9] N. L. Britton, Geological Notes in Western Virginia, North Carolina, and Eastern Tennessee (New York: Academy of Scientific Transportation, 1887), pp. 215-223.

the United States were located in North Carolina.[10]

Kerr and Hanna, in 1888, made quite a detailed report to the North Carolina Department of Geology in which they discussed the iron ore deposits by districts and illustrated the report with numerous maps.[11]

The general discussion about the mine is similar to that given in other contemporary accounts, except that Hanna was inclined to believe the ore is not deposited with the original sediment, but was formed at a later date by some metamorphic process. It seems that the greatest improvement over earlier accounts is the fact that this report goes into some detail describing the individual ore bodies.

No other account of the ore deposits is found until H. B. C. Nitze made his report in 1893, in which he gave a description of all the iron mines, as well as the undeveloped deposits, in North Carolina. A brief account of the development of the mines is included as well as a survey of ore composition with geological notes and analyses.[12]

Between 1903 and 1907 Arthur Keith wrote a series of folios on the quadrangles in western North Carolina and neighboring Tennessee. In these folios he presents the first precise views on the origin of the Cranberry vein. It is described as a series of ore bodies reaching

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[10] John Birkinbine, "The Iron Ores of the United States," Journal Franklin Institute, 126:196-198, 1888.

[11] W. C. Kerr and G. B. Hanna, Ores of North Carolina (Raleigh: Division of Geology, 1888), 2:125-187.

[12] H. B. C. Nitze, Iron Ores of North Carolina (Raleigh: Division of Geology, 1893), p. 239.

from the Old Fields of Toe River, northwestward, through Cranberry to Shell Creek in Tennessee. The many outcrops are stated to be in the Cranberry granite and extending in a direction nearly paralleling the boundary of the granite with the older Roan gneiss. He thought the ore occurred as a series of lenticular bodies of magnetite in a gangue of hornblende, epidote, pyroxene, and feldspar quartz. The ore and the gangue, he stated, occur as a series of great lenses dipping toward the southwest at angles of 45° to 50°, and about parallel to the schistosity of the Cranberry gneiss. It was his belief that the ore lenses varied from a few inches to fifty feet in thickness and from two to five times as long.

The minerals comprising the ore were stated to have been deposited probably after the enclosing granite had solidified and later than the deformation that caused the schistosity of the section. This brought him to believe that the ore body was secondary in formation, and that the iron in this area may have been dissolved from the Roan gneiss through which the mineralizing solutions must have flowed in several epochs.[13]

W. S. Bayley, in 1921 and again in 1923, wrote to some length about the magnetic ores of east Tennessee and western North Carolina in a report to the Geology Department of the two states and to the United States Division of Geology. He went into detail in describing the

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[13] Arthur Keith, Geological Atlas, Cranberry Folio (Washington: United States Division of Geology, 1903), p. 8.

occurrence of the deposits, analyses made, geology of the section, and something about each of the mines and prospects involved. This is possibly one of the best accounts available up to that time on the deposits of the Cranberry ore belt.[14]

During the years, up umtil 1930, that S. H. Odom was the superintendent of the Cranberry Iron Mines at Cranberry, he kept certain personal records in which he stated that the Cranberry forge was built about 1821 to 1825 on the Cranberry creek about a mile and a half below the mine at Cranberry. At this location a dam was constructed between the hills, a trip hammer for beating out the iron from the other materials, and a forge for heating the ore in preparation for hammering. Charcoal was used in those days for heating purposes, and it was procured by burning chestnut wood in pits. These pits were built like an Indian tepee, by standing split pieces of wood on end, short sticks first and then ever-lengthening ones until the desired amount had been stacked. All this was done inside a large round hole that had been dug into the earth about ten feet across and eighteen inches deep. The pile of wood was then covered with dirt, leaving only a small opening for firing and one for smoke to escape. After the fire had begun to burn these, too, were covered over with dirt. The slowness in burning, and the extinguishing of the fire at the proper time ,

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[14] W. S. Bayley, Magnetic Iron Ores of East Tennessee and Western North Carolina (Washington: Division of Geology, 1923), pp. 10-76, 97-131.

turned the wood into charcoal.

He stated that these pits were a common scene throughout the area during his childhood, and that several such pits were constructed on each location. Many persons fired such pits on their own land and sold the charcoal to the mining company.

He also stated that his father, Aaron Odom, taught school in the area, supplementing his salary with money he received for charcoal baskets he made and sold to the company. These he described as being made from splits of hickory and white oak trees which grew profusely on his acreage on Curtis Creek.[15]

These charcoal baskets were about six feet long and three feet wide, made in such a way as to have one side deeper than the other to facilitate pouring the charcoal from them. Each had a handle woven on either end and it took two people to carry a basket due to its length. The charcoal was loaded from the pits into the baskets, then onto wagons for transport to the furnace and forge, unloaded from the wagons, and then handled again in baskets when replenishing the fires with it. One may easily see that several baskets were used up until the time the railroad began to haul coal from the mines of Virginia for the purposes for which the charcoal had been used.[16]

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[15]Personal papers of S. H. Odom, Superintendent Cranberry Mines.

[16] Personal Interview with Mrs. J. M. Bowlick, sister to S. H. Odom and mother of the writer.

Finally, in 1948, M. H. Kline and T. J. Ballard wrote a report on investigations made by the United States Bureau of Mines of the Cranberry magnetite deposits. In this report the authors discussed the geology of the region, gave a very good description of the deposits of the area, included the latest mineral-dressing-tests data obtainable on the Cranberry ores, and concluded that the numerous tests made under their investigation proved a low-phosphorus and high-iron product can be obtained from concentrating the Cranberry magnetite. Also, their reasoning was that the grade of concentrates procured depended upon the extent of the fineness to which the materials are ground, and this upon the economic consideration involved.[17]

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[17] M. H. Kline and T. J. Ballard, Cranberry Magnetite Deposits (Washington: United States Bureau of Mines, 1948), pp. 2-84.

CHAPTER III

THE GEOGRAPHICAL AND GEOLOGICAL ASPECTS

The Cranberry ore belt is in Avery County, North Carolina, near Cranberry and Elk Park, and in Carter County, Tennessee, in the vicinity of Shell Creek and Roan Mountain. The main ore body is a series of deposits reaching from the old fields of Toe River near Newland, North Carolina, northwestward through Cranberry to Shell Creek. It is situated mainly on the northwest slope of the Hump Mountain and is traceable for nearly three miles to the Tennessee line, then shifting to a northeasterly direction for about three miles.[1]

The area is drained by the North Toe, Elk and Doe rivers.

The ores of the Cranberry deposits comprise magnetite, which occurs in a gangue of hornblende with minor quantities of quartz, epidote, feldspar, garnet, calcite, pyroxene, associated with granite and crystalline schists or gneiss and classified as siliceous magnetites to distinguish them from the ores associated with marble.[2] Hematite is also present in such small amounts as to make mining of it impractical. The brown hematite, magnetite, and titaniferous magnetite have all been smelted, but in later years the titaniferous varieties

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[1] Arthur Keith, Iron Ore Deposits of the Cranberry District (Washington: United States Bureau of Mines, 1903), p. 243.

[2] Hunter and Gildersleeve, Mineral and Structural Materials of Western North Carolina (Knoxville: Tennessee Valley Authority, 1946), p. 3.

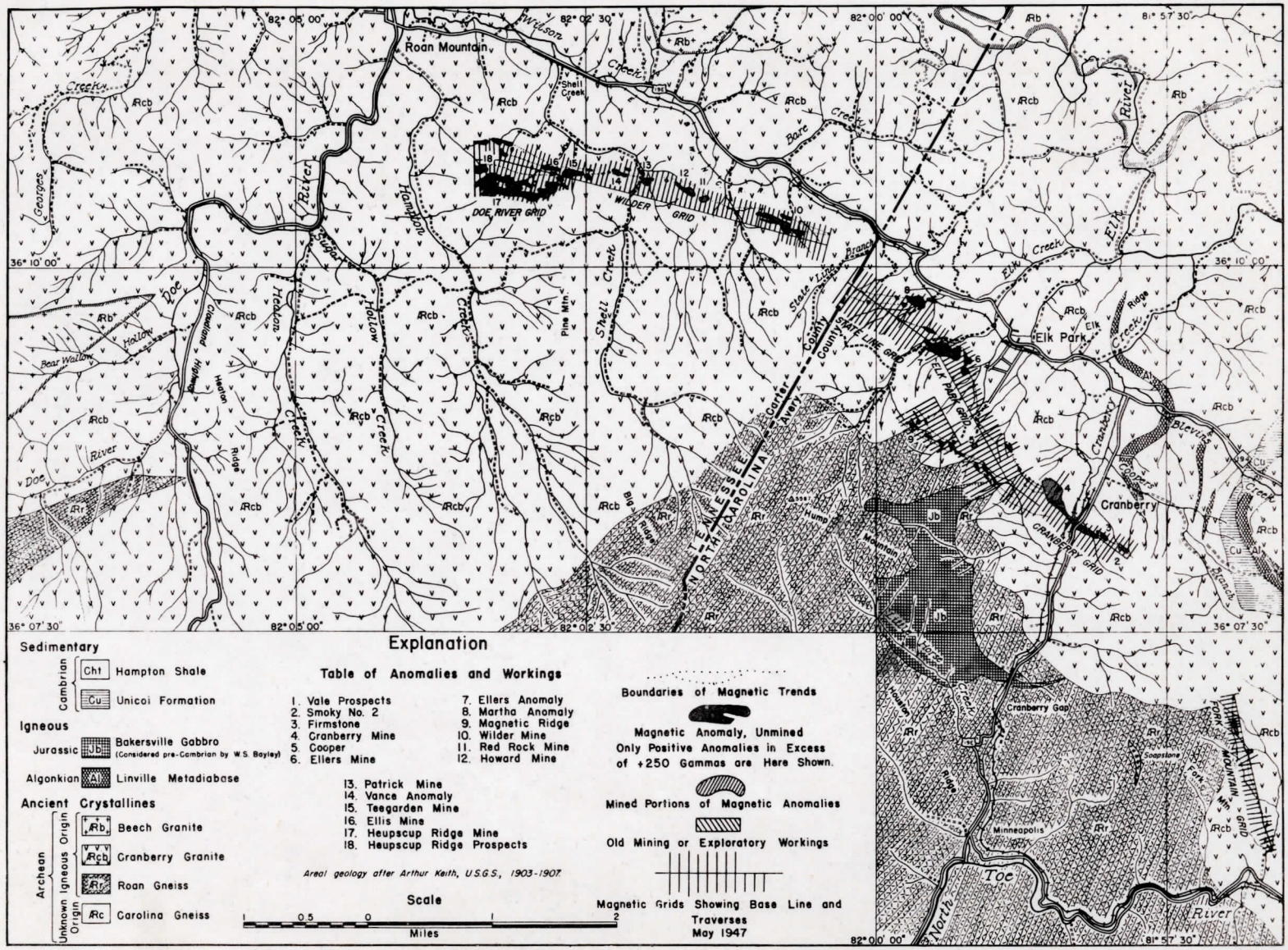

Figure 1. - Location and index map showing magnetic anomalies and areal geology, Cranberry magnetite deposits, Avery County, N. C., and Carter County, Tenn.

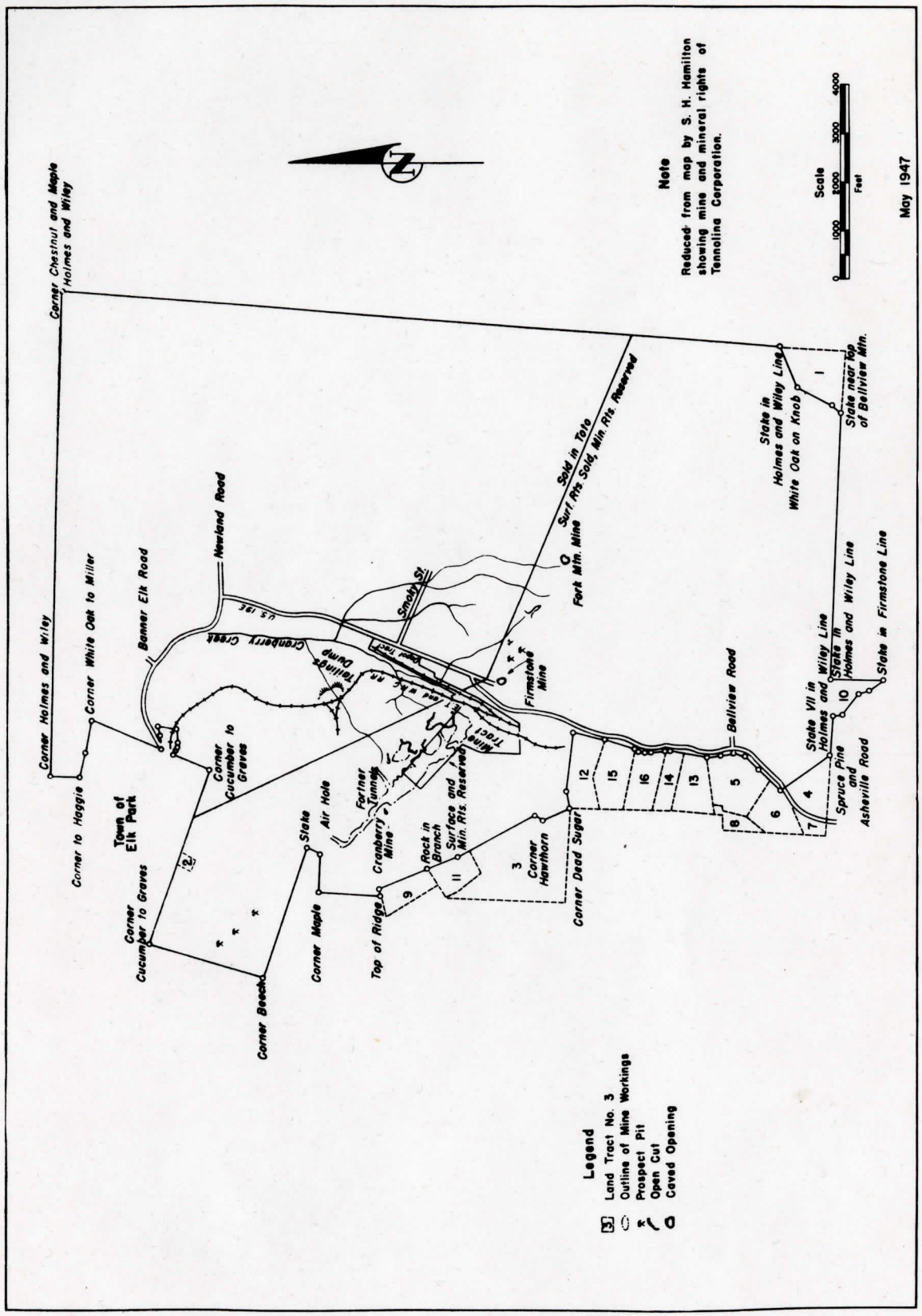

Figure 2. - Property map of Cranberry mine, Avery County, N. C.

were neglected because they were not as well adapted to the methods of extraction.[3]

The outcrops of magnetite are in the Cranberry granite and extend in a direction nearly parallel to the older Roan gneiss. The ore occurs as a series of lenticular deposits of magnetite and gangue. These dip toward the southwest at angles of 45° to 50° about parallel to planes of schistosity in the Cranberry granite. The ore is found in the gangue in the shape of smaller lenses, dipping southwest from 40° to 60°. They vary from a few inches to fifty feet in thickness and from two to five times as long. Sometimes these lenses have very sharp limits, but usually the gangue and ore grade into each other. Moreover, ore is sprinkled throughout the gangue and the gangue is scattered through the ore, the main vein comprising a plexus of rocks with the commercial ore interbedded. The plexus is cut by pegmatitic material and almost pure magnetite. The pegmatite cuts irregularly through the vein plexus, twisting and turning in a complex manner, and gradually thinning out. In some places it encloses lenses of ore and in others coarse, green hornblende. It cuts cleanly through the other rocks in many places and often with only one sharp wall. Usually the walls are indefinite and the pegmatite grades into the gneiss.[4] The siliceous magnetites are very low in titanium as compared with the

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[3] W. S. Bayley, Magnetic Iron Ores of Western North Carolina and East Tennessee (Raleigh: North Carolina Division of Geology, 1923), p. 17.

[4] Ibid., p. 30.

titaniferous type of deposit, which is always accompanied by basic intrusives. In this vein the magnetite, with varying proportions of hornblende and epidote, comprises the principal gangue material.[5] This type of deposit generally follows the structure of granitic rocks.[6]

The magnetic ores of the Cranberry belt are of three types. They are hematitic magnetite, titaniferous magnetite, and non-titaniferous magnetite. All of them belong to the pre-Cambrian period.

Those of the first group are composed of small deposits scattered over the mountain districts of western North Carolina and east Tennessee. They are associated with the old volcanic rocks thought to be of Algonkian Age, and these are associated with the chloritic schists that are probably metamorphosed basic volcanics. Both acid and basic rocks are intermixed with fluorite. Magnetite and hematite are so closely incorporated with the chloritic schists that the iron emanations may have accompanied the basic magmas and formed the ore. It is thought that the presence of the fluorine aided the formation of hematite in the area.[7]

The titaniferous magnetites are in deposits too small to be of value as sources of iron. So long as a supply of the non-titaniferous ore is available there will be little demand for the titaniferous ore

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[5] Interview with Joseph David, Geologist, Bureau of Mines, Elk Park, North Carolina, September, 1946.

[6] M. H. Kline and T. J. Ballard, Cranberry Magnetite Deposits (Washington: United States Bureau of Mines, 1948), p. 8.

[7] W. S. Bayley, op. cit., p. 12.

as a source for the metal. When the supply of the former is gone the latter will probably become important. At the present it would be necessary to separate from the titaniferous ores such concentrates as would decrease the titanium content to a competitive degree with the non-titaniferous variety. This is possible in some cases, but too expensive to be practical as long as the ores of the non-titaniferous class are available in quantity.[8]

Singewald showed that the titanium in these ores is due to an intricate mixture of some titanium with magnetite. He believed it to be ilemite in such small parts that it could not be separated from the magnetite without grinding the materials so fine as to make the cost prohibitive. Analyses of some of the titaniferous ores indicated the titanium not always present as ilemite but as an oxide of rutile.[9]

In the field of the titaniferous magnetites, magnetites may be recognized as associated with basic rocks like gabbro. They are believed to exist as segregations of minerals that were intruded into cool portions of the same magma from which they were segregated.[10]

The non-titaniferous magnetites are the most promising sources of iron in the Cranberry belt. They are low in phosphorus, titanium, and sulphur. The ore, when not concentrated by magnetic processes, is

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[8] Ibid., p. 21.

[9] J. T. Singewald, Bulletin 64 (Washington: United States Bureau of Mines, 1913), p. 6.

[10] W. S. Bayley, op. cit., p. 13.

found to be very low in iron, rarely reaching an analysis rating higher than forty-one per cent.[11] It was found, however, that when the ore was reduced to a minus-ten mesh size it yielded a magnetic concentrate of sixty-three per cent.[12]

The pegmatite is closely associated with the magnetite. Both of these cut across the lean ore veins in about the same manner, and the magnetite impregnations extend from the walls of the magnetite veins into the bordering rocks, enriching them and giving rise to magnetite gneisses. In many cases magnetite forms a part of the coarse pegmatite in the same manner that quartz, feldspar, and hornblende do. More frequently the magnetite forms groups, alone with hornblende, and constitutes lenses in the pegmatite.

It is difficult to determine the relation between the coarse hornblende masses and the pegmatite in the vein. In some cases the pegmatite appears to be older while in others the reverse seems to be true. It does intrude the hornblende in little stringers and distinct dikes, all running somewhat in the same direction and forming a gneiss.

In the case of the magnetite-epidote-hornblende gneiss, the hornblende and magnetite appear to be contemporaneous, but very definite layers of hornblende and magnetite cut across the schistosity of the

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[11] Ibid., p. 15.

[12] See Table I.

TABLE I

AVERAGES OF ANALYSES OF CRANBERRY ORES COVERING A CONSIDERABLE PERIOD OF OPERATION[13]

	Mine Run	Coarse Concentrate	Fine Concentrate	Selected Ores
Silica	27.13	20.31	8.33	5.96
Fe.	41.39	50.85	63.41	65.59
Mn.	0.41	0.37	0.24	
Lime	10.51	6.84	3.12	0.93
MgO	1.65	1.21	0.49	0.36
Alumina		1.39	0.41	
Sulphur	0.057	0.019	0.045	0.07
Phosphorus	0.008	0.019	0.004	0.950
Titanic Acid				0.950

[13] Hunter and Gildersleeve, op cit., p. 39.

gneiss in a manner as to leave no doubt to the material of the gneiss being the older. Thus it is certain that some of the pegmatite is later than some of the hornblende-magnetite aggregate.

Some specimens from the area show a continuous gradation from one mineral to the other, others having an arrangement of quartz and epidote, while some show epidote extending from masses of pegmatite. Much of the gneiss is a sheared magnetite, compressed, in which the feldspar has been altered to epidote and the augite to hornblende. It is possible that some of this originally contained magnetite.

The pegmatite contains very little quartz. In some cases it is nearly all feldspar, in others nearly all hornblende or magnetite and hornblende. The feldspar when freshly mined is a light pinkish color, but where it adjoins hornblende it is a greenish epidote or a dark hornblende color. It may be a distinct gneiss composed of these two minerals.

Where the pegmatite has been sheared and not epidotized its feldspar is crushed to a granular mass that is saturated with quartz. This material forms layers from one-fourth to an inch thick, separated by thin layers of hornblende. It appears that some of the gneiss in the vein is crushed pegmatite.[14]

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[14] W. S. Bayley, op. cit., p. 62.

The relative areas of the less gneissoid pegmatites are known, however, their ages are not. Probably they are contemporaneous in the sense that they were the result of a continuous intrusive process.[15]

The gneisses that constitute a large part of the materials of the Cranberry vein are mostly medium-grained schistose aggregates of epidotized feldspar, hornblende, and quartz, or quartz, magnetite, and feldspar. The gneisses are believed to be igneous rocks closely related to the pegmatite, and their structure the result of crushing and recrystallizing. They all show the same general features of composition.

Other gneisses, however, appear clearly to be products of injection. Thin layers of pegmatite are interlaminated with similar layers of hornblende and magnetite. The pegmatite must have intruded a schistose hornblende in the form of small veins running in the same direction, but in some instances crossing little streaks of the hornblende and surrounding tiny islands of rock. Some of the layers of pegmatite are very narrow and widen into lenses half an inch wide forming the augen gneiss. Some of these streaks are composed almost entirely of epidote.[16]

The relationship of the gneiss, hornblende, pegmatite, and magnetite in the vein suggests that they are all parts of a contemporaneous

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[15] M. H. Kline and T. J. Ballard, op. cit., pp. 9-10.

[16] W. S. Bayley, op. cit., p. 30.

intrusion that took place before the general formation of the mountain region of the Cranberry area.[17]

Drillings at the Cranberry mine indicated that, while all the granite exhibits schistosity parallel to the ore body, there is a zone that is more schistose on either side of it. It is then theorized that the folding which produced the condition also caused the fault into which the ore was forced.[18]

The mineral composing the ore and gangue at the Cranberry area are supposed to have been deposited long after the enclosing granite had solidified, much later than the deformation that produced its schistosity. This reasoning results from the supposition that the deposits are only slightly crushed or rearranged, although they are the same varieties which, in adjacent formations, show the greatest metamorphism. The ore deposit is thus reckoned to be secondary. It may have replaced a preexisting mass of rock by solution and substitution of new materials, or it may have been deposited from solution into open spaces in the enclosures. The latter is somewhat discredited due to the vastness of the deposit. It appears more possible that the ore replaced an igneous rock mass that intruded the granite, probably an igneous diabaselike mass. However, diabases elsewhere in the Cranberry region, though much altered, have not produced iron ore, it is presumed

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[17] Ibid., p. 68.

[18] M. H. Kline and T. J. Ballard, op. cit., p. 11.

that water charged with mineralizing agents perhaps added to the rock minerals and redeposited them in more favorable places. These deposits seem to have been controlled by the schistosity of the granite as it shown by the small veins and stringers of magnetite that could represent depositions from the mineralizing solutions where no readily alterable rocks were present, while at others the gangue minerals, and even magnetite, are developed in the mass of the red granite. These may be the channels through which the solution made its way into the larger deposits.

Since the magnetite deposits are supposed to be younger than the folding movements in the region and the gabbro much younger, since the magnetite deposits swing around the circumference of the areas believed to be underlain with the gabbro in the granite and in the Roan gneiss west and southwest of Cranberry, it is suggested that the magnetites are due to alterations begun by the gabbro intrusions.[19]

It seems evident that the deposits of magnetite, gneiss, hornblende, and pegmatite show they are all constituents of a contemporaneous intrusion that took place some time before the deformation of this mountain region. It may be that the first intrusion was of the magnetite-pyroxene-pegmatite variety, followed later by one of pyroxene-

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[19] Arthur Keith, op. cit., pp. 243-246.

magnetite, and finally by one of magnetite influence. Then, according to the theory, the magnetites of North Carolina originated in about the same way as those of New Jersey. The iron ore in New Jersey was thought brought up by the pegmatites in that some are differentiates of a lower igneous mass. In the area of western North Carolina it is believed a similar origin produced the ore deposits. In both places intrusions of less siliceous ferriferous liquids followed the more siliceous magmas. In North Carolina the severe deformation of the materials in the deposits indicates an earlier period than the Paleozoic Age. Since no pegmatites were known to exist in the rocks of this period, the probability is that they were formed in the pre-Cambrian time. However, the source is yet unknown. They may have come from the magmas that furnished the gabbro, diorite, and other basic sills in the Roan gneiss.[20]

In certain parts of the area may be found spaces underlain with gabbroic rocks regarded as Triassic by some, however, presently thought a part of the Roan gneiss series or equivalent to the meta-gabbro.[21]

Since the ore veins are not known to occur in the Cambrian or the Ordovician rocks, it is only necessary to consider the pre-Cambrian formations in connection with the Cranberry ore belt.[22]

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[20] W. S. Bayley, op. cit., p. 30.

[21] Arthur Keith, Asheville Folio (Raleigh: Division of Geology, 1904), p. 3.

[22] See Table II.

These rocks are folded into a complicated series of sharp anticlines and synclines, the outcrops covering irregularly shaped areas with a northeast to southwest elongation. In many places these occur on the surface as narrow parallel bands more or less curving but maintaining the same general directional pattern. In other places the Roan gneiss and Cranberry granite occur in broad areas enclosing narrow bands of other formations which follow the usual trend.[23]

In addition to the folding formation, faulting is an important structural feature in these pre-Cambrian rocks. The fault planes of the Cranberry region strike the same directional pattern as mentioned above.

During the folding and faulting these formations became sharply schistose, the strike of which parallels the strike of the fold in which the rocks occur, being straight where the axis of the fold is straight and curved where it is curved. Where the folds curve the strips of exposed rocks do likewise. Since the schistose planes are places of weakness in the formations, it is plain that intrusion into them of any kind, whether of dikes or of veins, would tend to follow the planes rather than cut across them, provided the intrusions were formed after the production of the schistosity. It is for this reason,

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[23] Arthur Keith, op. cit., p. 3.

TABLE II

PRE-CAMBRIAN ROCKS IN THE CRANBERRY AREA[24]

CAMBRIAN

Algonkian

Metarhyolite.	Grayish metarhyolite and rhyolite porphyry
Flattop schist	Gray and black schist
Montezuma schist. . . .	Blue and green epidotic schist
Linville metadiabase. .	Altered greenish diabase and gabbro

ARCHEAN

Igneous Rock

Beech granite	Coarse, reddish, or light granite
Blowing Rock gneiss . .	Dark, coarse, porphyritic gneiss
Cranberry granite . . .	Mainly granite and granite gneiss
Soapstone, serpentine .	Altered from peridotite and pyroxene
Roan gneiss	Hornblende gneiss and diorite

Metamorphic Rock

Carolina gneiss.	Mica schist and mica gneiss, igneous rocks

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[24] W. S. Bayley, op. cit., p. 38.

supposedly, that nearly all the ore veins of the region follow this pattern of the rock in which they were formed and tend to follow the structure of the country.[25]

The formations particularly associated with the Cranberry ore belt are the Roan gneiss and the Cranberry granite. Both are complex in their compositions in that they form a series of rocks. The members resemble each other more than they do any of the other formations. The granite is a series of light colored acid gneisses, and the Roan gneiss is a series of dark colored basic gneisses.

The Roan gneiss is presumed to consist of a great series of deposits of hornblende schist and diorite with some imbedded mica gneiss and schist. The hornblende beds are dark green or black, and the micaceous parts are dark gray. The micaceous beds range in thickness from fifty to sixty feet down to a few inches and are very numerous near contacts with the Carolina gneiss. They are believed to have been formed by either the intrusion of the Carolina gneiss, by dikes of magma that produced the beds of Roan gneiss, or by the infolding of the layers of the former with the latter.

The hornblende members are from a few inches to thousands of feet thick and the hornblende schist comprises a large part of the series

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[25] Ibid., p. 39.

consisting almost entirely of hornblende and a little quartz, feldspar, and biotite. The schist is interbanded with the hornblende gneiss which is different from the schist in that it is interlayered with sheets of feldspar and quartz. Beds of coarse gabbro or diorite occur in some places interlayered with schists and gneisses. It may be the formation was originally a series of interlayered diorites, gabbros, or other basic intermediate rocks that became metamorphosed through deformation processes producing a complete recrystallization of the components into new ones. Garnet was a common product of this process, so that many of the gneisses, schists, and larger dioritic beds are filled with small crystals of this mineral. These may now be found in the cuts on the old railroad bed of the East Tennessee and Western North Railway south of Cranberry and near Cranberry Gap.

The diabasic rocks now consist of plagioclase crystals, enlarged at the ends, lying in a matrix of serpentine, calcite, amphibole, chlorite, biotite, quartz, epidote, magnetite, and some pyroxene. This grouping suggests an olivine diabase beginning. [26]

Most of the rock is composed of a medium-grained aggregate of green hornblende, fresh striated and unstriated feldspar, lenses of granular garnet, and some quartz. Scattered among these are many comparatively large flakes of reddish brown biotite, small grains of

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[26] Ibid., pp. 40-41.

magnetite, and varying sizes of calcite nests. The larger grains are slightly elongated and the smaller ones grouped into little lenses that have a common orientation which causes the rock's schistosity. This is particularly noticeable in the case of the garnet which is found in lenslike formations composed of smaller round grains of colorless garnet, grains of quartz, particles of magnetite, and flecks of biotite. The pockets of calcite scattered throughout the rocks are larger when close to the garnet formations.

In the railway cuts mentioned above the interlayering of the massive and schistose condition is well shown. Here may be seen the hornblende, schists, garnetiferous hornblende, amphibole, gabbroic rocks, and gneisses. The schistose rocks are composed of green amphibole, brown biotite, quartz, feldspar, and small amounts of epidote, apatite, and ilemite.

A few schists are composed of quartz, green amphibole, and feldspar; and, others of green or reddish brown biotite, quartz, and feldspar. The biotite appears to be a metamorphosed mineral formed while the rock was being crushed. The original form of the richly micaceous schist is unknown, however, it may have been mica diorite.[27]

Some of the rock is igneous and comprises orthoclase, quartz, muscovite, biotite, and hornblende. Often thin striations are parallel

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[27] Loc. cit.

and composed of different minerals. Sometimes, in the most extreme schists, these bear little resemblance to the original rocks.

The ore vein at the southeast opening of Smoky Number One Mine is made in Cranberry granite. On the southwest wall of this tunnel may be seen the granite foliated with layers of hornblende gneiss and with others of a fine grained light colored gneiss that almost resembles a flow rhyolite. The farther away from the ore vein, the less abundant the interfoliated gneisses and the more homogeneous and less schistose is the light colored coarse-grained granite. Certain ledges show a porphyritic granite that is sheared in several places.

The fine-grained light gray rock near the opening is found to be schistose and minutely contorted when studied in thin sections. It may have been so crushed as to leave little of its original structure. In it are streaks of quartz, epidote, orthoclase, and muscovite.[28]

Throughout this entire region appears proof of considerable regeneration of quartz and feldspar. These resemble very closely some others of the Cranberry granite. For example on top of the mountain southeast of Smoky Number One Mine are light gray gneisses interlayered which, when examined in thin sections, are found to have the same formation characteristics as those at the opening. There are large sections of feldspar surrounded with a mosaic of quartz with occasional

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[28] Loc. cit.

biotite flakes through which run fibers of muscovite. Scattered throughout this formation are small pockets of epidote. As the other formation near the opening of the mine, the light colored gneisses resemble crushed rhyolite. They all contain a little magnetite and some epidote.

Some of the layers mentioned differ from the fine grained types, though nearly all have characteristics showing they have been crushed or sheared. Under the microscope this rock is shown to have been subjected to considerable stress. Almost every grain of the quartz shows strain shadows. Microline, orthoclase, and plagioclase are all quite evident, but the quartz appears subordinate. The dark parts are brown mica and gneiss amphibole that may have originated from a more compact amphibole or from pyroxene.

It is evident the Cranberry granite is a crushed or sheared complex of acid feldspathic rock varying in composition. It is probable that their layering is a result of shearing. In some cases the alternating light and dark layers is probably due to the intrusion of feldspathic veins along with the schistose planes. Much more basic layers are also evident and are believed to be parts of the Roan gneiss which have intruded the Cranberry granite. They are more prevalent near the peripheral areas.[29]

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[29] Ibid., p. 46.

Farther south, near the crest of the mountain, the formation consists of fine grained and coarse grained light rocks and fine grained dark rocks interlayered with coarse pegmatite. This region shows that the Cranberry granite must be intrusive in a series of basic schists and gneisses.

The Cranberry granite, Roan gneiss, and other rocks of the area are more or less related.

The oldest rocks in the mountains are the interbedded mica schists, fine-grained granites and mica gneisses listed as Carolina gneiss. They are regarded as the oldest of the more distinctly igneous rocks. The narrow dikelike beds of the Carolina gneiss found in the Roan gneiss suggest that the Roan gneiss may cut the Carolina gneiss. The Roan gneiss is presumed to be older than the Carolina granite because the granite clearly cuts into the gneiss. If this granite is the same as that constituting the greater part of the Cranberry formation, then the Roan gneiss must be the older.

All the other formations of the area, except the soapstone, intrude the Cranberry granite and other rocks which cut the granite. These are thus supposed to be younger than the granite.[30]

Immense dumps of material are still at the Cranberry mine in which the different kinds of rocks occurring in the veins are found.

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[30] Ibid., pp. 47-48.

Moreover, on the walls of the open pits the relation of the rocks may be observed. At no other place in the ore belt may so much space be examined for such purposes. Since nothing is observed at the Wilder, Teegarden, and other openings essentially different it may be concluded the veins of the Cranberry ore belt are relatively the same. [31]

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[31] Information from S. H. Odom, Superintendent of the Cranberry Mines until 1930, during many discussions about the operations in the Cranberry ore belt.

CHAPTER IV

THE GEOPHYSICAL SURVEY AND DESCRIPTION OF THE DEPOSITS

A geophysical survey was conducted by the Division of Geophysical Exploration, formerly a part of the United States Bureau of Mines, from November, 1943, until May, 1948, to determine the extension of the ore deposits in the Cranberry ore belt. Also, there was a need for developing additional deposits of high grade ore during World War II for replenishing the diminishing iron ore reserves for peacetime economy. During this program about ten miles of the eastern part of the Cranberry ore belt were surveyed.[1]

At this time the Metallurgical Division of the Bureau of Mines was conducting extensive research in the production of sponge iron. The Cranberry magnetite ores were considered preferable for treatment by this process, and a pilot plant was built at the Cranberry mine site to supply concentrates for the sponge iron plant at Salisbury, North Carolina.

The geophysical survey and drillings at several of the magnetic anomalies provided data for correlating geophysical interpretations with actual drilling results. Previous geophysical assumptions were

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[1] M. H. Kline and T. J. Ballard, Cranberry Magnetite Deposits (Washington: United States Bureau of Mines, 1948), p. 4.

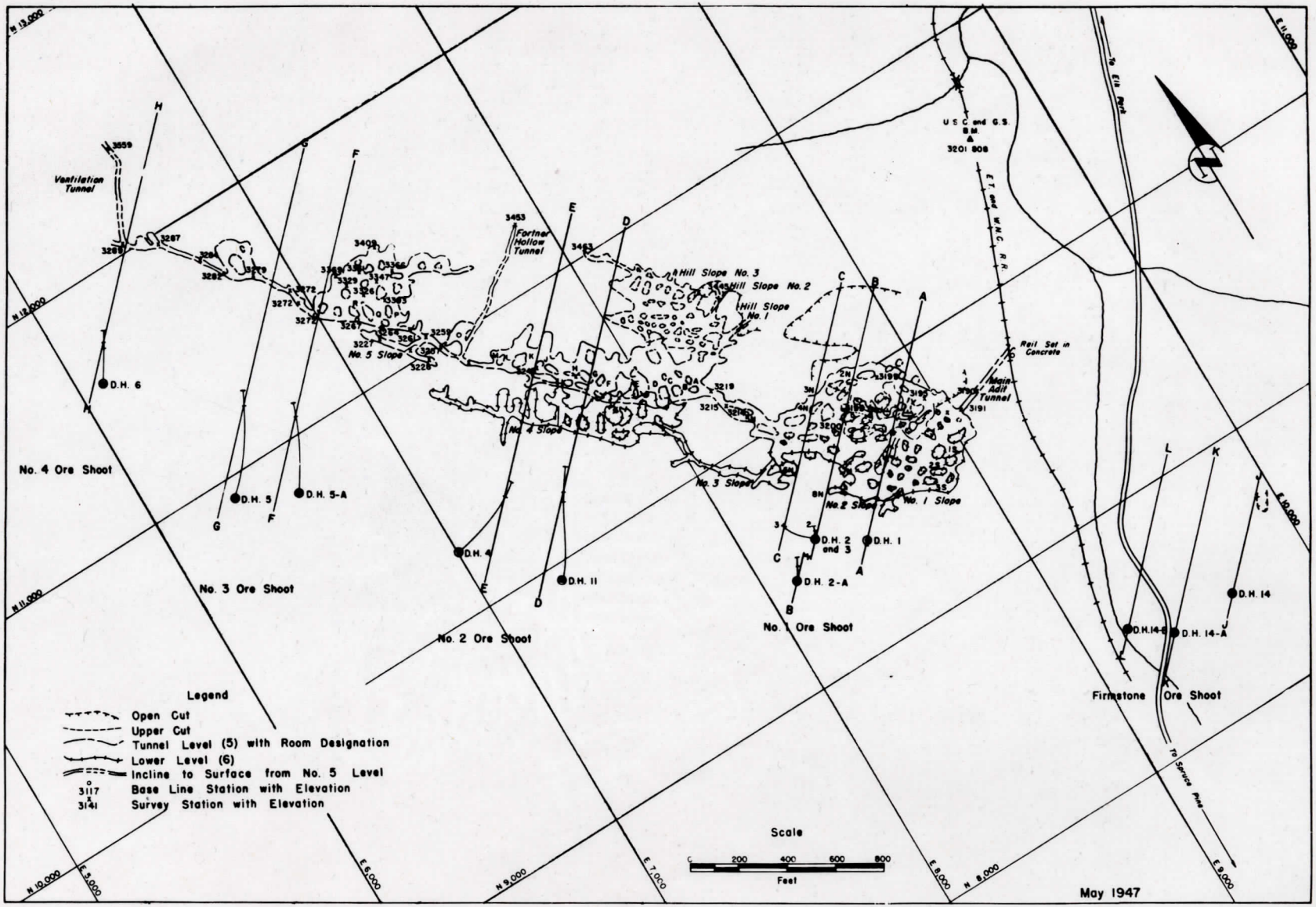

Figure 3. - Plan of underground workings of Cranberry mine.

generally correct for the anomalies containing mostly consolidated deposits of magnetite, such as the Ellers anomaly. However, where the formations combined disseminated magnetite and low-grade magnetite bodies, such as the Wilder anomaly, the magnetometer determinations were difficult to interpret and would have required much closer drilling.[2]

All the field measurements were made with a vertical Askania magnetic field balance. The sensitivity of the instrument was maintained at approximately thirty gammas per scale division by frequent calibrations employing a Helmholtz coil.

Traverses were laid out at approximately right angles to the general strike of the magnetic belt at intervals of two hundred feet. In places where unusual changes in the earth's magnetic field occurred, closer intervals were used.

Seven hundred twenty-nine magnetometer field stations were used along the traverses. All readings were corrected to base station, reduced to gammas, and corrected to the common base station erected for all the Cranberry ore belt.

From this survey it was learned that narrow, intense magnetic anomalies occur parallel to the general strike of the ore outcrops. These anomalies decrease in intensity down dip from the ore outcrops, the vertical field rapidly approaching the norm for the area.

From the drilling tests ore was found to exist at depths under

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[2] Loc. cit.

places where the magnetometer did not indicate any pronounced anomaly. A change of a few tens of gammas in the vertical component represents an ore body. This is because of the attitude of the area, the earth's magnetic field being at almost right angles to the main ore bed in the Cranberry belt, and the positive and negative magnetic polarization rapidly balancing out the depth increases.

A study of the magnetic results of the survey suggests the following evaluation:

1. The general magnetic picture comprises two parts: (a) a series of intense magnetic highs along the general line of outcrops of the mineralized zone, paralleling approximately the general strike of the ore outcrops, and (b) a series of low intensity magnetic highs down-dipping from the outcrops of the magnetic mineralized zone.

2. The evidence produced agrees with earlier geologic findings and mining results by indicating a southwestward rake for ore lenses. The magnetic trends and the orientation of the minor magnetic highs suggests a line of rake at an angle of about 56° with the base line of the magnetic anomaly.

3. Some evidence indicates that small magnetic highs lie along the line of rake drawn through high intensity, near the surface magnetic highs, or through the surface outcrops, or old mine workings, representing down-dipping ore lenses. It is still recommended that further testing be done in the belt by drilling.

4. The strong magnetic highs near the outcrops of the mineralized

zone decrease somewhat in intensity toward the east. This suggests a probable diminishing in the intensity of mineralization in that direction.

5. That another series of diamond-drilled holes be completed to test some of the more interesting anomalies, including a number of the small down-dipping anomalies that appeared to have ore along the rake of near-surface deposits. These proved of special interest geophysically, since drilling results from them could furnish important information for use in interpreting similar small-intensity magnetite highs in other parts of the ore belt.[3]

The drilling tests to locate downward extension of the ore did not prove entirely satisfactory due to the depth of the holes and the comparatively small ore shoots for drilling targets. Some results of the drilling are: ore shoot one showed 8.7 feet of ore that averaged 22 per cent iron when the first hole was drilled, however, at the second hole, one hundred twenty-five feet northwest, less than a foot of magnetite was found that tested 14.4 per cent iron. Ore shoot two showed a 5.8 foot ore vein averaging 10.9 per cent iron. Ore shoot three disclosed 39.6 feet of ore averaging 19.6 per cent iron. Ore shoot four had two lenses running through it, one of seven feet averaging 15.3 per cent iron in magnetic concentration and the other, about one

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[3] Ibid., p. 18.

TABLE III

ANALYSES OF CRUDE AND COBBED ORE[4]
CRANBERRY MINE

	Crude	Cobbed	Selected
Silica	20.97%	20.74%	23.50%
Alumina		1.55	
Iron	45.93	48.57	46.55
Manganese	.31		.46
Copper			.004
Lime	10.10	8.01	8.94
Mangnesia	1.43	1.74	1.68
Sulphur	.02		.041
Phosphorus	tr.	.0093	.0068
Titanium dioxide			.039

4 W. S. Bayley, op. cit., p. 52.

TABLE IV

PARTIAL ANALYSIS OF GOUGE IN HANGING WALL OF VEIN AT CRANBERRY MINE[5]

Ingredient	Per Cent
Silica	58.46
Alumina	19.52
Feris oxide : Ferrous oxide :	11.28
Magnesia	3.10
Lime	.96
Phosphorus pentoxide	.47
Water	2.78

[5] Ibid., p. 117.

hundred feet deeper, 14 feet of spotted magnetite averaging 10.5 per cent iron. The Firmstone ore shoot showed a thickness of 29.5 feet that tested 20.8 per cent iron.

The survey included twelve holes, drilled with a diamond drill, totaling 9,891.6 feet. Nine of these were located to determine the downward extension of the ore bodies formerly mined by the Cranberry Iron and Coal Company. Four were drilled in the first ore body to intersect the vein at about three thousand feet. These indicated a lenslike cross section thinner than the ore body on the Cranberry mine, however, the fourth hole showed at 2,900 feet a swelling of the ore body down the dip. Two holes were drilled to intersect the vein at 3,000 feet and showed good magnetite in a lenslike cross-section. Another hole indicated good magnetite concentration that made a low grade ore zone six feet thick.[6]

During the operation of the mine at Cranberry the hill slopes and open cuts were mined from the surface. The lower deposits were reached by tunneling from the adit at a level of 3,200 feet. At the time of the survey the portal of the mine opening was caved in and entry had to be made into the main part of the tunnel through an open cut. The grades on the 3,200 foot level are steep, approaching three per cent in many places and averaging near 2.4 per cent overall. The level was driven

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[6] M. H. Kline and T. J. Ballard, op. cit., p. 13.

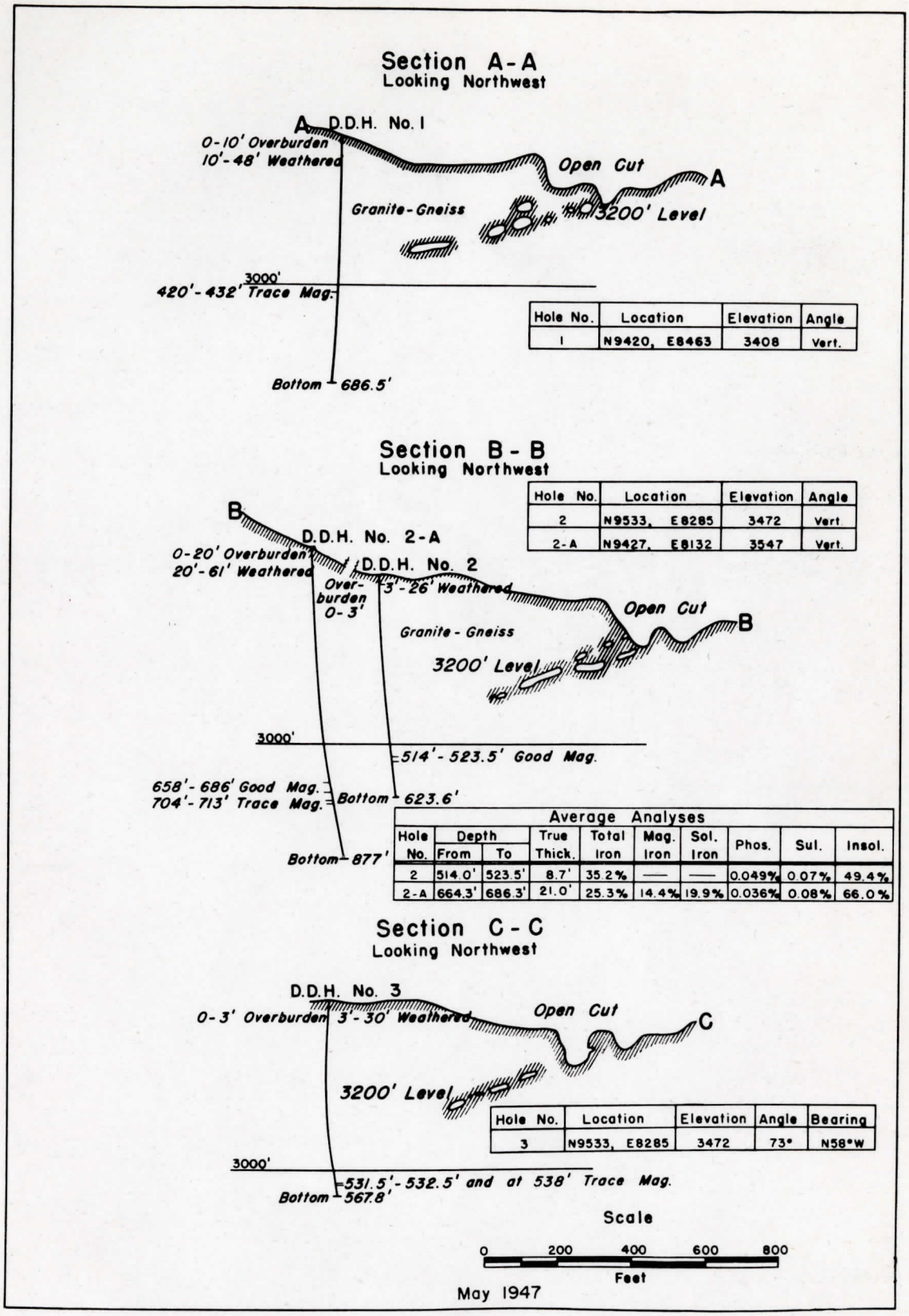


Figure 4. - Sections of No. 1 ore shoot, Cranberry mine.

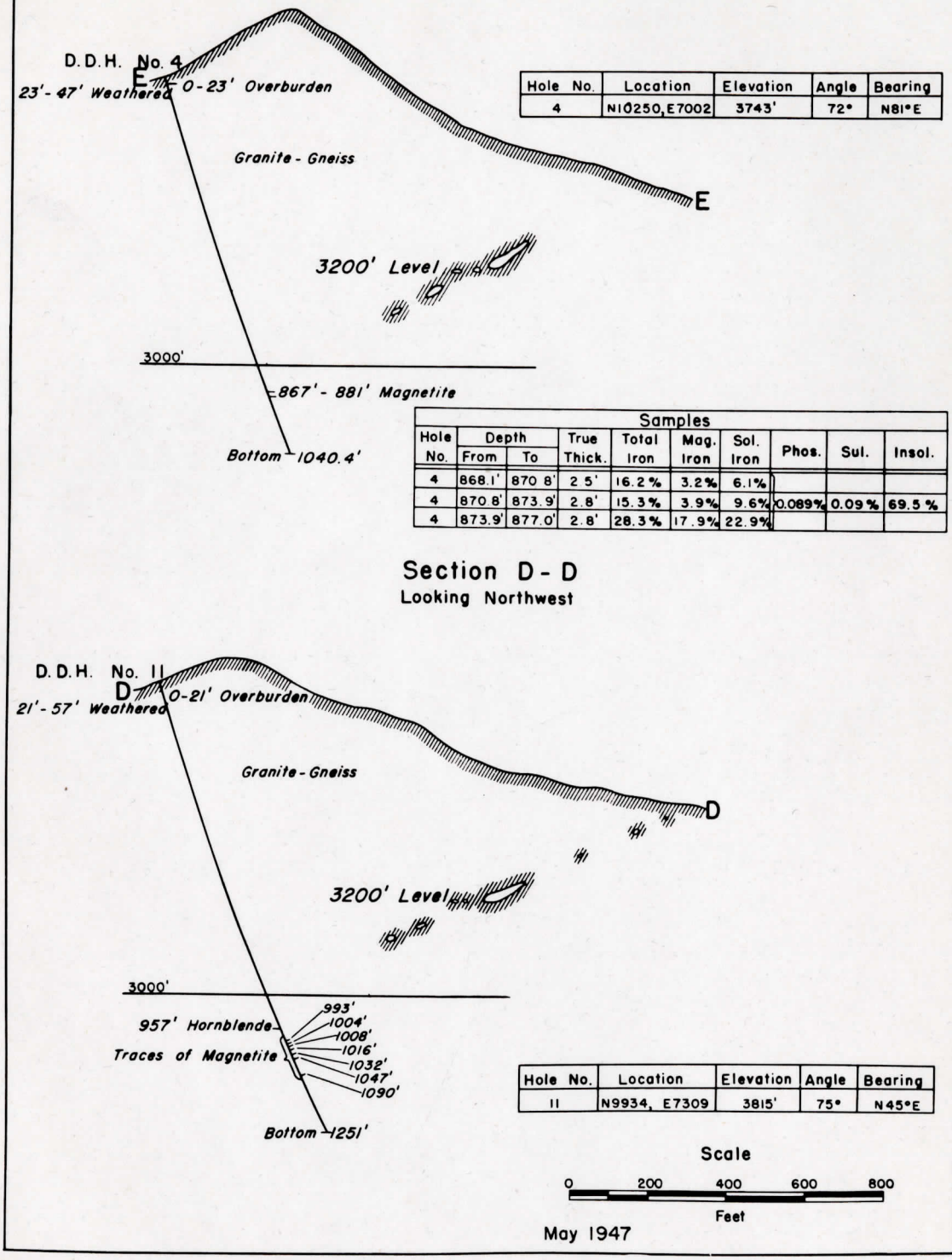


Figure 5. - Sections of No. 2 ore shoot, Cranberry mine.

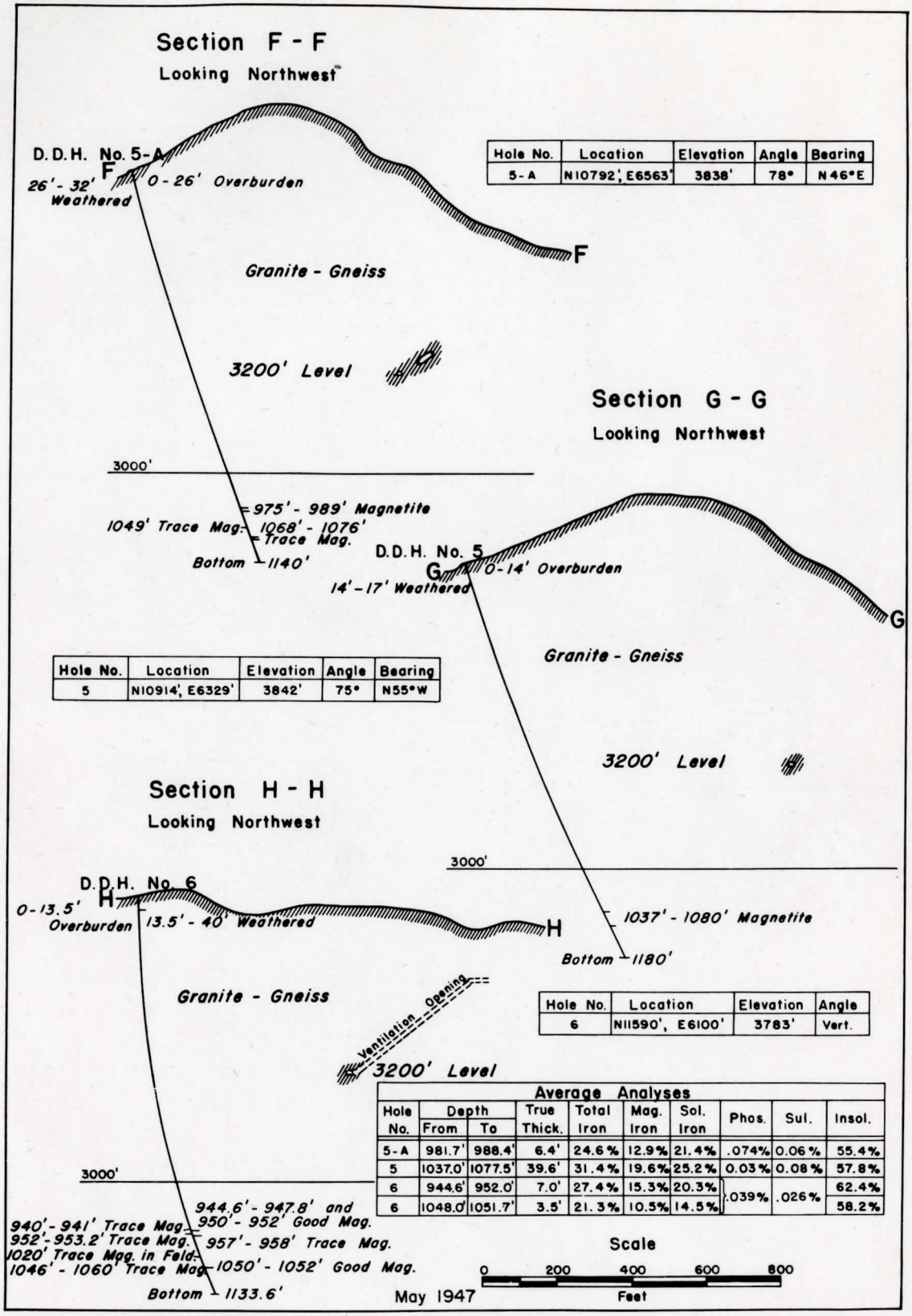
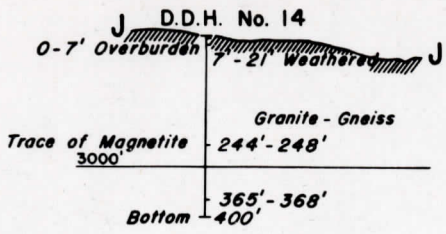


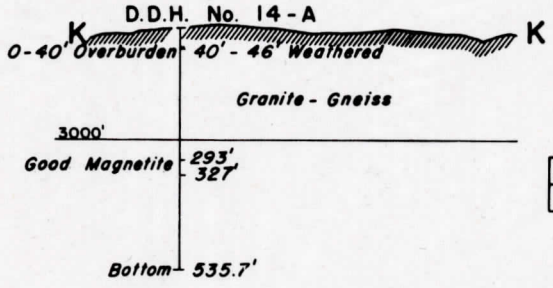
Figure 6. - Sections of No. 3 and 4 ore shoots, Cranberry mine.

Section J - J
Looking Northwest



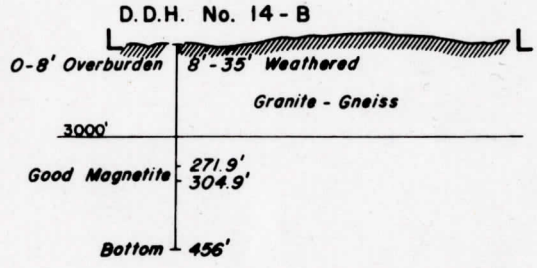
Hole No.	Location	Elevation	Angle
14	N8451', E9643'	3290'	Vert.

Section K - K
Looking Northwest



Hole No.	Location	Elevation	Angle
14-A	N8444', E9350'	3249'	Vert.

Section L - L
Looking Northwest



Hole No.	Location	Elevation	Angle
14-B	N8556', E9200'	3202'	Vert.

Average Analyses

Hole No.	Depth From	Depth To	True Thick	Total Iron	Mag. Iron	Sol. Iron	Phos.	Sul.	Insol.
14	243.6'	249.0'	4.7'	———	5.8%	———	———	———	———
14	365.5'	367.5'	1.7'	———	0.6%	———	———	———	———
14-A	293.0'	327.0'	29.5'	30.4%	20.8%	25.4%	.038%	0.04%	62.4%
14-B	271.9'	304.9'	28.4'	20.7%	11.0%	16.2%	.036%	0.04%	70.1%

Scale

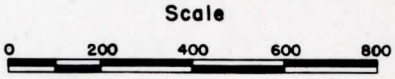


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Figure 7. - Sections of Firmstone ore shoot, Cranberry mine.

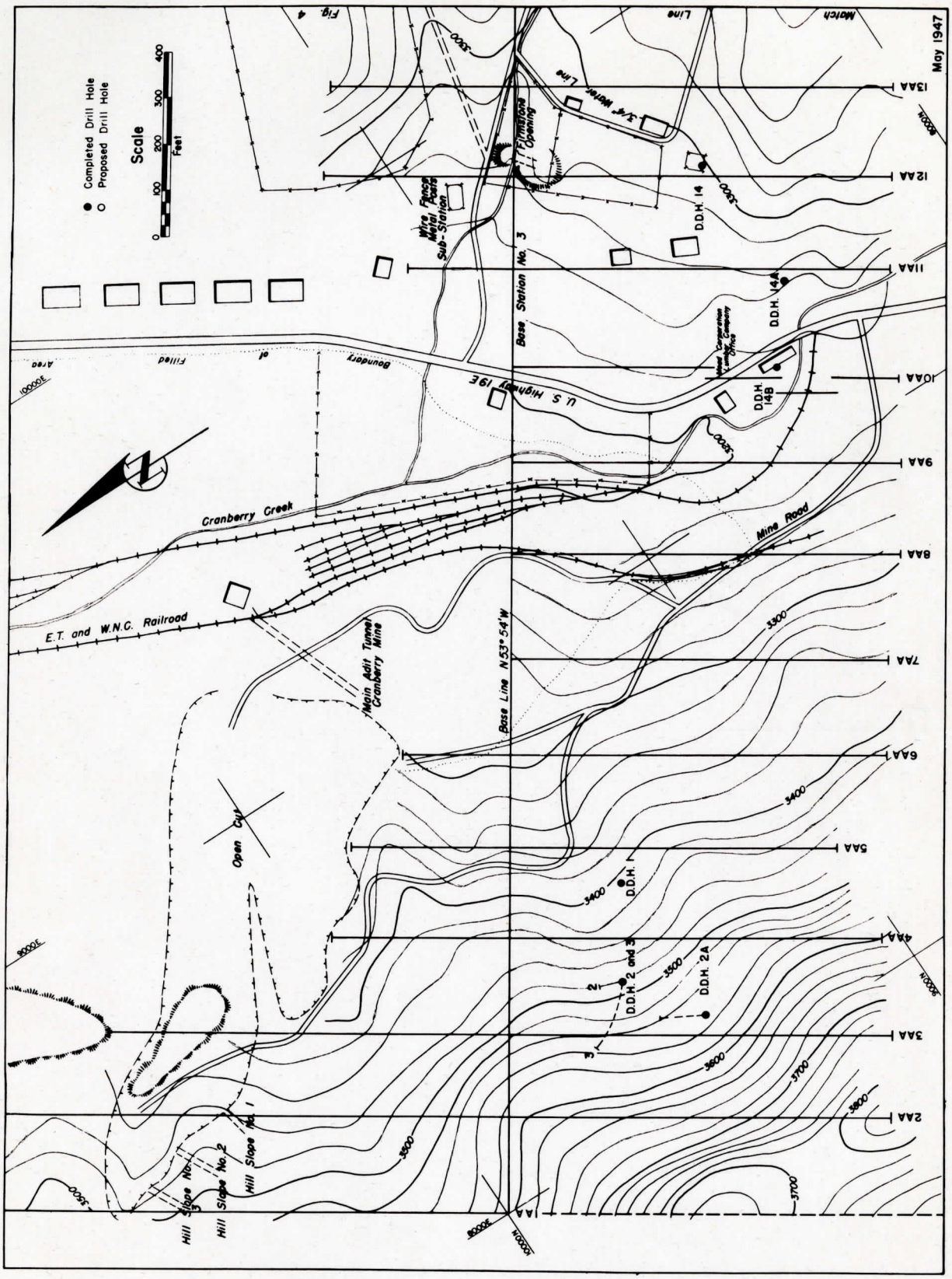

Figure 8. - Topographic map of Cranberry mine area, Avery County, N. C.

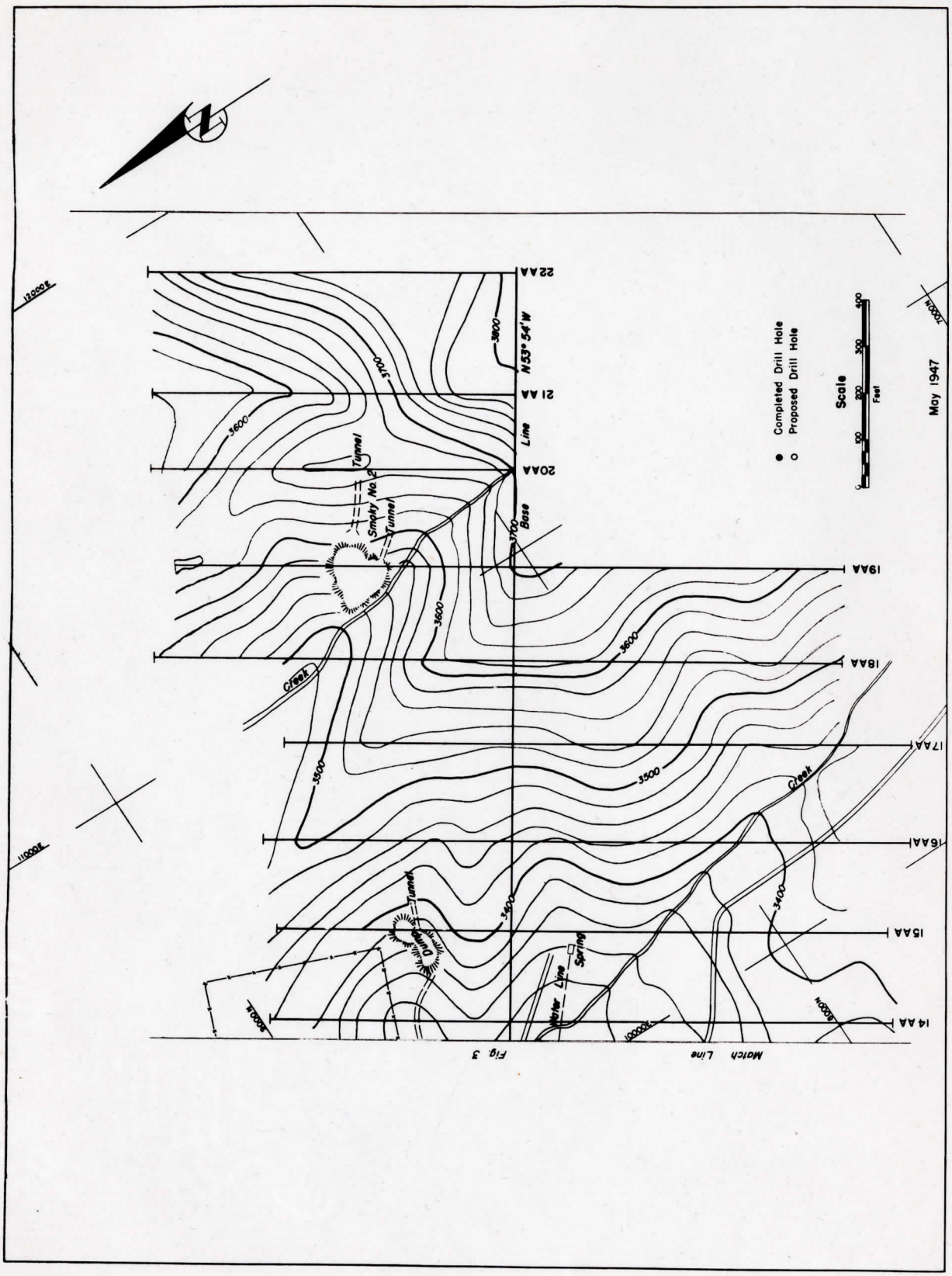

Figure 9. - Topographic map of Cranberry mine area.

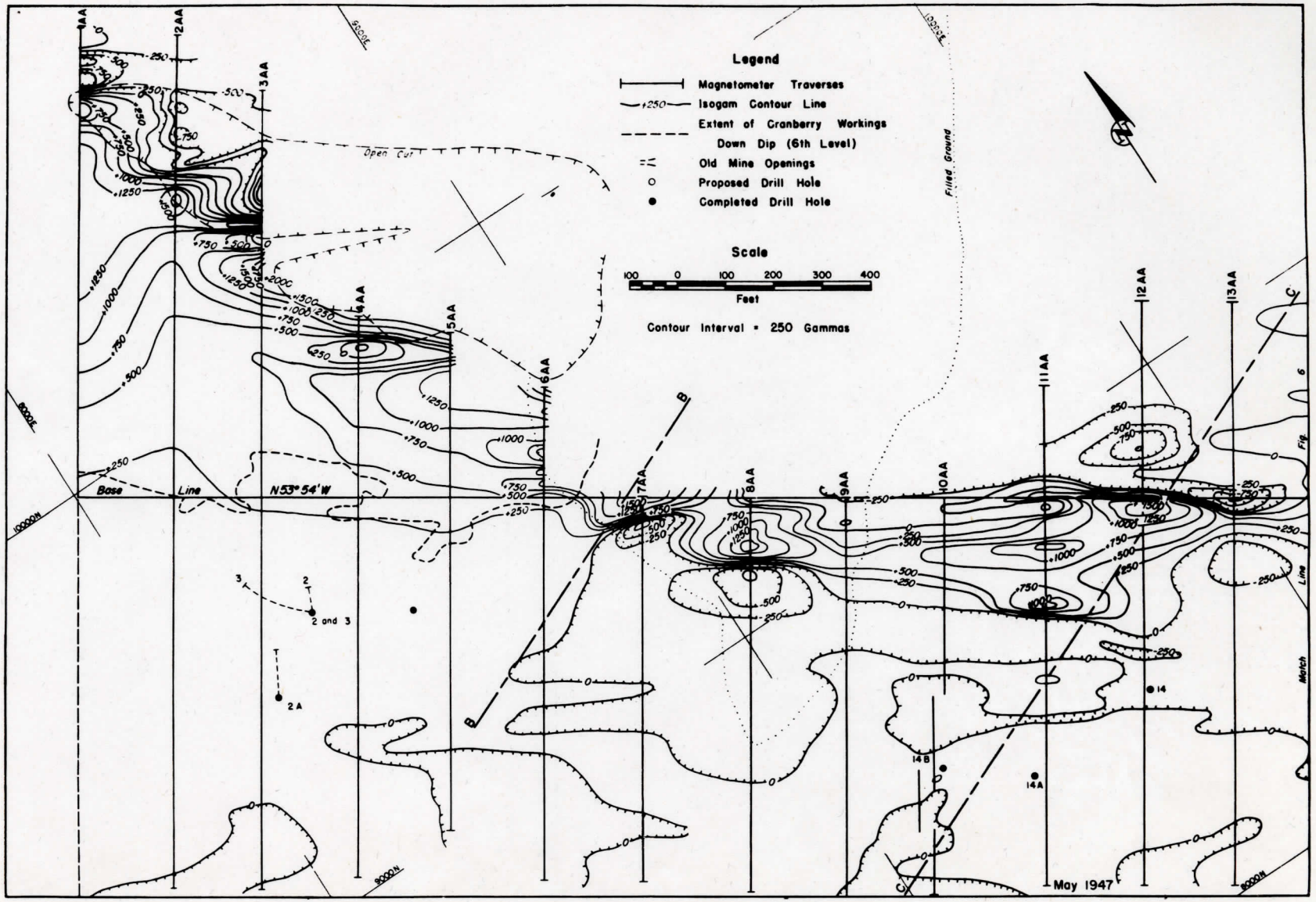

Figure 10. - Isogam map of Firmstone and east end of Cranberry mine.

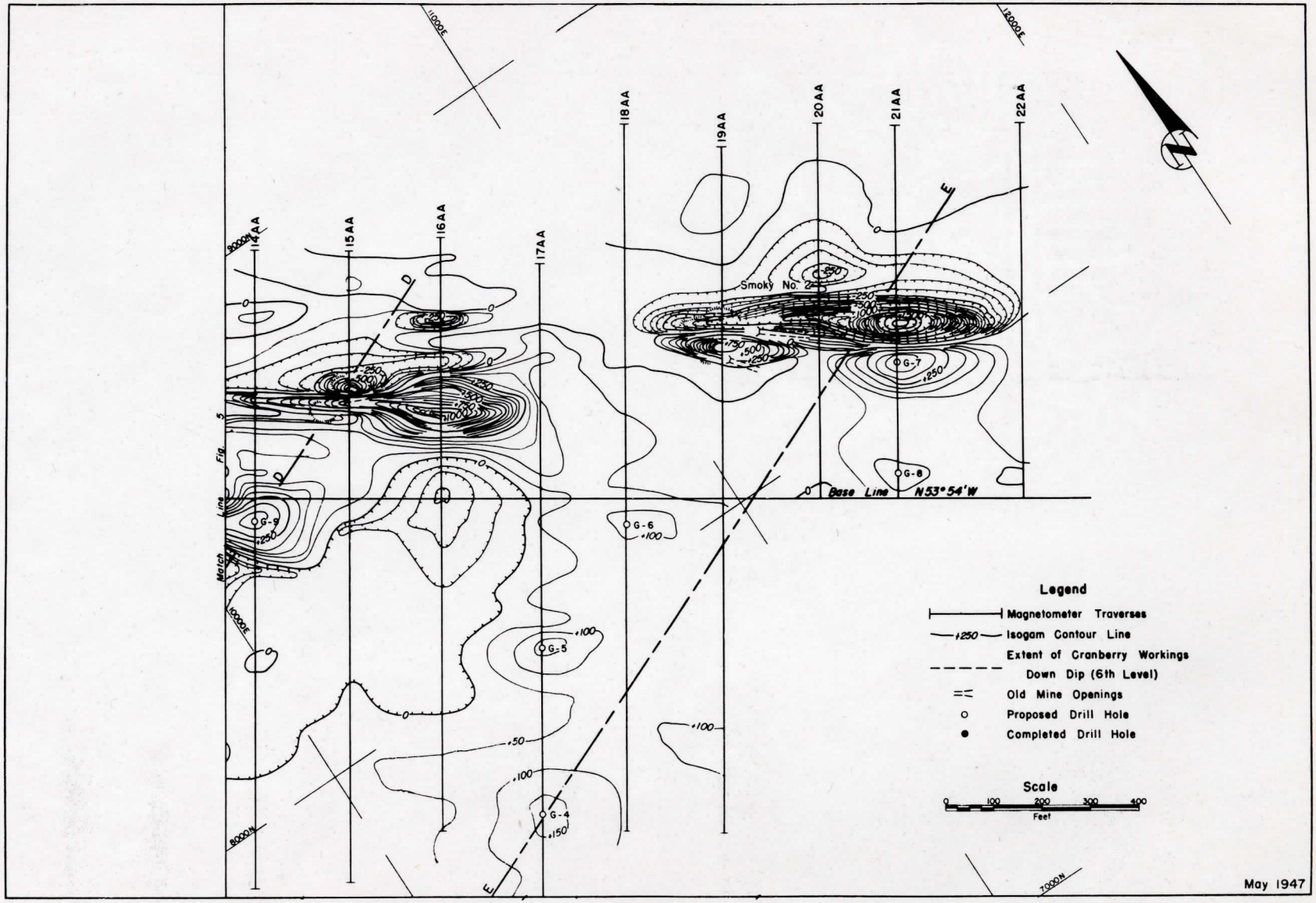

Figure 11. - Isogam map of Firmstone and east end of Cranberry mine.

along the tunnel wall and from it a mining system was employed using open stopes with pillars of rock. Part of the stopes connected with the open cut were mined with the hill slopes. Openings below the 3,200 foot level were driven downward and called slopes. Drifts were opened up along the bottom of the slopes on what was probably a 3,100 foot level. All these workings below the 3,200 foot level are now flooded with water from underground sources. Other nearby workings are located southeast of the main mine. They are the Firmstone, Smoky Number One and Smoky Number Two.[7]

At the Fortner Hollow tunnel area much dip needle work has been done by the North Carolina Geology Division and the United States Bureau of Mines. Some drilling has followed this work. In some of the places ore was suggested, but the results were negative in others. When the diamond-drill hole was made southwest of the tunnel it was disclosed that there was about two feet of magnetite ore at a depth of 875 feet, and a trace at 867 feet. Due to the low magnetic permeability of the ore it was felt the area warranted a magnetometer survey before further drilling was done. Thus a magnetometer grid was laid out with its origin at the coordinate point with a base line running for 1,600 feet S. 56° 19' E. Traverses 1,600 feet long were run at eight hundred foot intervals perpendicular to the base line. Three hundred forty magnetometer stations were located at intervals of fifty feet along these traverses.

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[7] Talks with S. H. Odom and J. M. Bowlick, uncle and father of writer.

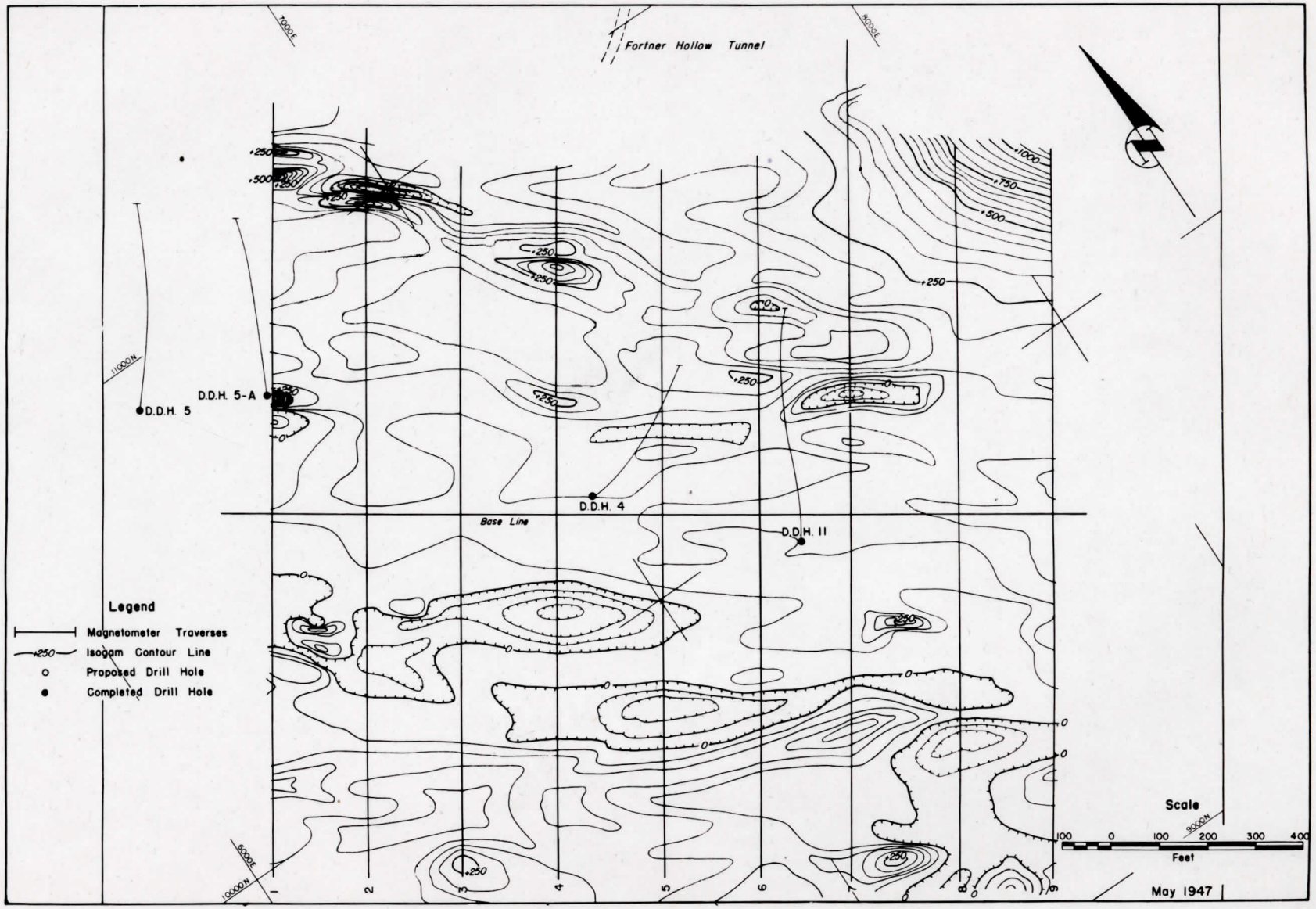

Figure 12. - Isogam map of Fortner Hollow tunnel area, Cranberry magnetite area.

A total traverse length of 14,740 feet was surveyed. The variations in vertical magnetic intensity, with a contour interval of fifty gammas, was plotted.

The result was found that the magnetic relief in the northeast corner, where the magnetic intensity reached a maximum of 1,200 gammas, may be assigned to the remnants of the ore surrounding the workings of the Cranberry Iron and Coal Company south of the Fortner Hollow tunnel. On the upper northwest corner appeared another magnetic high reaching a maximum of 600 gammas. This anomaly is seven hundred feet south of the old workings northwest of the Fortner Hollow tunnel.[8]

The work done at the Fork Mountain place was a magnetometer test and survey. It was undertaken to determine whether magnetite ore bodies were sufficiently prevalent to warrant diamond-drill testing. Several pits, open cuts, and mine workings occur in the area. They are locally known as Fork Mountain, Calhoun, Lee Jackson, Interstate, and Vale mines, and referred to in the papers of the Cranberry Iron and Coal Company as the Vale Prospects because of the uncertainty of their exact and respective locations.

The Fork Mountain was the most easterly grid surveyed in the Cranberry belt. It is located about one and a half miles northwest of Newland, North Carolina, and many of the localized magnetic highs here

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[8] M. H. Kline and T. J. Ballard, op. cit., p. 27.

Figure 13. - Topographic map of Fork Mountain area, south half, Avery County, N. C.

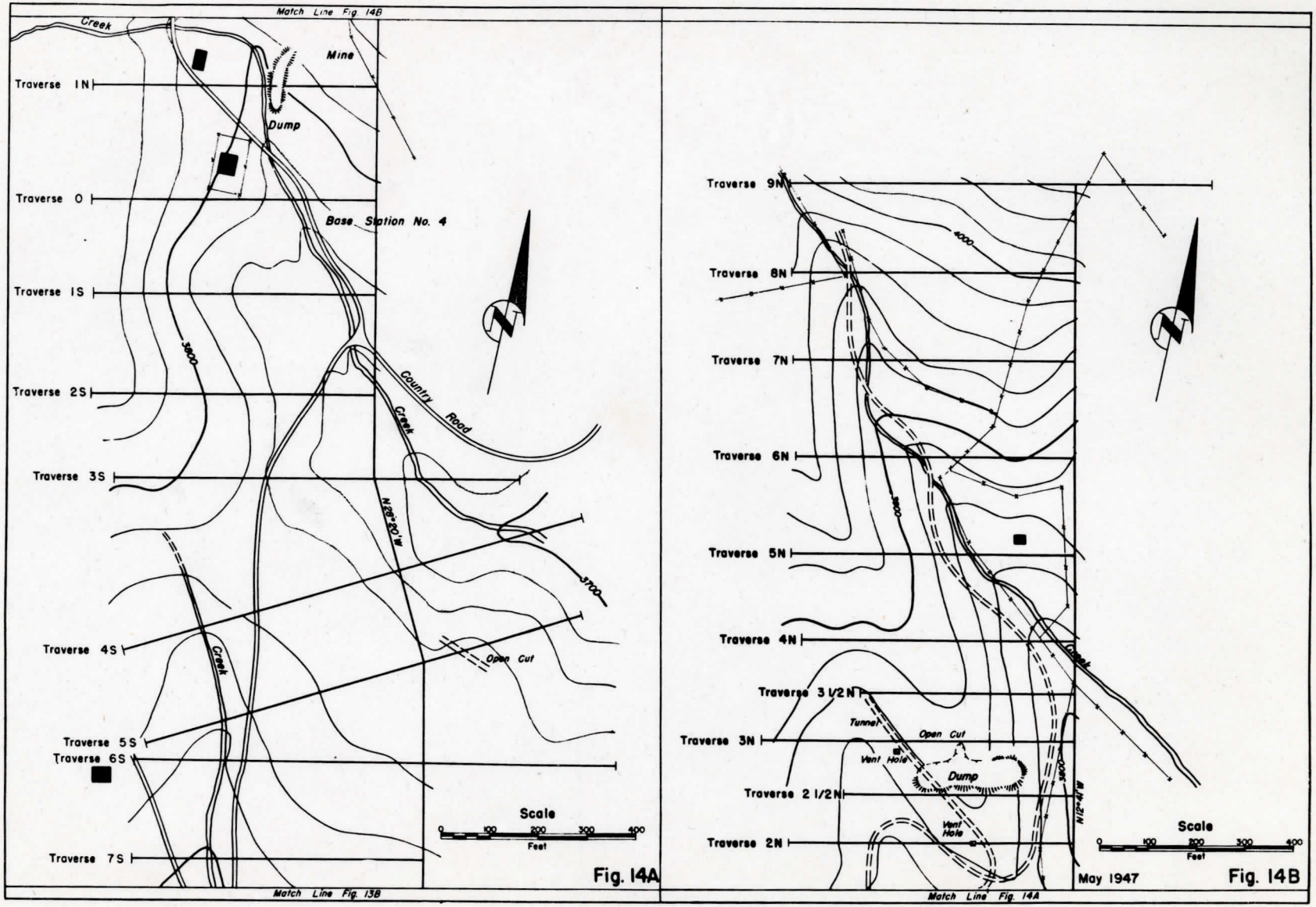

Figure 14. - Topographic map of Fork Mountain area, north half, Avery County, N. C.

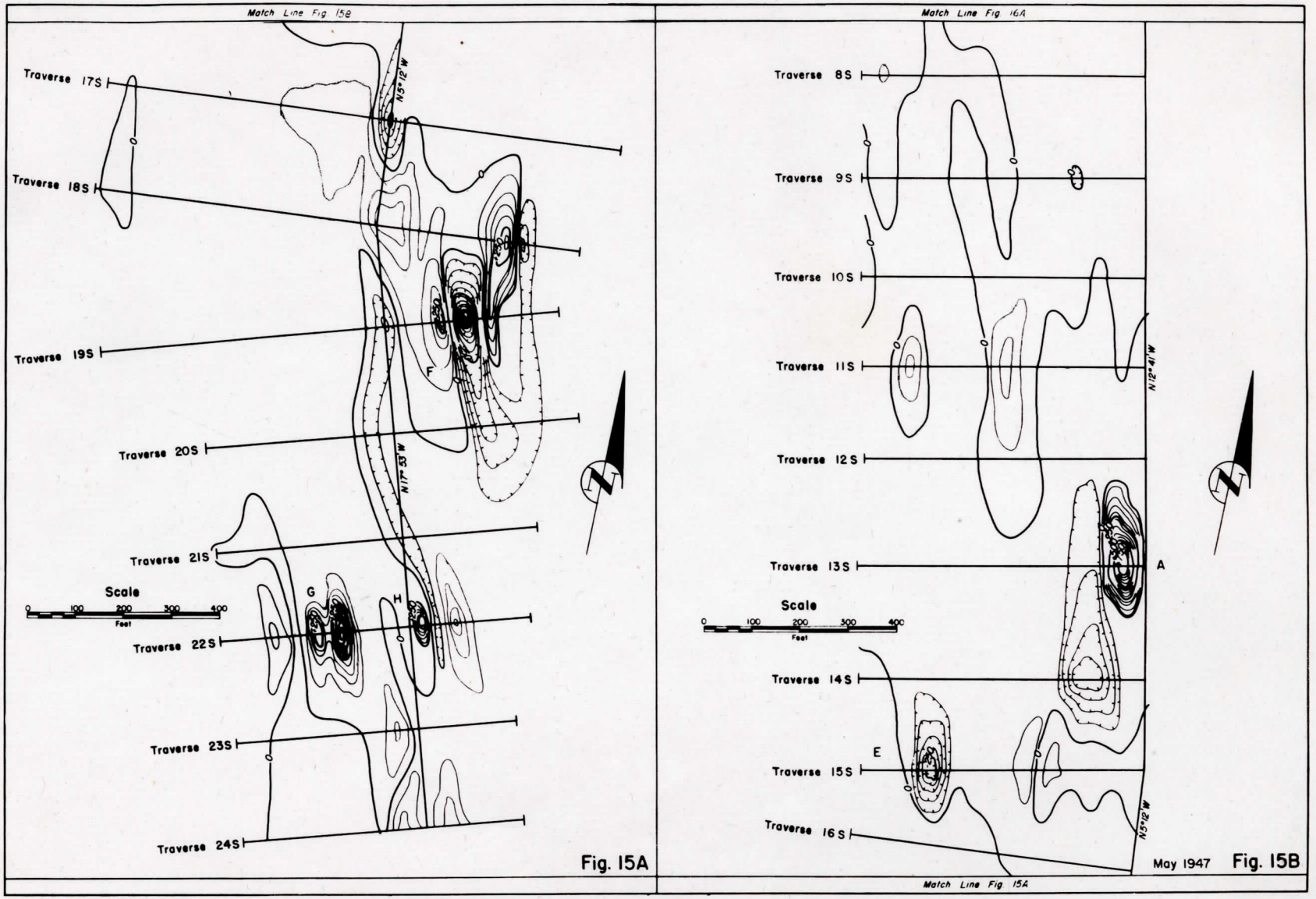

Figure 15. - Isogam map of Fork Mountain area, south half.

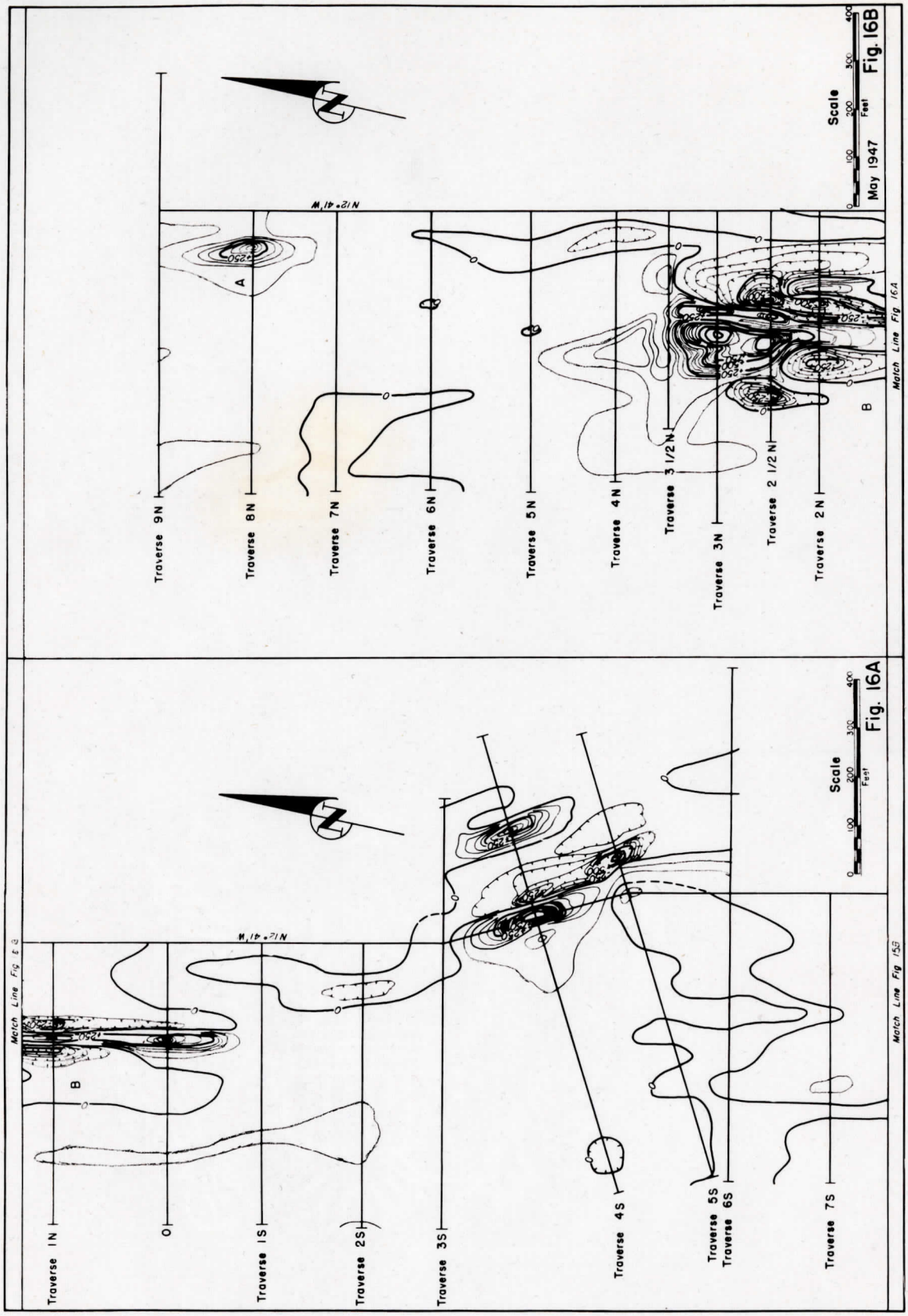

Figure 16. - Isogam map of Fork Mountain area, north halt.

reached 4,000 gammas, with the low of less than five hundred gammas. From these readings was determined that many of these anomalies are associated with surface features that may easily account for them. The majority are of small size and apparently of little significance. However, the anomaly of major concern appeared over the old dump which was thought to be a part of an abandoned stock pile. It continued southward, following the old tunnel, crossed the old mine dump, and extended to the creek. The anomaly probably represented more ore extending underground. There appeared no great extension of other ores beyond this which had already been mined, and the magnetite data gained gave no indication of commercial ore in the Fork Mountain area. Thus, because of the attitude of the ore deposits in reference to the earth's magnetic field in the Cranberry ore belt, the positive and negative polarizations of ore bodies at depth nearly balanced out. This survey did not definitely rule out the possibility of ore at depth, but contended that no deposits of appreciable size existed at or near the surface.[9]

The first openings on the main vein at Cranberry were made at the old Cooper place about three-fourths of a mile above Elk Park, North Carolina, on the northeast side of the Hump Mountain. There is nothing now to show the workings except several large depressions where the old

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[9] Ibid., p. 31.

cuts were made. These were dug about 1884 and a small amount of ore was mined and shipped to Roanoke, Virginia. At the time it was said that a vein was exposed at the place varying in thickness from five to ten feet and that it dipped about 35° southwest.[10]

The magnetic measurements taken in the locality of the Cooper mine showed very little disturbance. The very small anomalies found did not verify the report about the vein being exposed in 1884.[11]

South and west of the Cooper mine, cutting diagonally across the map for about 1,700 feet is a series of pronounced magnetic highs. It was noticed that the western part of the Cranberry grid showed a magnetic trend as far as this one. The magnetic ridge is quite strong and in several places of the magnetic highs near-surface bodies of ore are almost certain. Such near-surface anomalies were regarded as representing relatively thin lenses of the magnetite which seems to agree with the openings on the northeast side of the Hump Mountain. Some of these openings showed ore of negligible width and only one to two feet thick. The magnetic ridge mentioned above has a considerable width and constitutes a generally broad magnetic high on the up-dip side where the superimposed near-surface peaks occurred. This broad high may have represented a granite zone carrying numerous stringers and lenses of magnetite which,

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[10] H. B. C. Nitze, Iron Ores of North Carolina (Raleigh: Division of Geology, 1883), p. 9.

[11] M. H. Kline and T. J. Ballard, op. cit., p. 52.

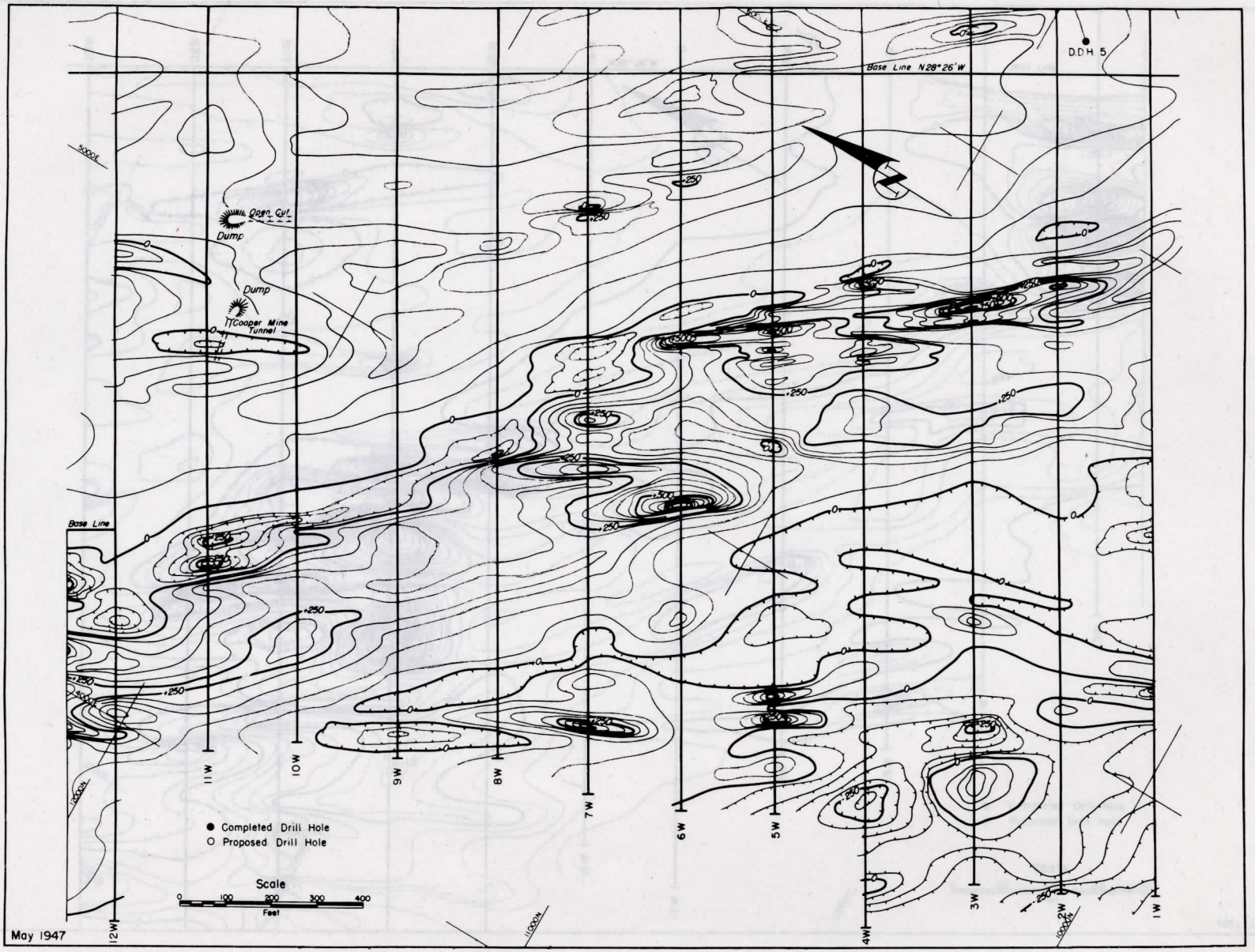

Figure 17. - Isogam map of magnetic ridge, SE half, Cranberry magnetite area.

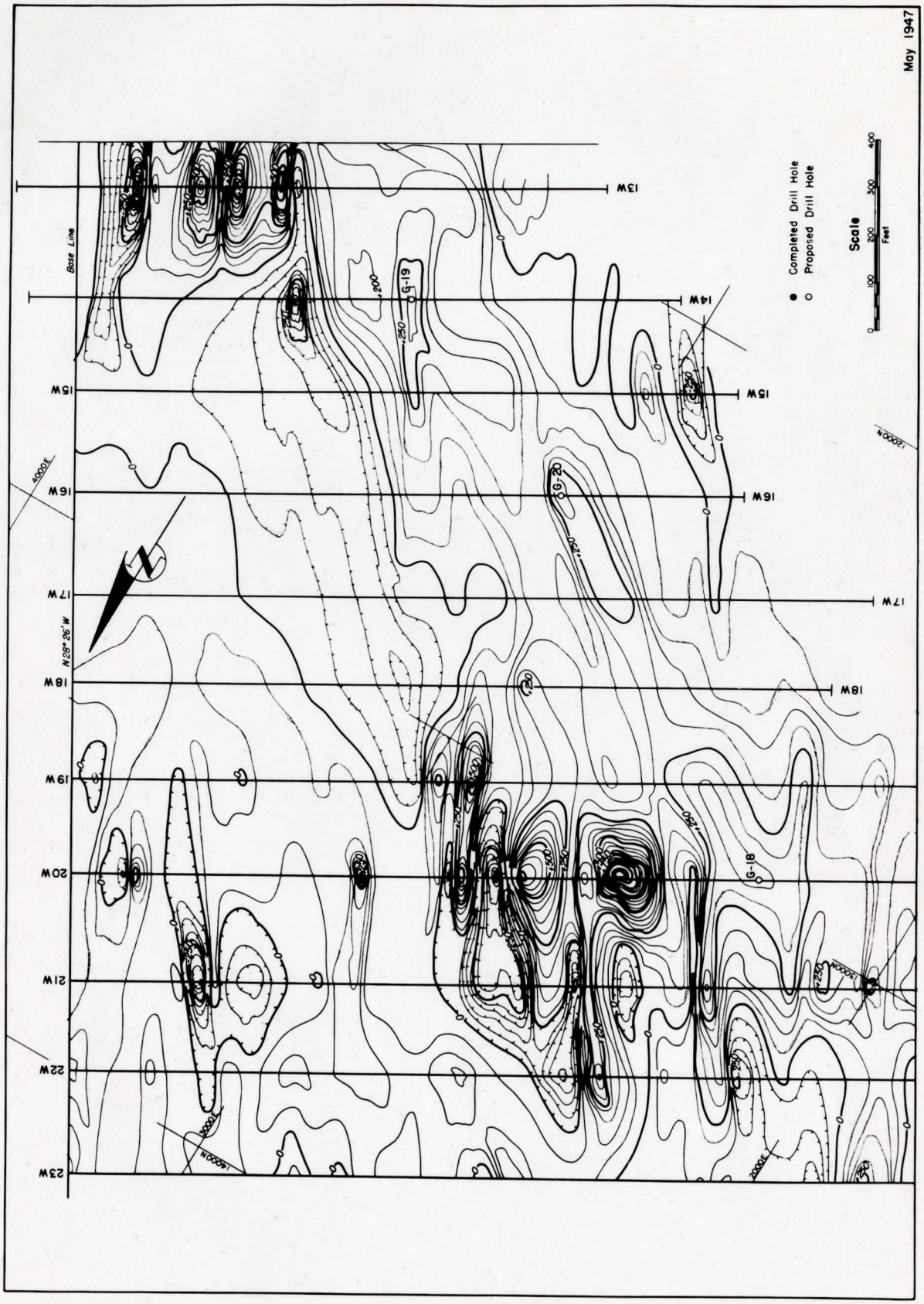

Figure 18. - Isogam map of magnetic ridge, NW half, Cranberry magnetite area.

in their cumulated effect, produced the magnetic ridge. The narrowness of the surface anomalies and the low magnetic values down-dip would go along with such an interpretation. However, the mineralized zone dips into a steeply rising mountain slope, and the ore body present must dip below the surface at an exaggerated rate. This accounts for the lower magnetic values down-dip. Thus the existence of ore bodies of commercial value in this area could not be ruled out entirely by the findings.[12] The small amount of geologic evidence available at the time indicated that the magnetic ridge occupies a position at or near the contact of the Cranberry granite with the Roan gneiss. Many believe this contact is a frequent locus for mineralization, and it appears probable that this magnetic ridge represents such a mineralized contact zone.[13]

The Ellers mine and the Hardigraves Elk Park openings are about one-half mile southwest of Elk Park on a small tributary of Elk Creek. It is locally reported these openings, one a shaft, have produced about 3,000 tons of ore averaging 42 per cent iron with only .012 per cent phosphorus.

At the Hardigraves workings very little may be observed because of the debris. However, it is known that the vein shows a general southwest dip, and that a large vein of pegmatite material is present.[14]

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[12] Loc. cit.

[13] Scharon, Preliminary Results of Magnetometer Survey on Elk Park and State Line Grids (Washington: United States Bureau of Mines, 1945), p. 22.

[14] W. S. Bayley, Magnetic Iron Ores of East Tennessee and Western North Carolina (Nashville: Division of Geology, 1923), p.118.

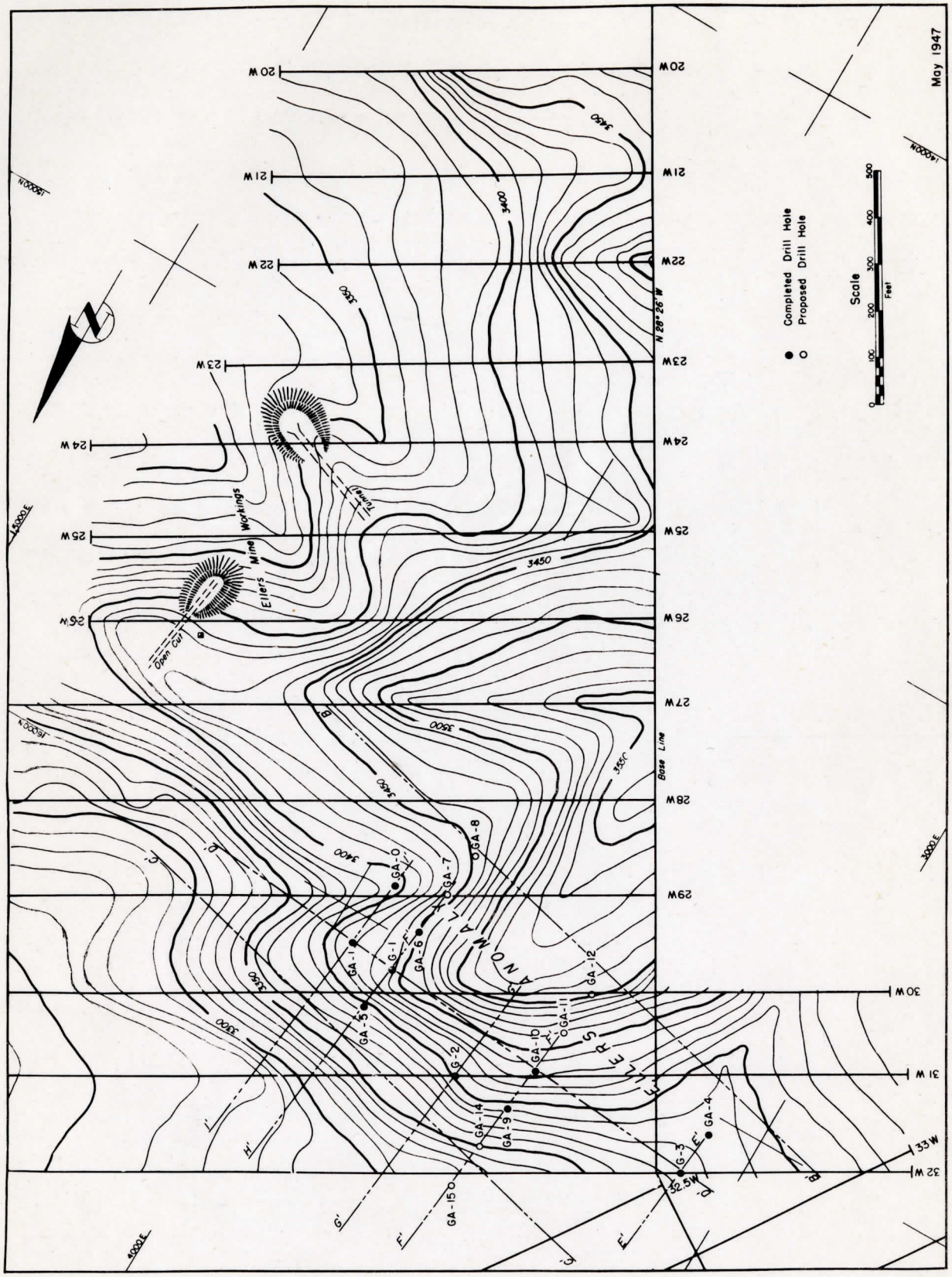

Figure 19. - Topographic map of Ellers anomaly, Cranberry magnetite area.

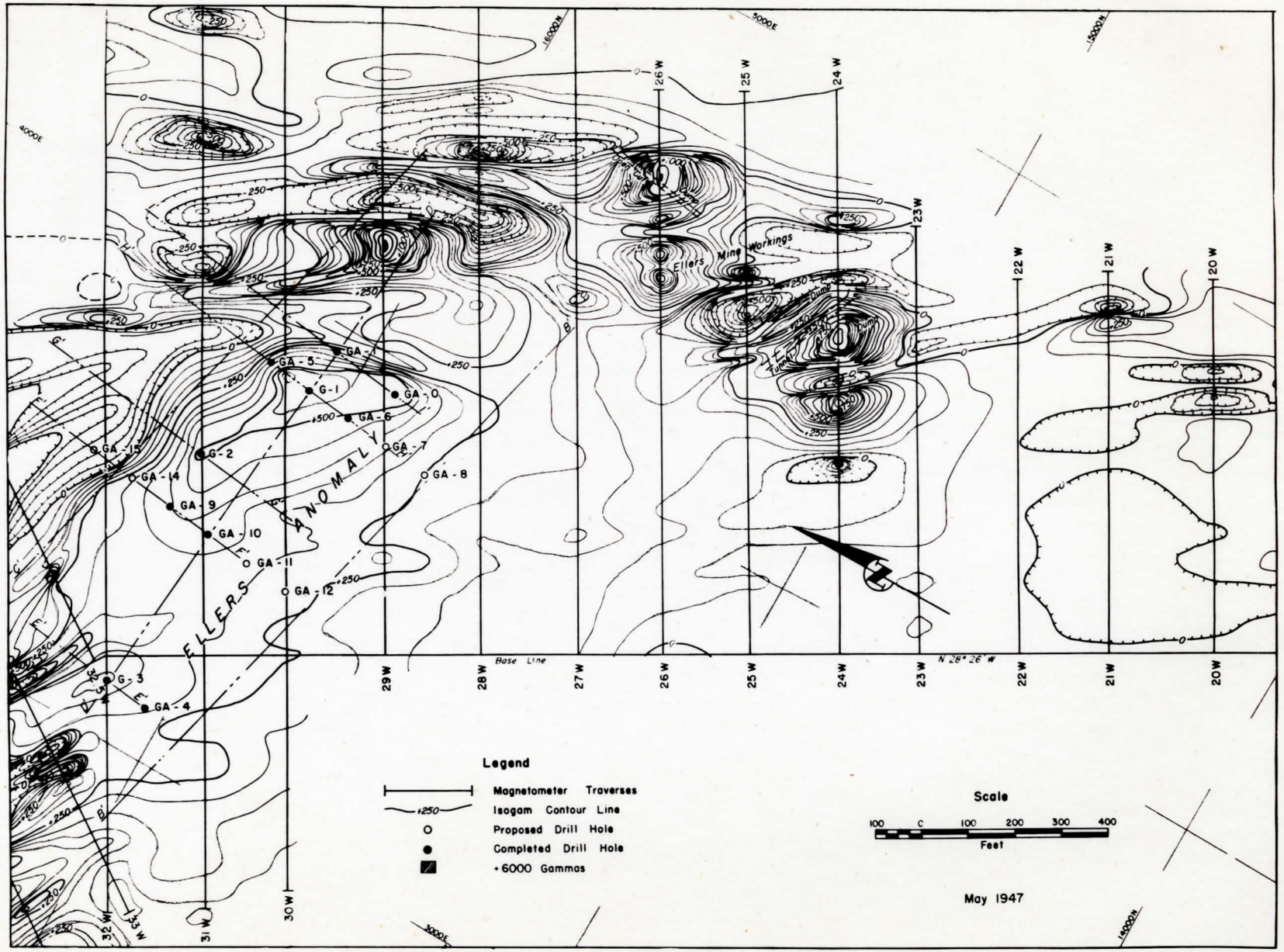

Figure 20. - Isogam map of Ellers anomaly.

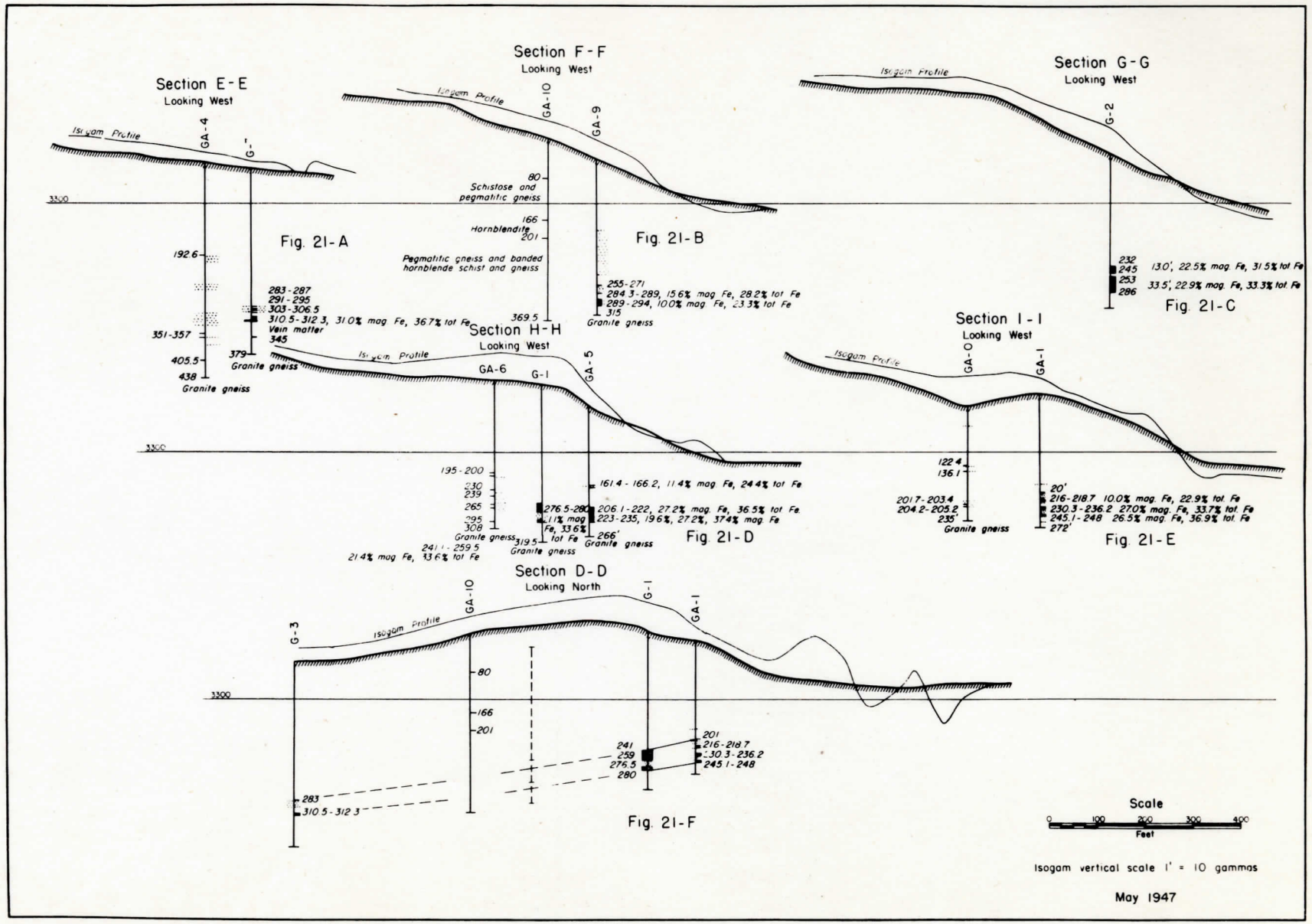

Figure 21. - Drill-hole section of Ellers anomaly.

The Ellers anomaly is near the abovementioned working. The mine is situated in an area of marked magnetic disturbance with the workings traversing the two strongest of the four magnetic highs found there. The two less intense highs underlay areas showing no evidence of mining or exploration and indicates probable unexposed ore lenses unexplored or reported.

This anomaly is about 1,700 feet long and five hundred feet wide, and enclosed by the plus two hundred fifty gamma contour. It may represent an entirely new and previously unknown ore bed. The peak of 6,000 gammas was regarded as representing a near-surface part of the ore lens. If the trend of the near-surface high and its adjacent magnetic registration is taken as the approximate strike of the vein outcrop of this area, the trend of the Ellers anomaly makes an angle of about 45° with the vein outcrop. This angle is in general agreement with the rake angle of 56° found in the eastern extension of the mine at Cranberry and is accepted as representing the rake of the ore lenses in the vicinity of the Ellers mine.[15]

The Hardigraves anomaly is much less striking in appearance than the strongly localized, intense peaks of magnetic registration caused by the near-surface and surface ores at the Ellers mine, however, the larger area enhances its importance.[16]

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[15] Loc. cit.

[16] M. H. Kline and T. J. Ballard, op. cit., p. 34.

The Wilder mine is northwest of the Ellers mine and about three-fourths of a mile west of the North Carolina-Tennessee line in Carter County, Tennessee, not far from highway 19E.

The mine was first opened before 1880 and worked on a small scale. It was acquired by a man named Milt Miller, and associates, in 1916, and about 5,000 tons of lean ore were mined and shipped to the Cranberry Furnace Company in Johnson City, Tennessee. The last load of ore was shipped in July 1918 and comprised ten narrow-gauge railroad cars of ore that averaged 30.7 per cent iron and only .014 per cent phosphorus. The average iron content of the 4,915 actual tons shipped from this mine was reported as 37.5 per cent with .15 per cent titanium oxide.[17]

The mine comprised open pits, tunnels, and underground drifts, plus a number of smaller openings distributed in a complex manner due to the folded condition of the ore vein. The vein material is similar to that at the Cranberry mine, the major part being in layers of interbedded hornblende and epidote, alternated with coarse layers of coarse hornblende. The epidote grades into pegmatite which is clearly intrusive into the hornblende and forming an impregnation gneiss.[18]

The Wilder deposit was investigated and surveyed by the Cranberry

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[17] Report by E. B. Kirby, Cranberry Furnace Company, 1918, and verified by the personal papers of S. H. Odom, Superintendent.

[18] W. S. Bayley, op. cit., p. 119.

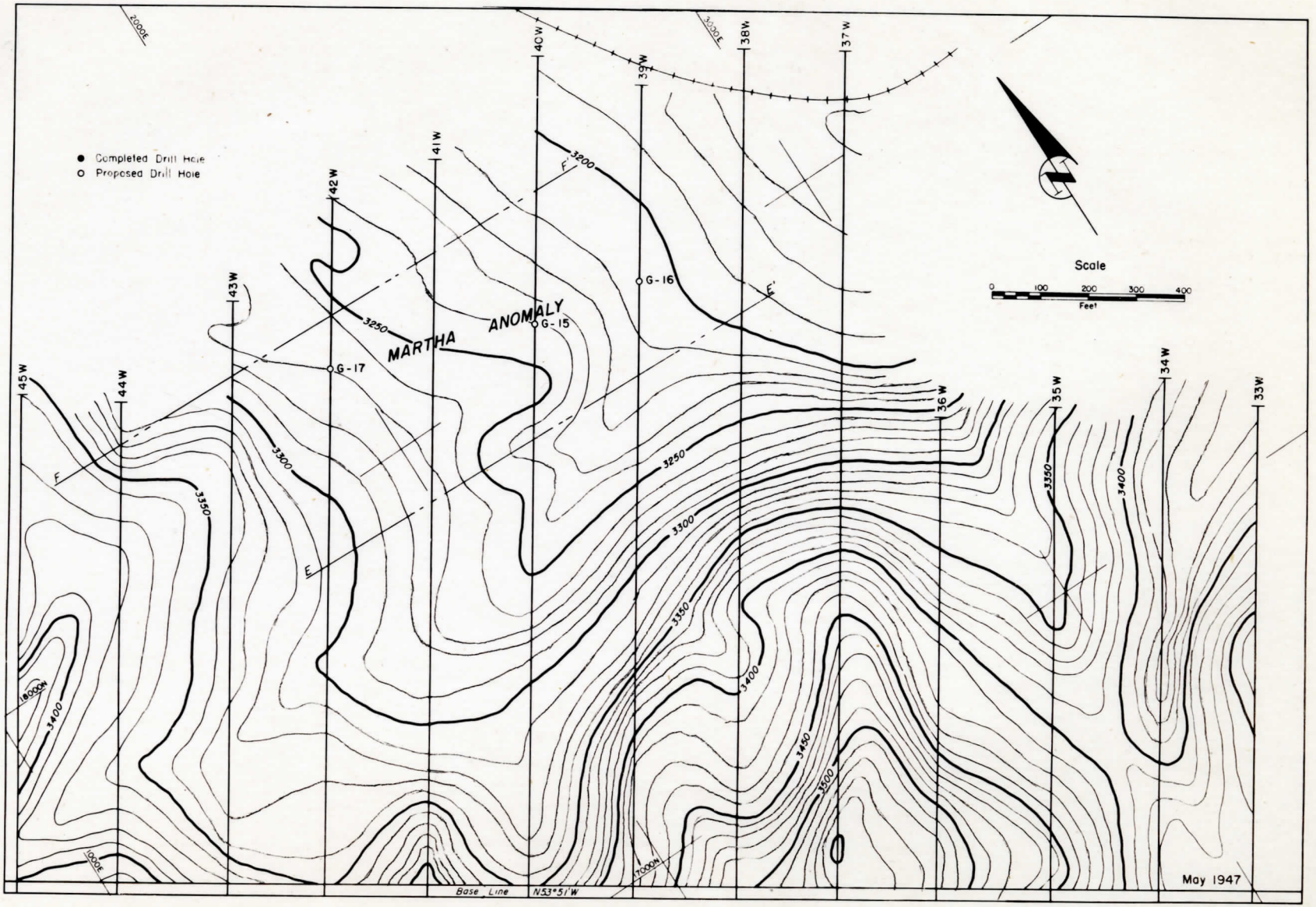

Figure 22. - Topographic map of Martha anomaly.

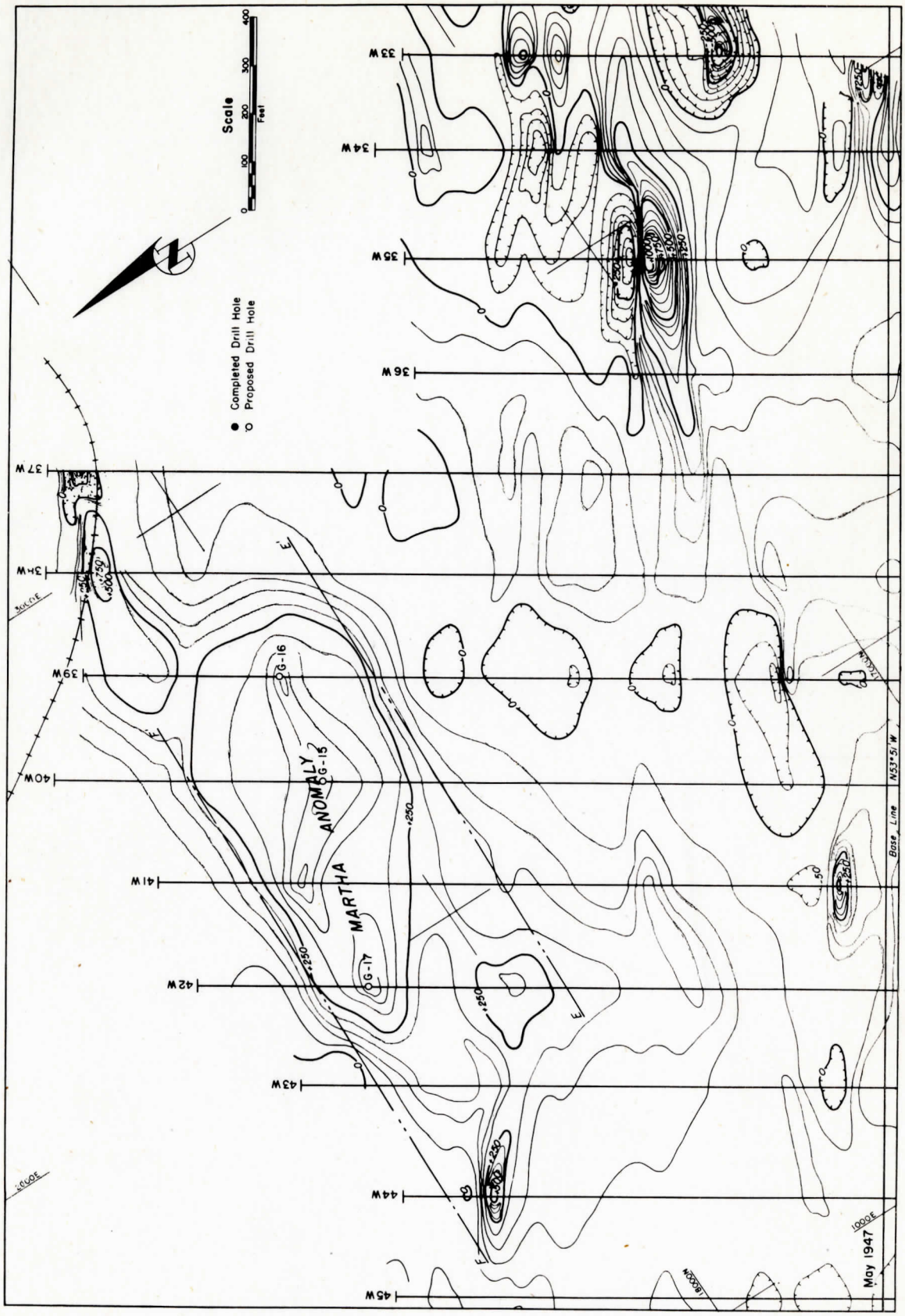

Figure 23. - Isogam map of Martha anomaly.

TABLE V

PARTIAL ANALYSIS OF VEIN-FILLING AT WILDER MINE AREA OF THE CRANBERRY ORE BELT[19]

Ingredient	Per Cent
Silica	46.22
Alumina	5.44
Iron oxides	27.52
Lime	16.00
Magnesia	2.92
Water	.40

[19] W. S. Bayley, op. cit., p. 120.

Furnace Company. In 1918 it was estimated to contain 150,000 tons of probable ore and 600,000 tons of possible ore. It was also stated that due to the low iron content of the ore, it would require very fine grinding to produce an acceptable concentrate.[20]

The Wilder anomaly extends down-dip from the strike of the outcrop of the mine workings at an angle of 45° southwest, appearing to the west as two parallel highs which indicate a series of parallel ore lenses. However, dip observations along the vein showed that the parallel magnetic highs were not caused by two separate ore bodies but by one of the limbs of a synclinal fold where the axis occurs between two magnetic highs.[21]

During the survey made by the Cranberry Furnace Company in 1918, using either a superdip or miner's compass, it was indicated that to the east of the creek dividing the property a buried magnetic mass occupying about 210,000 square feet exists. To the west of the same brook another ore body was indicated, but it was thought to be broken in several places so less importance was placed upon it.[22]

The result of the survey in 1946, using an Askania vertical magnetometer, generally agreed with the former one. It was learned that a greater part of the anomaly is west of the creek rather than east

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[20]Report by S. H. Hamilton, Geologist, Cranberry Furnace Company, according to personal papers of S. H. Odom, Superintendent.

[21] M. H. Kline and T. J. Ballard, op. cit., p. 44.

[22] S. H. Odom, op. cit.

of it, however, a small anomaly was located in the eastern part.[23]

The exploration at the Wilder mine in 1946 consisted of drilling four diamind-drill holes with a total of 1,392.6 feet confined to the eastern part of the anomaly adjacent to the old mine workings. Numerous concentrations of magnetite were penetrated from thirty-six to 238 feet which ended in granite gneiss. None of the ore was considered of value commercially. On the east side of the magnetic high near the old mine relatively good magnetite 2.9 feet thick was struck at fifty feet, and several concentrations of fair magnetite were penetrated at depths ranging up to 273 feet. The samplings from these holes proved 31.7 per cent iron.

The magnetic highs in the eastern part of the Wilder mine did not indicate the presence of any considerable amount of magnetite, but rather the combined effect of the magnetic intensity of several stringers, low grade concentrations, and disseminated magnetite which occurs in the formation. The western part of the anomaly was judged to have similar conditions throughout the extent of the anomaly.[24]

The Red Rock mine is located about one-half mile from the Wilder mine and is on the west side of Morgan Branch hollow. The property is now owned by the Tennessee Coal, Iron, and Railroad Company. During operation of the mine this working was leased to a man named Steve Pittman who mined a small quantity of ore before abandoning it.[25]

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[23] M. H. Kline and T. J. Ballard, op. cit., p. 45.

[24] Loc. cit.

[25] S. H. Odom, op. cit.

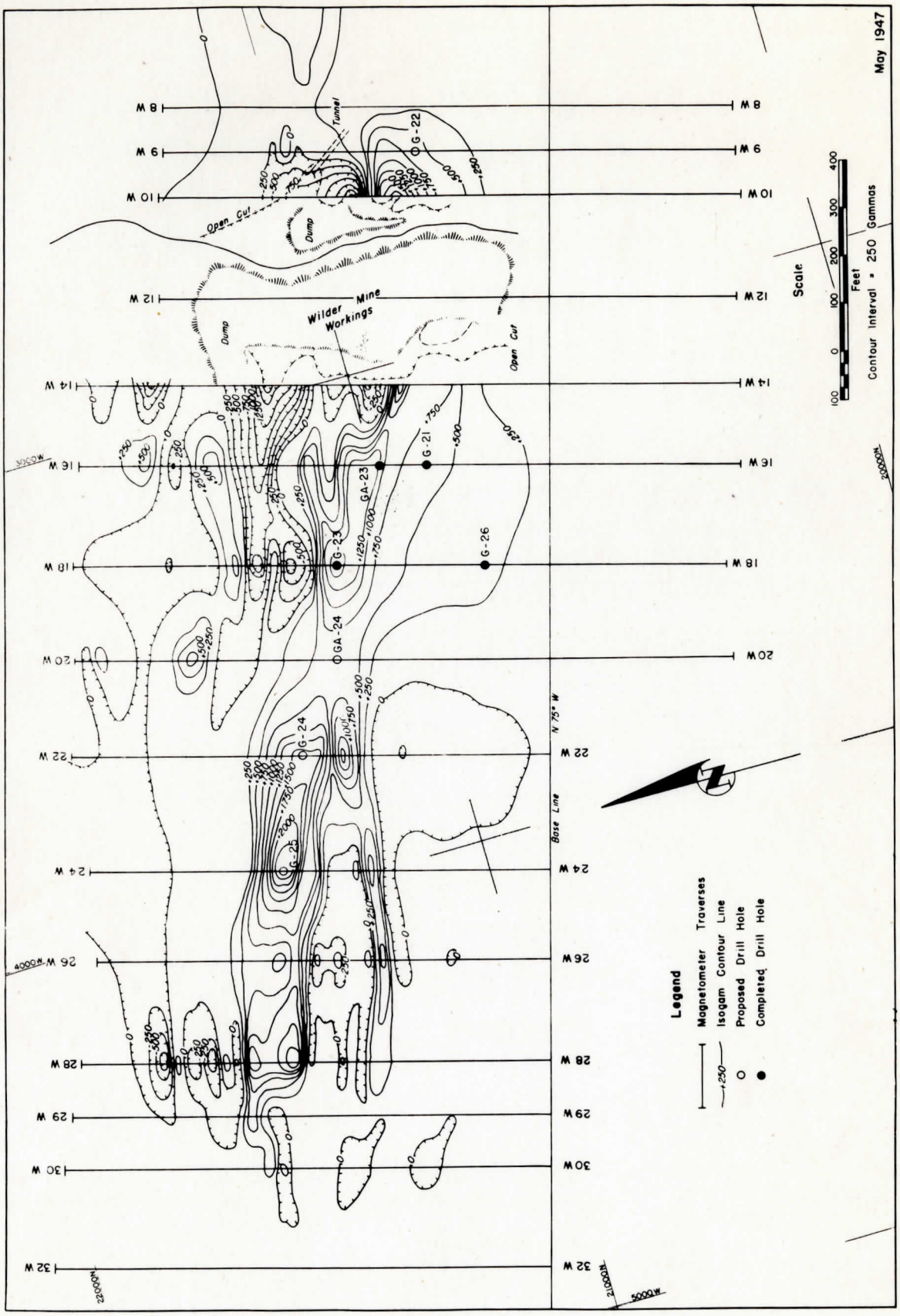

Figure 24. - Isogam map of Wilder anomaly.

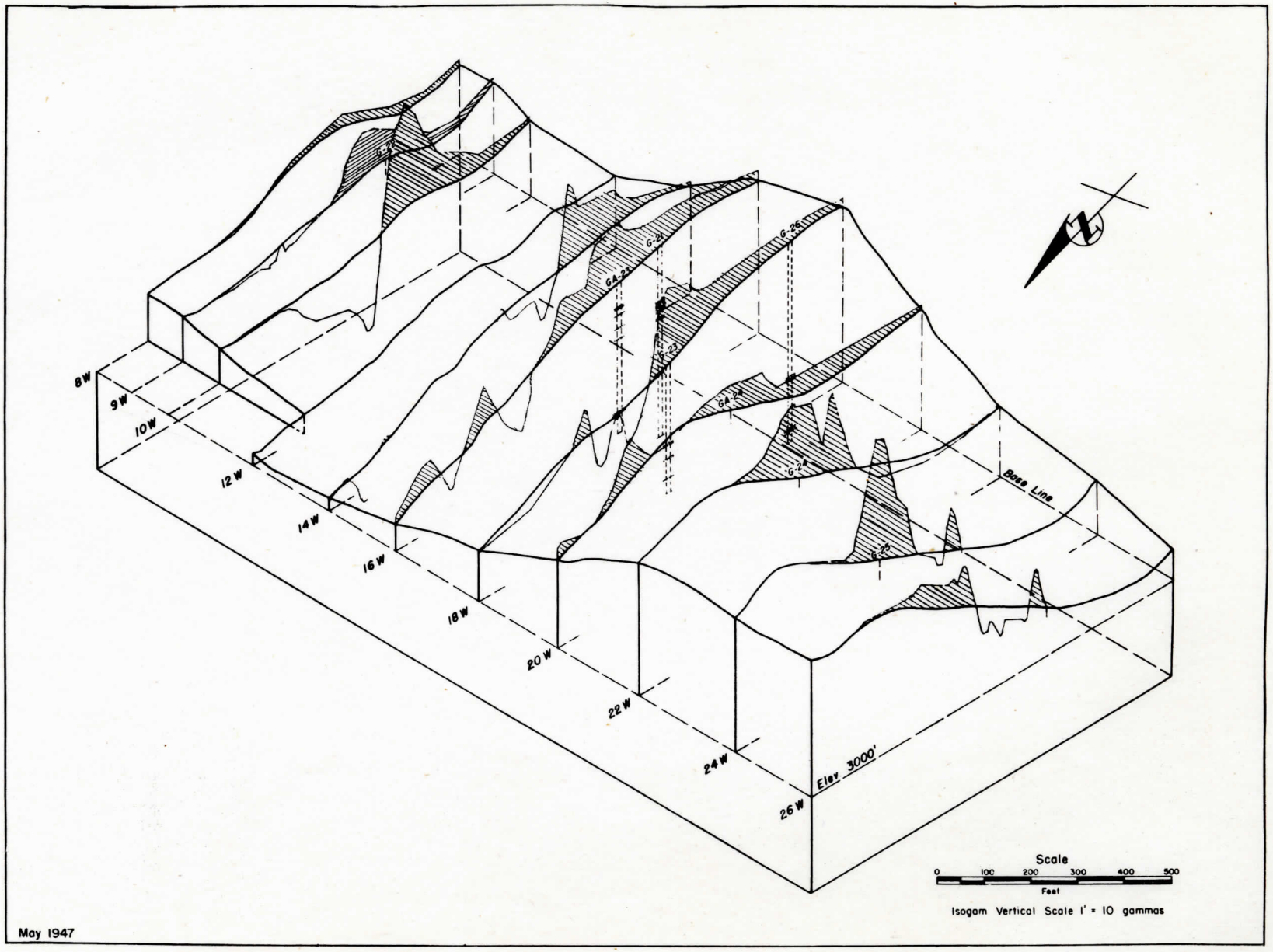

Figure 25. - Isometric view of Wilder anomaly.

During the 1946 survey the undergrowth in the area hindered observing the character of the vein, but fragments of the rock, containing garnet, magnetite, epidote, calcite, quartz, and coarse pieces of pegmatite were taken from the dumps nearby. These showed that the vein materials are somewhat different from others of the Cranberry ore belt in that this ore contains considerable amounts of calcite.[26]

The geophysical measurements also indicated westward extension of the Red Rock deposit. A strong magnetic anomaly occurred at the mine openings, and to the west a small registration of a definite positive anomaly appeared which reached a peak several feet farther west. This anomaly was found to be rather small but considered worthy of testing.[27]

The Howard anomaly is west of the Red Rock mine but in close proximity to it. A low magnetic field connects the two, indicated by a magnetic saddle. The ridge to the west lies along the trend of the western end of the Howard anomaly. A magnetic survey showed the 250 gamma contour having a strike length of 1,100 feet and a width of 250 feet. Its trend is N. 60° W., reaching a peak magnetic intensity at two places.

One diamond-drill hole extending to a depth of 142 feet showed five areas of slight magnetic concentrations between depths of seventy-eight and 128 feet. From this it was concluded that the collective

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[26] M. H. Kline and T. J. Ballard, op. cit., p. 53.

[27] Loc. cit.

magnetic intensity of these low ores accounted for the magnetic peak at this place.[28]

The Patrick mine is located about 3,000 feet northwest of the Red Rock mine near Shell Creek, Tennessee. Some ore was produced here about 1900 and proved similar to that at Cranberry.[29]

The magnetic survey disclosed the reason for abandoning the mine with so little production. In the immediate proximity a very intense magnetic high occurred with an associated magnetic low. This shows the ore to be very near the surface. The magnetic area is very limited in size and indicates that little ore exists.

A much larger anomaly, referred to as the Patrick anomaly, is about one hundred feet down-dip from the one associated with the mine opening and is separated from it by a low magnetic saddle. This anomaly is 550 feet long and about three hundred feet wide. The maximum intensity of 650 gammas was located at six hundred forty-five feet north. The down-dip from this major part of the anomaly, the magnetic contours, assumes a definite trend toward the southwest and is regarded as the rake of the ore deposit down-dip.

The ore bearing veins dip into a rising hillside toward the southwest which probably accounts for the decrease in magnetic intensity as the depth increases.[30]

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[28] Loc. cit.

[29] W. S. Bayley, op. cit., p. 104.

[30] M. H. Kline and T. J. Ballard, op. cit., p. 55.

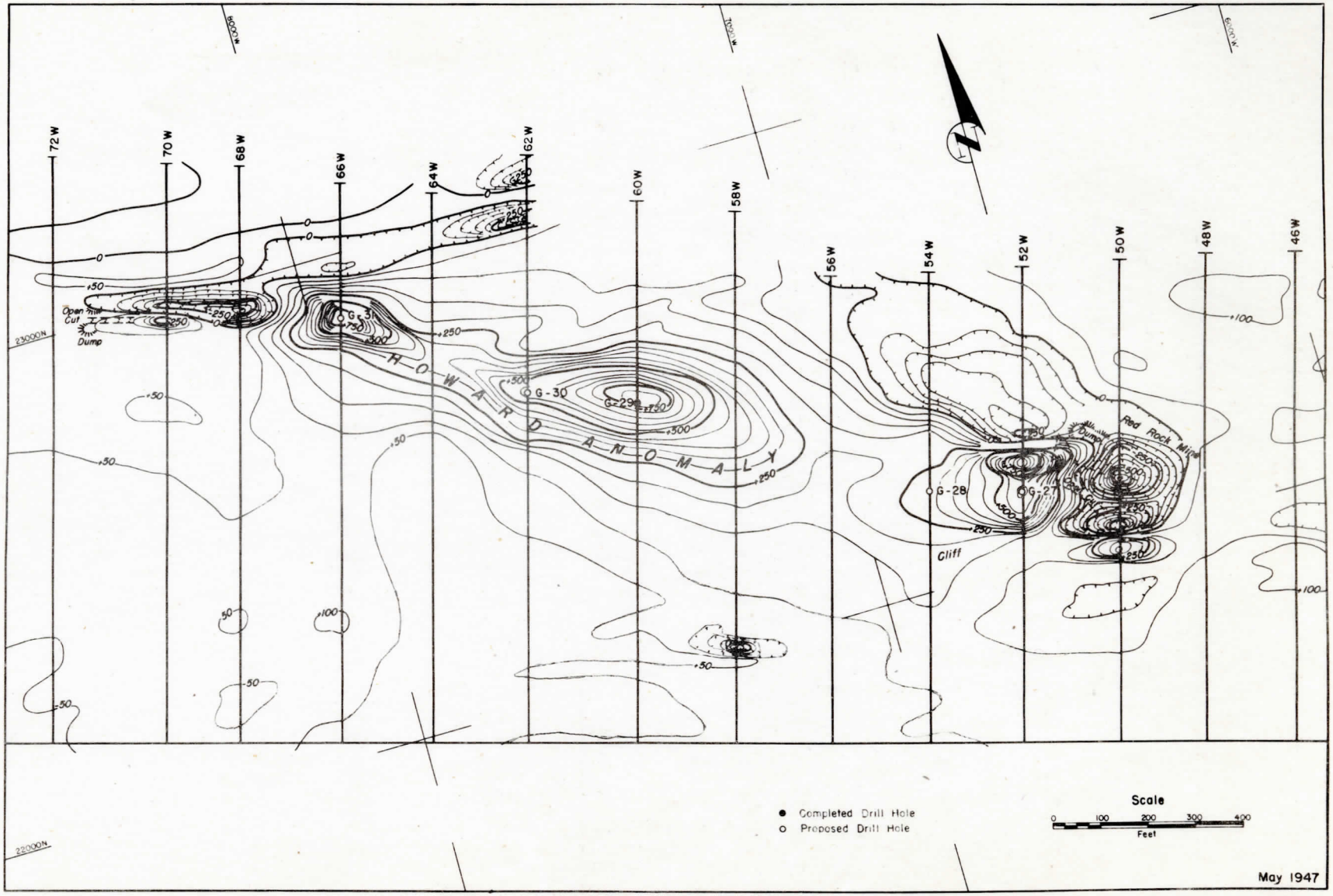

Figure 26. - Isogam map of Howard anomaly, Carter County, Tenn.

Three holes totaling 521 feet were drilled on the property for exploration purposes in 1947. These disclosed several ore bodies of magnetite. One concentration found at 161 feet contained 40.4 per cent iron.[31]

The Vance anomaly is about the same size as the Howard anomaly and near it. The extension of the eastern trend would intersect the Howard anomaly. Similarly, a smaller anomaly is to the north of the main one from which it is separated by a magnetic saddle.

The 250 gamma contour line outlines an area seven hundred fifty feet long and about 190 feet wide. Two holes were drilled during 1947 and neither penetrated any magnetite concentrations of commercial value.[32]

The Teegarden and Ellis mines are about three-fourths of a mile from Shell Creek, Tennessee, on the Shell Creek road. The eastern mine in the Vance hollow is known as the Teegarden mine, and the one in the Ellis hollow is called the Oaks or Ellis mine.

These two openings were worked by Ellis and Kirkpatrick in 1917. They produced about five hundred tons of ore that were shipped by rail to the Cranberry furnace in Johnson City. In December 1917, the Cranberry Furnace Company leased the property and operated the Teegarden mine until the end of May in 1919.[33]

During the period of operation 17,375 tons of ore were shipped

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[31] Loc. cit.

[32] Ibid., p. 59.

[33] S. H. Odom, op. cit.

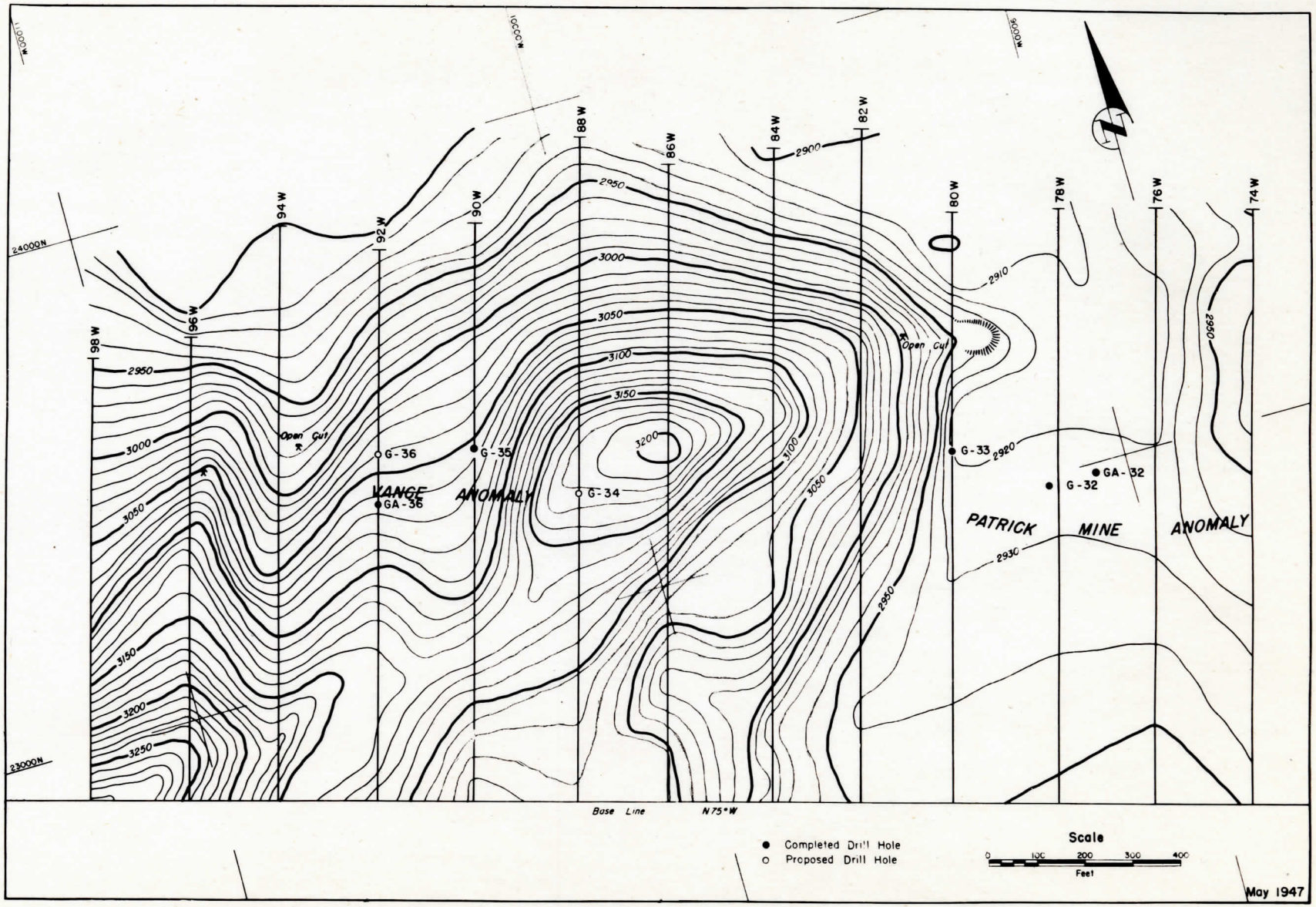

Figure 27. - Topographic map of Vance and Patrick anomalies, Carter County, Tenn.

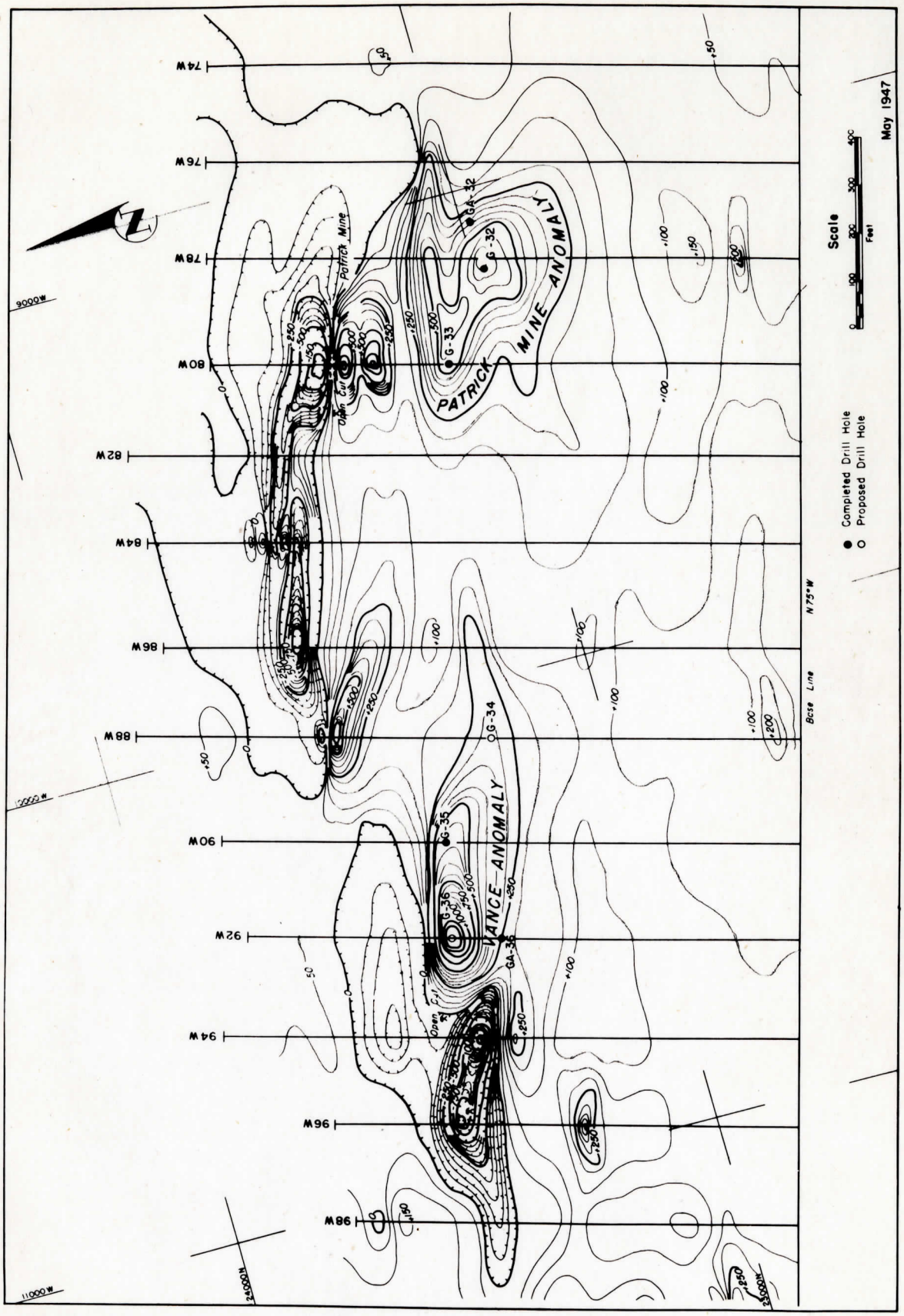

Figure 28. - Isogam map of Vance and Patrick anomalies.

TABLE VI

ANALYSIS OF LEAN ORE FROM THE TEEGARDEN MINE AREA
CRANBERRY ORE BELT[34]

Ingredient	Per Cent
Silica	22.65
Alumina	.48
Ferric oxide	10.30
Magnetite	37.46
Magnesia	0.00
Lime	10.24
Phosphorus pentoxide	.16
Titanic dioxide	0.00
Carbon dioxide	2.70
Water	.28

[34] W. S. Bayley, op. cit., p. 125.

from the property, averaging 36.36 per cent iron and only .0113 per cent phosphorus. This ore was fed into the furnace without any beneficiation. As mining progressed the quality of the ore decreased so much that it was no longer acceptable at the furnace and shipping was halted. Between May and September 1917, the average content of the ore shipped was 43.63 per cent iron and .0093 per cent phosphorus; while from January until May in 1919, the average iron content was 32.1 per cent and the phosphorus .014 per cent.

At the Teegarden mine it was stated a streak of rich magnetite five or six feet wide in a lean ore vein twenty feet wide existed. From the materials on the dump it closely resembles the geologic formation at the Cranberry mine.

At the Ellis mine the vein was found to be ten feet wide with a strike varying ten to fifteen degrees north of west.

A short distance east of the Teegarden opening is a narrowing in the deposit extending about a hundred feet. Beyond this and to the east a lenslike formation is indicated. Still further is another larger ore body that is folded. Below the level of the mine and farther west an ore deposit three hundred feet long has been found. However, none of these ore bodies is very large,[35] the whole area being estimated by the company geologist to contain 250,000 tons.[36]

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[35] M. H. Kline and T. J. Ballard, op. cit., p. 61.

[36] S. H. Odom, op. cit.

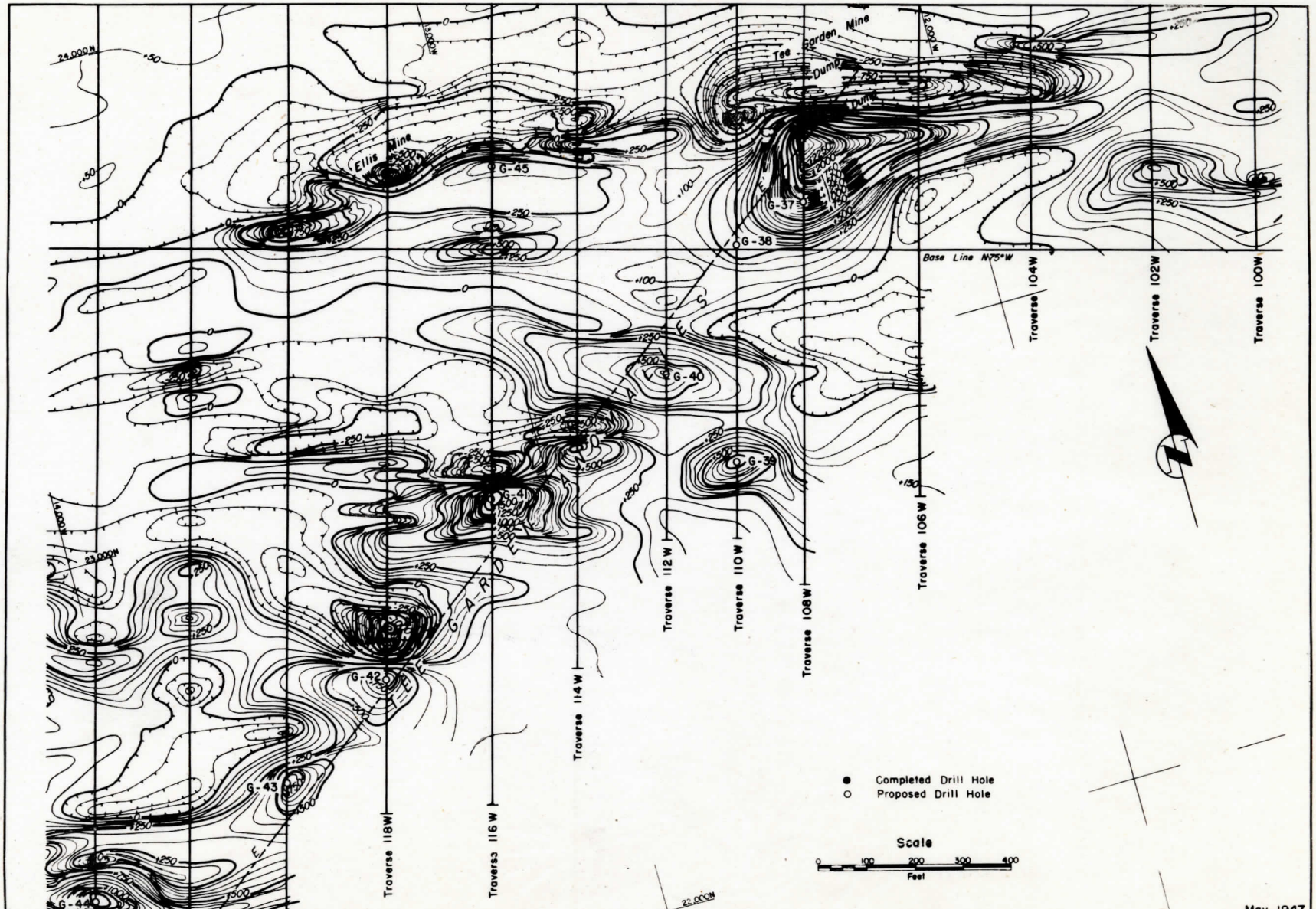

Figure 29. - Isogam map of Teegarden anomalies.

There are a few outcrops and prospect holes on the slope of Heupscup Ridge reportedly made before 1923. The ridge is a spur of Big Yellow Mountain and extends northward between Shell Creek and Hampton, Tennessee. The magnetic survey of this area disclosed a very intense anomaly of large areal extent. All the workings are north of the Heupscup Ridge anomaly along the approximate trend of the Teegarden-Ellis mineral zone. This anomaly represents a newly discovered body of possible ore.

Inspection of outcrops in the vicinity showed light gray granite, presumably Cranberry since the area is mapped as being in the Cranberry granite zone.

This anomaly is the largest in the entire Cranberry ore belt and contains about 1,900,000 square feet. For exploration purposes nine holes were drilled in 1947, totaling 1,357.8 feet, which penetrated magnetite at from twelve to sixty-four feet below the surface and contained over 20 per cent iron.[37]

The Peg Leg mine is situated on the divide between Hampton Creek and Doe River. It has been worked intermittently since colonial days, and as late as 1885 ore was taken from the surface to supply the Doe River forge that was operated on the banks of the river. The Crab

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[37] M. H. Kline and T. J. Ballard, op. cit., p. 69.

Orchard Iron Company of Roan Mountain reopened the mine in 1898 and shipped about 1,000 tons of ore. The mine was again closed and remained so until 1917 when it was prospected by the Magnetic Iron and Coal Company. During the last operation a cut was driven 600 feet in an easterly direction through a vein of ore fifty feet wide of which about one-third was lean ore. This cut produced ore averaging 33.8 per cent iron for a distance of one hundred fifty feet.

At the opening about one mile south of Roan Mountain is a large dump of materials on which nearly all the varieties found at Cranberry may be examined. The ore fragments are very rich coarse magnetite like the ore last taken from the Cranberry mine.[38]

The Old Forge opening is about five hundred feet from the west bank of the Doe River and nearly opposite the Peg Leg mine. Old pits are so distributed as to indicate a vein about one hundred feet wide. On the west bank of the river the ore appears in two streaks about five or six feet wide. The ore in the first streak tested up to 39.98 per cent iron, and that in the second 21.3 per cent iron. Sixteen hundred feet downstream are exposures of 36 per cent iron ore in a face sixteen feet wide, and on the crest of the hill thirteen hundred feet to the west a seven foot vein is exposed.[39]

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[38] Interview with W. T. McCloud, Roan Mountain, Tennessee, December 8, 1954.

[39] W. S. Bayley, op. cit., p. 126.

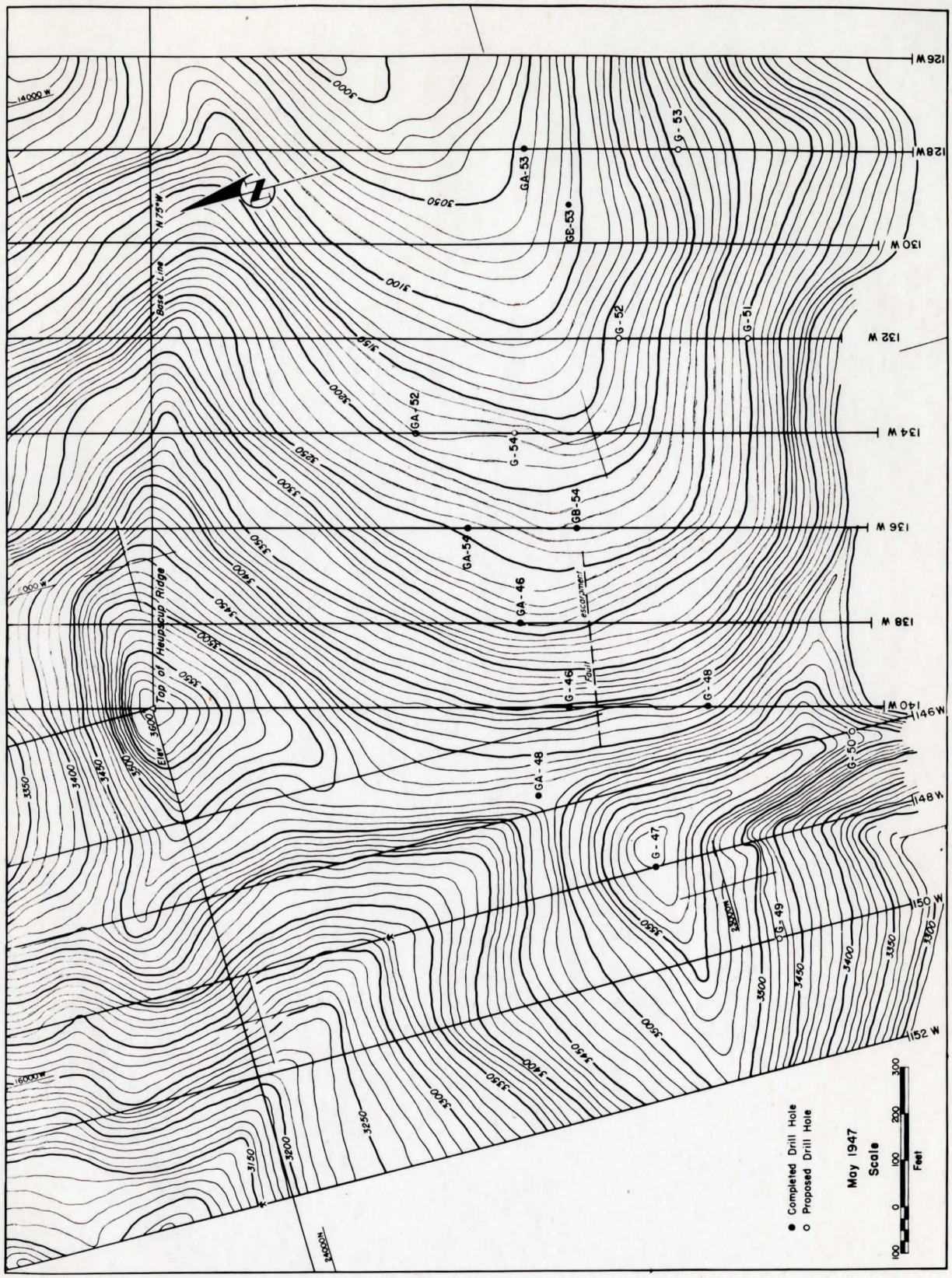

Figure 30. - Topographic map of Heupscup Ridge anomaly, Carter County, Tenn.

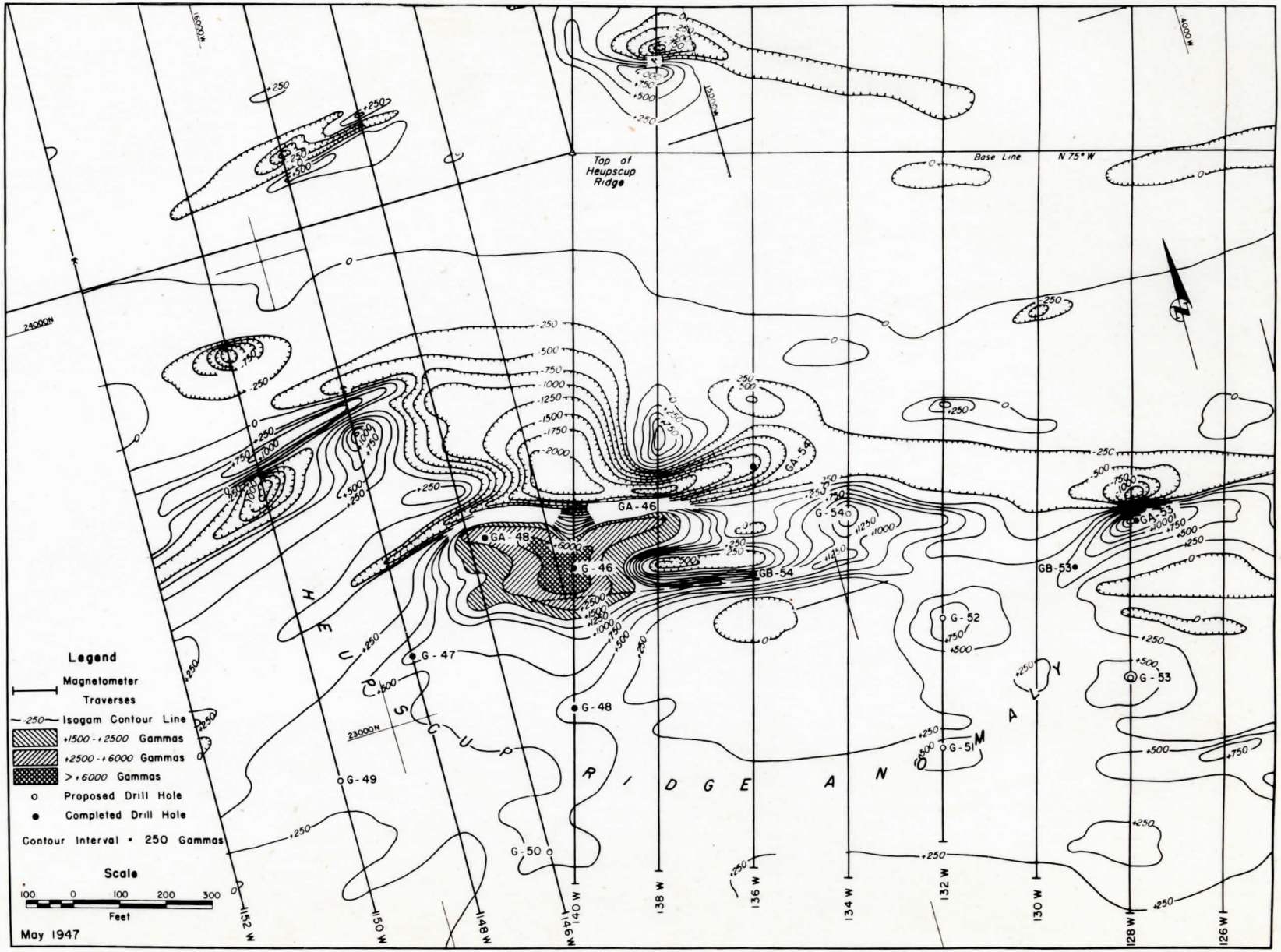

Figure 31. - Isogam map of Heupscup Ridge anomaly.

TABLE VII

ANALYSIS OF LEAN ORE FROM THE PEG LEG PROSPECT CRANBERRY ORE BELT[40]

Ingredient	Per Cent
Silica	23.52
Alumina	.60
Ferric oxide : Ferrous oxide	66.15
Lime	7.20
Magnesia	Trace
Barium oxide	.21
Soda	1.12
Potash	Trace
Phosphorus	Trace

[40] W. S. Bayley, op. cit., p. 127.

The Julian Prospect is between Heaton Creek and Sugar Hollow in Tennessee on the west side of the Shore Hollow. This prospect is on the south side of the Peg Leg mine and about the same distance south of the main mine at Cranberry. The old dump shows lean ore comprising mainly epidote and magnetite. An analysis showed 15.68 per cent iron.[41]

At the Horseshoe Curve of Doe River, running back into the hill on the west side, are a few exposures. Several pits and an opening show that much of the ore has been merely prospected. These are open cuts about six hundred feet above the river, however, due to the lay of the land the workings are about one and a half miles from the river.

The vein rock is very dark and cut by epidote, quartz, and pegmatite as at the Cranberry mine. The strike is a little north of west and is probably a different vein from the Peg Leg body of ore.

The ore is mainly low grade, but one streak about 400 feet long assayed 31.9 per cent iron.[42]

The divide between Doe River and Georges Creek is called the Chestnut Ridge. The small tunnel in a vein of epidotized pegmatite contains a magnetite seam about a foot wide. It is situated on the west side of the ridge about halfway down the slope of the Little Rock Knob. The rock is a schistose granite and classified as Cranberry

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[41] Ibid., p. 127.

[42] M. H. Kline and T. J. Ballard, op. cit., p. 71.

TABLE VIII

PARTIAL ANALYSIS OF ORE FROM THE JULIAN PROSPECT CRANBERRY ORE BELT[43]

Ingredient	Per Cent
Silica	48.20
Alumina	5.03
Iron	15.68
Lime	14.80
Magnesia	9.78
Phosphorus pentoxide	Trace

[43] W. S. Bayley, op. cit., p. 129.

granite.

Some of the ore was mined and shipped in 1890 from an eastern spur of Chestnut Ridge, locally known as Strawberry Ridge.

About a mile west of Little Rock Knob outcrop, a magnetic attraction over an east-west belt was noted during the survey in 1947. It was ascertained that the working here was done between 1895 and 1890 under the direction of a man named J. R. Englebert. From all appearances a very large ore body was discovered. The vein turns south near the working and crosses into North Carolina.[44]

The Campbell Prospects are located on a strike of the vein between the Horse Shoe and the Peg Leg mines about one-half mile west of Georges Creek. One survey had shown magnetic attraction over a much larger area than the Cranberry mine and operation was started there. However, several of the people financing the project were drowned in the Titanic disaster and work was abandoned for lack of funds. Tests in 1947 substantiated the claim that the iron content in the ore is 62.6 to 67 per cent and phosphorus .05 per cent.

Even though the ore proved to be very rich in iron it is not available in commercial quantities.[45]

About one mile south of the North Carolina-Tennessee line are

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[44] Ibid., p. 72.

[45] Ibid., p. 73.

a group of ore prospects known as the Magnetic City Prospects. The main opening is located about two and one-half miles above the mouth of Greasy Creek. A large opening, extending about one hundred feet along the strike and 130 feet above the creek level, was once worked to supply iron for a forge in Magnetic City. The main ore body is eighteen feet wide and similar to the one at Cranberry. The gangue was once thought to be similar to that at Cranberry, but the relation of the ore to the gangue was not determined. The dip is 45° southeast.

A smaller opening is situated above the creek level and shows a very lustrious, compact ore, free from gangue, and about five and a half feet wide. Near the top of the ridge is another vein that shows an ore body of some extent. From the two upper cuts ore of 63.41 per cent iron and 54.48 per cent iron have been taken. The ore at the smaller opening is strongly titaniferous.[46]

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[46] Ibid., p. 72.

CHAPTER V

THE TRANSPORTATION FACILITIES

The establishment of the Cranberry Iron Works created a need for transportation facilities to convey the ore from the mines to the forges, and later to the furnace built at Johnson City, Tennessee, forty miles away. Supplies for the mines, food for the miners and farmers, clothing for everyone, had to be brought into the area to supplement the few necessities produced there.

There is evidence that two roads crossed the mountains from North Carolina into Tennessee as early as 1772. Mention is made of a party of surveyors coming to the Yellow Mountain near the Cranberry ore vein where their compass deflected. This was probably caused by their proximity to the Cranberry iron ore vein about which they then knew nothing. It is also stated that a man named Bright lived at the Crab Orchard about a mile above the present village of Plumtree, North Carolina, at the old Avery farm. One road was named in honor of him. There is information that this surveying party continued from the Yellow Mountain and surveyed the line to a low gap at the headwaters of Roaring or Sugar creek of Toe River and a creek emptying into Doe River at the

road leading from Morganton, North Carolina, to Jonesboro, Tennessee. This establishes the main road between North Carolina and the Watauga settlements in Tennessee and leaves the conclusion that these two roads were in use at that time.[1]

It is stated by Wheeler that when the Watauga settlements became Washington County in 1778, a wagon road was opened up across the mountains into the settled parts of western North Carolina. This road probably traversed the mountains from the Johnson City area into the Cranberry region.[2] The Act of Cession of 1789 states that the line be at the top of the Yellow Mountain where Bright's road crosses it.

One of the roads was in the proximity of the Cranberry mine, running through Elk Park, or where the town now is located, across the farm of Peter Hardin, and on into Tennessee.[3] The old bed of this road is still visible on this farm today. The land is now owned by R. N. Cardwell of Elk Park, who purchased it from a woman named Alice Carson, the step-daughter of Peter Hardin. The old Indian and Negro cemetery, in which Peter Hardin is buried, is on the lower end of this farm and near highway 19E.[4] It is reported that Hardin fell from a wagon loaded high with hay on this farm and sustained fatal injury. The marker at the head of his grave is a huge triangular stone and is

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[1] J. P. Arthur, Western North Carolina (Raleigh: Edwards and Broughton, 1914), p. 14.

[2] Ibid., p. 232.

[3] Interview with R. N. Cardwell, Elk Park, North Carolina, February 5, 1955.

[4] Personal knowledge of the writer.

said to be of his own choosing.[5]

A man named John Strother wrote in his diary about the survey between North Carolina and Tennessee in 1799, and of his surveying party crossing a road leading from Morganton to Jonesboro.

Chancellor John Allison of Tennessee spoke about Andrew Jackson traveling the same road when he moved from Morganton, North Carolina, to Jonesboro, Tennessee, in 1788.

All these dates referring to the roads are prior to the passing of the first recorded wagon over the mountains from North Carolina into Tennessee in 1795.[6]

It is evident that the iron ore, the charcoal for the forges, the finished iron, and many other items were hauled over these roads from, and to, points of purchase and sale. Peter Hardin hauled iron from the Cranberry forge to Camp Vance, some distance south of Morganton, during the Civil War.[7]

About this time the formation of a company for the purpose of building a railroad to transport the iron and ore from Cranberry to Johnson City was being planned. As a result the East Tennessee and Western North Carolina Railroad Company was chartered by Legislative Act on May 24, 1866 in the Tennessee General Assembly.[8]

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[5] R. N. Cardwell, op. cit.

[6] J. P. Arthur, Loc. cit.

[7] J. Preston Arthur, History of Watauga County (Richmond: Everett Waddy Company, 1915), pp. 265-266.

[8] Tennessee Acts, 1865-68, Chapter 88. See Appendix for copy of the charter.

The charter gave the company two years to begin the construction; which time would be used to complete the organization, survey the right-of-way and sell stock in the firm. It provided that the railroad should be completed in five years from the date of granting the charter.

Similar to so many other grandiose business ventures of the time the company experienced financial difficulty when only five miles of the track had been placed from Johnson City. After a short ownership by a John Hughes, and others, of Johnson City, a man of experience in the building of railroads, Ario Pardee of Philadelphia, Pennsylvania, bought the company. He had once worked with Colonel Thomas E. Matson on many engineering projects. Also, he owned a sizable interest in the Cranberry Iron Works.[9]

The actual construction of the narrow-gauge-track railroad proved very difficult. Mountains of the Doe River Gorge were tunneled with pick and shovel. Wheelbarrows were used in removing surplus dirt and rocks in preparing much of the road bed, however, most of the materials were hauled away in mule-drawn carts. Where the cliffs were too high and precipitous for the mules to climb in order to get into the places where they were needed, the colonel had them lifted up and over the steep rocks with block and tackle. Also, to speed up the work, he a plan to work from both sides of the mountain at the same time.[10]

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[9] W. W. Whisman, Souvenir Programme, 85th Year of Service (Johnson City: East Tennessee and Western North Carolina Transportation Company, 1951), p. 3.

[10] Ibid., p. 4.

In due time, Dr. Abram Jobe of Elizabethton, Tennessee, brought his family to Elk Park on the first train that operated over the railroad on June 13, 1881.[11]

In the nineteen miles from Johnson City to Hampton, Tennessee, the railroad reached an elevation of about nineteen hundred feet and, upon reaching the Cranberry mine in North Carolina, it attained the altitude of nearly three thousand feet. Due to this change in elevation the grade of the railroad was very steep.

A catastrophic cloudburst in the mountains in 1901, known to the elderly people around here as the May Tide, washed away the track in thirty-nine places and all the bridges but two. Nevertheless, in a very short time the train was operating as before over the reconstructed railroad.[12] To make the bridges and fills more substantial after this, trainloads of the slag from the boilers at Cranberry and the rock from the mines were dumped along the railroad at most of these places until they were deemed secure for the train to operate over.[13] One such fill has already supplied over 300,000 tons of this material for recent highway surfacing. It is located below the North Carolina-Tennessee state line northwest of Elk Park.[14]

In the early days of the railroad it was the contact medium with

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[11] Diary of Dr. Abram Jobe, now in possession of Mrs. Elva Aleminer, 611 Cherry Street, Bristol, Tennessee.

[12] W. W. Whisman, op. cit., p. 5.

[13] Personal observation of the writer.

[14] Interview with Floyd Hayes, Elk Park, North Carolina, February 12, 1955. He is currently removing, crushing, and selling the stone.

the outside markets for the people who lived along it. "Tweetsie",[15] as the little train was nicknamed, became a center of interest for the mountain folk. Splendid resort hotels sprang up amidst the mountain scenery of Roan Mountain, Cranberry, Linville, and Elk Park. The daily unscheduled stops of the train along the line proved helpful to those desiring to get some member of the train crew to do some shopping in Johnson City. The desired items arrived generally on the return trip. The conductor is said to have been ever watchful for the multi-colored cloth flags the people used to wave when desiring the train to stop.[16]

All these unscheduled activities were in addition to the regular work of transporting the necessities for the mountain people and hauling the coal from the Virginia mines to Cranberry for the boilers; conveying the ore from the mines of the Cranberry ore belt to Johnson City; and, in time, taking out lumber, tan bark, acid and pulp woods, and timbers from the Cranberry area. "Tweetsie" proved to be the life-line for the development of the region.[17]

The railroad was completed to the iron mine at Cranberry in 1882, however, it was extended to Saginaw, or Pineola, North Carolina, in 1900 by a man named E. H. Camp to transport timber and lumber from his

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15 "Tweetsie" was given the train by students at Appalachian State Teachers College in Boone because the whistle blew "Tweet, tweet" while passing the campus. Reported by Professor Edwin Dougherty to the writer.

16 Interviews: Kenneth Jobe and Raymond McCrary, Elk Park, North Carolina, December 27, 1954. Former conductor and brakeman, respectively, of the railroad.

17 Interview: W. W. Whisman, Vice-President, East Tennessee and Western North Carolina Railroad Company, Johnson City, Tennessee, November 13, 1954.

large tract near Saginaw. This extension was paid for by profits from the sale of Arbuckle coffee and this part of the railroad was called the Arbuckle Line, although its real name was the Linville River Railroad.

The entire railroad, the East Tennessee and Western North Carolina Railroad and the Linville River Railroad, went into receivership and was purchased by a man named Isaac T. Mann of West Virginia who interested the W. M. Ritter Lumber Company in it. In 1913, the W. M. Ritter Lumber Company sold the majority of the stock in the railroad to the Cranberry Iron and Coal Company of Johnson City, Tennessee, and Cranberry, North Carolina.

Due to economic factors beyond the control of the company, the mining operation at Cranberry was stopped in 1930, the furnace at the Johnson City site having been dismantled and sold the year before.[18] The timber and other natural resources within the service area of the railroad had long since neared exhaustion, or shipment changed to motor transportation, thus leading to the abandonment of the railroad in 1950 from Cranberry to Johnson City.[19] The track extending to Boone, North Carolina, from Cranberry had been removed several years before after impairable damage by flood in 1940 which washed out much of the Linville

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[18] Treated more fully in Chapter VI.

[19] W. W. Whisman, op. cit., p. 6.

River Line.[20]

After Ario Pardee the railroad had as presidents: Frank Firmstone, General Robert Hoke, Frank P. Howe, Edgar P. Earle, Louis E. Kirk, and G. B. Steel. All of these are now deceased.[21]

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[20] Personal knowledge of the writer.

[21] W. W. Whisman, op. cit., p. 8.

CHAPTER VI

THE ECONOMIC AND TESTING ASPECTS

It was decided that the use of the Cranberry magnetite ore depended upon being able to supply it to the furnace at a reasonable cost and in sufficiently large quantities, and that to be of commercial value it should have an iron content of forty per cent, or more.[1]

There are several deposits that will supply small amounts of the desired grade ore, but the expense of selecting the right quality would be considerable. Insofar as is now known there are no such deposits in the ore belt that may be made to yield a continuous supply since most of the ore is of a lower grade than needed unless concentration is used. During the last years of operation of the Cranberry mine, ore of comparatively low grade was furnished to the furnace. This was hand-cobbed to some extent. During May, June, and July of 1920 the test showed an iron content of 38.72 per cent and phosphorus as .0112 per cent. These shipments were made from selected headings in the mine and represented what was thought to be some of the best ore obtainable in tonnages. It was not thought that any other place in the area would furnish as much ore as the mine at Cranberry, and that most of the

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[1] M. H. Kline and T. J. Ballard, Cranberry Magnetite Deposits (Washington: United States Bureau of Mines, 1948), p. 10.

ore in the Cranberry ore belt would have to be concentrated before it was used. Also, the mining of the ore would be economically profitable only if the concentrate would yield an iron low in phosphorus. The Cranberry ore was guaranteed to produce iron with a phosphorus content not exceeding .035 per cent. Consequently the ore from which it was smelted was not to concentrate more than .02 per cent phosphorus.[2]

Until October 1919, the ore was cobbed and then concentrated magnetically which resulted in using much of the ore that was too lean to be shipped directly to the furnace. During the last four months of operation in 1919, 9,941 tons of ore were shipped and classified as cobbed, fine, and concentrates. The fine ore contained five-eighths inch materials and dust.[3]

In 1913, twenty carloads of crude ore were tested to determine the amounts of various grades of concentrates. The aggregate weight of the crude ore was 120,353 pounds. The weights and proportions of the ore produced are shown in Table X. These results show that it is possible by magnetic methods to secure concentrate with a higher iron content than that in the crude without increasing the content of phosphorus. In fact, the phosphorus content decreases as the iron content increases. This is probably due to the fact that most of the

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[2] Arthur Keith, Asheville Folio, Geological Atlas (Raleigh: Division of Geology, 1904), p. 69.

[3] W. S. Bayley, Magnetic Iron Ores (Nashville: McQuiddy Company, 1923), p. 69.

TABLE IX

PEOPORTIONS AND QUALITY OF DIFFERENT CLASSES OF ORE
CRANBERRY MINE IN SUMMER OF 1919[4]

Class	Tons	Per Cent	Iron	Phos.
Crusher ore		100.	33.28	.0275
Cobbed ore	1712	17.2	48.00	.0095
Tails			28.29	
Coarse concentrates				
Heads			44.90	.0104
Tails			25.07	
Coarse concentrate retreats				
Heads			42.60	.0113
Tails			14.57	
Finer concentrates				
Heads	7676	73.25	45.15	.0111
Tails			18.41	
Finer concentrate retreats				
Heads			40.76	.0134
Tails			15.89	
Finer concentrates				
Heads			57.91	.079
Tails			17.27	

[4] W. S. Bayley, Magnetic Iron Ores of East Tennessee and Western North Carolina (raleigh: Division of Geology, 1923), p. 70.

TABLE X

GRADES OF CONCENTRATES PRODUCED
CRANBERRY MINE ORE
1913[5]

Types	Pounds	Per Cent
Cobbed heads	18,450	15.3
Coarse concentrates	28,895	19.8
Finer concentrates	14,700	12.2
Fine concentrates	11,600	9.6

[5] Loc. cit.

phosphorus is in the mineral apatite which is more closely related with the hornblende than with the magnetite. It was found that this method is satisfactory in producing a commercial ore, its success depending on the cost. The Cranberry mine ceased operations, not because it was impossible to produce a satisfactory concentrate there, but due to the expense in producing the required concentrate. The 1913 operation showed that two tons of ore were required to produce one ton of concentrate that would test 46.5 per cent iron.

In order to figure a cheaper method for the concentration of magnetites in the mountainous area, samples of the ores from the mine at Cranberry were tested at the Bureau of Mines Experiment Station in Minneapolis, Minnesota. One series of low grade ores included five samples from the walls of the Cranberry mine.[6] These were analyzed for total magnetic iron and phosphorus content and then subjected to the following tests.

One set of samples was crushed to quarter inch size and magnets of increasing strengths were used. The results are shown in Table XII. A second set of tests combined a fine grading to pass sieves of minus 14, 28, 48, and 100 meshes, and concentrating under water with sufficiently strong magnets to prevent loss of tailings. The results are shown in Table XIII. One sample was given a wet magnetic test

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[6] See Table XI.

TABLE XI

COMPOSITIONS OF SAMPLES OF LOW GRADE ORE
CRANBERRY MINE[7]

Sample	Soluble Iron	Magnetic Iron	Phosphorus
Lot 5G	15.52%	10.47%	.0362%
5H	13.84	7.35	.0223
5I	15.11	9.81	.0303
5J	21.51	14.54	.0180
5K	25.47	22.03	.0575

[7] Ibid., p. 72.

TABLE XII

RESULTS OF CONCENTRATIONS TESTS ON SAMPLES
TABLE NO. XI
-SAMPLE 5L[8]

	Concentrates			Tailings		
Test	Yield	Iron	Phosphorus	Yield	Iron	Phosphorus
1	29.57%	59.65%	.0076%	70.43%	11.11%	.0785%
2	36.85	56.82	.0125	63.15	7.17	.0838
3	41.91	51.83	.0198	58.09	6.44	.0847
4	58.95	39.87	.0326	41.05	4.78	.0392

[8] Loc. cit.

TABLE XIII

RESULTS OF CONCENTRATION TESTS
CRANBERRY MINE[9]

Sample and Composition	Mesh	Concentrates Yield	Iron	Phosphorus	Tailings Yield	Iron in Magnetite
1 Fe 41.20	100	43.26%	71.49%	.005%	56.74%	4.19%
P 0.009	48	45.39	69.10	.005	54.61	4.03
	28	52.05	62.86	.006	47.95	3.58
	14	62.55	55.63	.006	37.45	3.50
2 Fe 37.12	100	36.88	71.44	.004	63.12	3.59
P 0.012	48	39.79	68.03	.004	60.21	2.89
	28	45.04	62.10	.005	54.96	3.50
	14	61.53	50.38	.006	38.47	3.35
3 Fe 30.92	100	29.83	71.14	.004	70.07	4.49
P 0.013	48	32.29	67.42	.005	67.71	4.26
	28	35.29	61.79	.005	64.71	5.02
	14	45.13	51.90	.005	54.87	4.87
4 Fe 34.50	100	30.37	70.99	.004	69.63	8.91
P 0.016	48	32.69	68.18	.005	67.31	8.14
	28	37.29	61.95	.006	62.71	8.37
	14	57.01	47.03	.010	42.99	8.45

[9] Ibid., p. 74.

TABLE XIV

CONCENTRATION TESTS ON SAMPLE 5L
TABLE NO. XI[10]

(Wet Magnetic Concentration)

Test	Concentrates			Tailings		
	Yield	Iron	Phosphorus	Yield	Iron	Phosphorus
1	39.38%	57.87%	.0107%	60.62%	4.27%	.00
2	34.07	64.91	.0058	75.93	4.95	.00
3	33.95	67.91	.0038	66.05	3.52	.00
4	31.89	70.46	.0020	68.11	4.27	.00

[10] Ibid., p. 72.

and the results are recorded in Table XIV. This single result is given because this sample represents the lowest grade ore that might be used for concentration with a reasonable expectation of profit.[11]

A second series of samples were taken to represent the ore that might be readily procured from the vein without including the leaner ones. These were taken from the headings in the mine where work had been done during regular operations in 1920. One was the ore shipped directly to the furnace with concentration, one was good milling ore, and two were of average milling ore. These were treated similarly as the first series, and the results of testing are shown in Table XVI.

The results obtained in the dry-cobbing tests showed that each of the four samples when crushed to one-fourth inch mesh size produced a concentrate assaying between 50 and 60 per cent iron and .007 to .010 per cent phosphorus. The amount of the concentrate varied, however, with the samples. According to Table XVI it may be seen that sample three, in test four, showed that 28.30 per cent of the crude ore was recovered as a concentrate assaying 58.44 per cent iron, whereas sample one showed that fifty per cent of the crude was recovered as a concentrate assaying 57.17 per cent iron. The difference was supposed to have been caused by the amounts of iron in the original samples and the differences in their structures.[12]

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[11] W. Bayley, op. cit., p. 71.

[12] Ibid., p. 75.

TABLE XV

CRANBERRY MINE ORE[13]

(Magnetic Concentration Tests)

Sample	Soluble Iron	Total Iron	Iron in Magnetite	Phosphorus
1	33.25%	41.20%	31.02%	.009
2	28.45	37.12	26.09	.012
3	24.41	30.92	21.42	.013
4	27.67	34.50	22.96	.016

[13] Ibid., p. 73.

TABLE XVI

CONCENTRATION TESTS ON CRANBERRY ORE[14]

(Dry Cobbing Tests)

Sample and Composition	Test	Concentrates			Tailings	
		Yield	Iron	Phosphorus	Yield	Iron in Magnetite
1 Fe 41.20%	1	89.74%	43.88%	.008%	10.26%	1.69%
P .009	2	77.77	47.60	.008	22.23	1.74
	3	61.97	53.24	.007	38.02	5.36
	4	50.00	57.17	.007	50.00	9.85
2 Fe 37.12	1	82.83	41.12	.009	17.17	2.60
P .013	2	69.10	45.44	.008	30.90	2.83
	3	54.94	50.87	.007	57.07	9.07
3 Fe 30.92	1	71.70	37.47	.011	28.30	3.05
P .013	2	52.45	44.72	.011	47.55	3.44
	3	36.60	54.20	.010	63.40	5.17
	4	28.30	58.44	.009	71.70	8.18
4 Fe 34.50	1	75.37	39.73	.012	24.63	1.76
P .016	2	59.83	44.71	.011	40.17	3.31
	3	43.11	51.92	.008	56.89	5.69
	4	31.97	56.31	.007	68.03	9.48

[14] Ibid., p. 74.

It may be noted that in the wet concentration tests a concentrate assaying 70 to 71 per cent iron and between .004 and .005 per cent phosphorus in all four samples at minus 100 mesh. Coarser grinding and concentrating lowered the total iron content from two to four per cent but increased the yield. This slightly increased the ratio of concentration.[15]

As a result of these tests it would seem that a satisfactory method of concentration could be devised by cobbing out thirty to forty per cent of the crude ore assaying five per cent magnetic iron and then reducing the concentrate to a minus-48 mesh size before the wet magnetic concentration. It probably would be necessary to mine and cobb three tons of ore, discarding 1.2 tons of tailings, to get 1.8 tons of cobber to be crushed for testing. One ton of concentrate would actually be prepared from the three tons, and it would assay about 63 per cent iron and .006 per cent phosphorus.

By working carefully a dry method of concentration could produce a concentrate assaying about 56 per cent iron and .01 per cent phosphorus.[16]

The conclusions are shown in Table XVI. They show that by dry concentration methods a concentrate assaying about 56 per cent iron and .01 per cent phosphorus is possible with a ratio of $2\frac{1}{2}$ to 1, and that

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[15] Ibid., p. 75.

[16] Loc. cit.

by the wet concentration method a concentrate may be produced with as high a percentage of iron as desired. Also, they prove the finer the grinding the more expensive the process, that most any fine grade concentrate can be produced, but to determine the grade most desirable economically to produce would require a careful consideration of the milling and mining costs. In estimating the value of the ore in any deposit, therefore, it is necessary to consider the quality and quantity of magnetite present and the cost of producing a commercial grade of iron from it.

In 1946, a pilot mill test was done on samples from the Cranberry mine. These were taken from a place in the tunnel about one half mile from the opening, and comprised 1,400 tons. About two-thirds of the ore was cobbed from lean ore broken and left in the stopes during the regular operation of the mine. The remaining ore was blasted from the faces of the stope. Thirteen hundred sixty-five tons were milled and 301.2 tons of concentrates produced. This averaged 70.3 per cent iron.[17]

Several samples of high grade magnetite concentrates were needed to carry out tests by the United States Bureau of Mines for its sponge iron program. The testing was done at the pilot plant in Salisbury, North Carolina, and the laboratory tests proved the magnetite from the Cranberry mine the most favorable from the standpoint of grade of the

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[17] Lamb and Woodard, Pilot Plant Production of High Grade Magnetite Concentrates (Washington: Bureau of Mines, 1946), p. 7.

concentrate produced.[18]

The wet magnetic concentration method produced a low phosphorus and high iron concentrate. As a result of these tests it was decided to recommend the construction of a pilot mill at the Cranberry site and ship the concentrate produced to the Salisbury plant for testing purposes.

A sample of the ore from the mine was submitted to the Eastern Station of the Bureau of Mines for ore-dressing tests to determine the quantity and grade of concentrates that could be obtained for possible use in producing sponge iron. A partial analysis of the heads sample used in the laboratory tests showed 48.1 per cent iron, 41 per cent insolubles, 17.8 per cent silica, .14 per cent sulphur, and .005 per cent phosphorus. Table XVII shows the results of a dry screen analysis for a heads sample after crushing to minus one-half inch mesh.

Six representative samples were taken from the minus one-half inch mesh heads sample and crushed further to minus-8, 48, 65, 100, and 200 mesh sizes. Each sample was then separated into magnetic and non-magnetic fractions by using a Davis tube tester. It may be seen in Table XVIII that the maximum liberation of the magnetite from the gangue occurs at 100-mesh and that concentrates may be produced to assay 71.7 per cent iron with a recovery of as much as 88.6 per cent total iron. Since the results obtained with a Davis tube are usually

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[18] M. H. Kline and T. J. Ballard, op. cit., p. 78.

accepted as standard with one hundred per cent recovery of magnetic iron, it would be expected that with a commercial machine a somewhat less percentage of recovery would result. However, the total production would tend to increase in volume.[19]

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[19] Loc. cit.

TABLE XVII

DRY SCREEN ANALYSIS OF HEAD SAMPLE
CRANBERRY MINE[20]

Mesh Size		Weight	Total Iron	Insolubles	Total Iron Distribution
½"	to 8"	22.9%	40.1%	55.0%	20.6%
8	10	13.6	40.5	53.9	12.1
10	20	20.3	40.6	53.8	16.4
20	35	13.7	46.2	44.5	14.1
35	65	11.5	56.6	26.8	14.6
65	100	5.0	54.7	29.1	6.1
100	200	5.9	53.0	33.4	6.9
200	-	7.2	44.6	46.6	7.2

[20] Ibid., p. 79.

TABLE XVIII

DAVIS TUBE MAGNETIC SEPARATION TESTS
CRANBERRY MINE HEADING[21]

Mesh	Product	Weight	Iron	CaO.	S.	Phos.	Total Fe.
-8	Magnetite	87.0%	51.8%	7.52%	.062%	.001%	95.5%
	Nonmagnetic	13.0	17.2				4.5
	Composite	100.0	47.3				100.0
-28	Magnetic	68.5	67.0	.80	.041	.001	91.0
	Nonmagnetic	31.5	15.5				9.0
-48	Magnetic	59.2	69.4	.80	.034	.002	85.5
	Nonmagnetic	40.8	17.0				14.5
-65	Magnetic	64.6	70.9	.80	.035	Nil	88.5
	Nonmagnetic	35.4	16.2				11.5
-100	Magnetic	59.0	71.7	.46	.041	.20	88.6
	Nonmagnetic	41.0	13.0				11.4
-200	Magnetic	55.0	69.0	.08	.029	.005	83.3
	Nonmagnetic	45.0	17.0				16.7

[21] Loc. cit.

TABLE XIX

PRODUCTION OF IRON ORE
CRANBERRY MINE
1900 to 1922[22]

Year	Long Tons	Value
1900	21,000	$42,000
1901	2,578	4,997
1902	34,336	52,771
1903	82,851	78,540
1904	64,347	79,846
1905	56,282	70,352
1906	56,057	75,638
1907	75,638	113,488
1908	48,522	76,877
1909	61,150	107,013
1910	65,278	114,237
1911	84,782	148,369
1912	68,322	186,264
1913	69,235	
1914	57,667	
1915	65,596	
1916	60,043	
1917	55,353	
1918	60,593	
1919	43,483	
1920	44,482	
1921	-	
1922	4,321	

[22] Pratt, The Mining Industry in North Carolina (Raleigh: Division of Geology, 1924), pp. 64, 73.

CHAPTER VII

CONCLUSIONS

The results of this study tend to show that the Cranberry ore belt occurs in a pre-Cambrian granite gneiss extending from three miles southeast of Cranberry, North Carolina, to about six miles southwest of Magnetic City, Tennessee; that the ore is an elongated area of deposits curving toward the north for about twenty-six miles; that the ore is in successive lenses or shoots which are usually connected; that a repetition of lenses occurs along the strike and dip in the old workings without any structural or other known reason why this repetition does not continue, even though the lenses may vary in size as the depth increases; and, that some of the ore might be hand-picked to produce a high grade concentrate, however, the bulk of the ore is of comparatively low grade, containing forty to forty-five per cent iron.[1]

From a study made by the United States Bureau of Mines, accounts of the mine superintendent in his personal papers, and the size of the dumps, some of which have been used recently by the North Carolina State Highway Commission for surfacing highways, it appears that the average iron content of the ore used was about thirty per vent.[2] The

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[1] W. S. Bayley, Magnetic Iron Ores of East Tennessee and Western North Carolina (Nashville: Division of Geology, 1923), p. 23.

[2] M. H. Kline and T. J. Ballard, Cranberry Magnetic Deposits (Washington: Bureau of Mines, 1948), pp. 1-85.

average total iron content of the ore sent to the mill by the recent testing operation by the United States Bureau of Mines was between thirty and forty-five per cent, although there were some high grade stopes from which the ore might be shipped directly to the furnace.[3]

The magnetite lends itself to concentration as shown by tests by the Bureau of Mines, and a high grade concentrate of high iron and low phosphorus content can be produced by fine grinding and magnetic separation, the top quality of the concentrate depending upon the extent of the fineness to which the material is crushed. By dry concentration methods a concentrate assaying about 56 per cent iron and .01 per cent phosphorus can be made from a ratio of 2½ to 1, and by wet concentration methods a concentrate as high in iron as desired may be produced, depending on the fineness of the material after grinding. Nevertheless, to determine the grade most desirable economically to produce would require a careful study of milling and mining costs. At most of the Cranberry belt deposits ores of a satisfactory iron content may be mined, but the production must be in suitable quantities to keep mining costs low. In estimating the value of this ore belt it is necessary, therefore, to determine the quantity and quality of the magnetite present and the cost of producing iron from it.[4]

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[3] Ibid., p. 11.

[4] Ibid., p. 76.

It is a well known fact that parts of the Cranberry ore belt have been mined since colonial days, and that much magnetite has been removed and smelted into high grade iron. From numerous geologists we learned that much magnetite still remains in the area, and that it produces iron of low phosphorus content. However, the cost of operations while the mine was producing ore for the furnace in Johnson City hindered the continuation of the work. The cost of transporting coal from Virginia to Cranberry for the steam plant with which the drilling and crushing were done; the hauling of the ore to Johnson City, a distance of forty miles, by the railroad for smelting; and, bringing in the coal for the furnace at Johnson City, all contributed to the cost of production of iron from the magnetite mined in the Cranberry ore belt. All this was before ample supplies of electricity were available in the area. Now that electricity is available in abundance, mining operations in the Cranberry belt should be comparatively inexpensive. The excavation, drilling, and smelting could all be done less expensively now than when the mine was operated under less modern conditions. The gneiss wall rock stands up well and regularly-spaced pillars of it tend to eliminate the need for much timbering. Many of the deposits are so situated that they may be reached by short tunnels or drifts. The magnetometer tests indicated appreciable magnetic attraction over practically the entire length of the ore belt covered by the survey. The general alignment

of the magnetic trends indicates they form part of the more or less continuous mineralized zone. The drilling tests show ore shoots to continue, with local swelling and pinching, to an undetermined depth. The grade of the ores proved very similar to that mined in the past.

The United States Bureau of Mines survey indicated that several of the magnetic anomalies drilled are promising ore bodies and merit additional development should the Cranberry ore belt again be operated, and that systematic exploration of the many anomalies would probably develop into a number of smaller deposits similar to the Patrick Prospect, and many larger ones approaching the size of some of the ore shoots in the old Cranberry mine.[5]

In conclusion, it is believed that the vast amount of magnetite in the Cranberry ore belt can be made to produce high grade iron at a reasonable cost with modern methods of mining and extraction. This is especially true if, and when, the present supplies of magnetite ore become more exhausted and necessity requires the production of iron from the Cranberry magnetite.

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[5] Ibid., p. 85.

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Bowlick, J. M., died December 25, 1954 at 81 years of age, father of the writer, worked at Cranberry and discussed the operation with the writer many times.

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APPENDIX

DEED
TO
THE CRANBERRY PROPERTY[1]

This Indenture made the 10 day of July A. D. Eighteen Hundred and eighty-three 1883 Between John E. Brown of the City of Christ Church Province of Canterbury and Colony of New Zealand Esquire by his agents and attorneys in fact William J. Brown and William B. Canter thereunto lawfully empowered and appointed and appointed of the First part and Alfred H. Brownson of the City of Philidelphia and State of Pennsylvania Esquire of the Second Part. Witnesseth that the said John E Brown for and in consideration of the sum of Five Thousand Dollars $5000.00 unto him in hand paid by the said Alfred H. Bronson at and before the sealing and delivery of these presents the receipt whereof is hereby acknowledged and for and in the further consideration of the further sum of Twenty Thousand Dollars $20,000.00 hereafter to be paid to the said John E Brown by the said Alfred H. Bronson in two equal annual payments one in twelve months and the other in twenty four months from the date of the delivery of these presents with interest at six per cent per annum according to the tenor of two certain bonds or until obligatory being equal date here with for the sum of ten thousand dollars $10,000.00 each and given unto the said John E. Brown by the said Alfred H. Bronson at the sealing and delivery of these presents to secna which defered payments and interest a vendor lien is hereby reserved on all lands ores mines mineral and property hereinafter granted and conveyed. Given granted bargained sold aliened conveyed and confirmed and by these presents do give Grant Bargain Sell alien convey and confirm unto the said Alfred H. Bronson his heirs and assigns forever all the lands ores mines minerals and other property following to unite Lot number one. All that certain tract of land situated in the Counties of Watauga and Mitchell and State of North Carolina and bounded and described as follows to wit.

Beginning at a stake in the middle of Elk River below and near where Delilah Beard now lives in the northeast line of the original pattent to William Cathcart for fifty nine thousand 59000 acres No.2149 and thence running with the said lines of the said original pattent North thirty 30° West to a white oak in the old Washington County line in or near the present line of division and boundry between the State of Tennessee and North Carolina and on or near to the stone mountain being the most northerly corner of the original pattent afore said thence south twenty four° West with the line of the original pattent to a stake in the middle of Elk River thence with the said river and its meanders to the beginning, Also Lot number two all that contain other tract of land situated in the County of Mitchell County of North Carolina and bounded and described as follows to wit: Beginning at the beginning corner of the tract of land first above described and thence by the most direct course to the head spring of

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[1]Watauga County, Deed Book D, p. 344.

the most northerly branch or tributary of North Toe River thence by the most direct course to the short bend in said river at the mouth of white oak creek at Abraham Johnsons near to and below the old fields of Toe thence down said river to two lynn trees & corner in the compromise line between William J. Brown and Isaac T. Avery and thence with the calls of the said compromise line And for the connect calls of the said line spread reference is hereby made to the deed between the said Brown and Avery and between either of them and the heirs of the other of record in the County of Mitchell heretofore said to a large rock on Beach hill corner to and of the said compromise line thence south forty-five-45° East three hundred and sixty two 362 poles to a white oak on a ridge some distance below the same Carpenter place and on or near the closing line aforesaid thence with the original line and its various calls reversed to the south east corner to the said fifty nine thousand 59000 acre tract near to or on the Grandmother Mountain thence North thirty-30° east and with the original line to the beginning excepting alway from the said two tracts of land heretofore sold to other persons by the said John E. Brown or those through or under whom he holds Provided always that it be distinctly understood that the said John E. Brown conveys only such title as he may have to or much of the said lands as upon the twelfth day of December A.D. Eighteen hundred and eighty two 1882 had been held for seven years in possession advance to the said John E. Brown and those under whom he holds by and under grants from the State of North Carolina to other persons to the date subsequent to the twentieth day of July A.D. Seventeen hundred and ninty six 1796 and also to as much of the said lands as is covered by Grants from the State of North Carolina to dther person of a date previous to the twentieth day of July A. D. Seventeen hundred and ninty six 1796 excepting under all circumstances the Grant No. 2129 twenty one hundred and twenty nine from the State of North Carolina to Messrs Tate and Cochran dated the thirtieth day of January A. D. Seventeen hundred and ninty five 1795 for about One hundred thousand and Six hundred acres it being understood that the said John E. Brown Warrents generally against the said Grant to Tate and Cochran and all persons claiming thereunder and it being further understood that the said John E. Brown covenants that they are within the boundaries above recited and set forth ten thousand acres more or less of free unoccupied and unincumbered and unsold land of and to which he has possession and a perfect title uneffected by any of the adverse claims and Grants above mentioned. And also Lot Number three to wit all the minerals and mines reserved on the lands heretofore sold within the aforesaid boundaries either by the said John E. Brown or those under whom he claims and also lot number four to wit: All the reserved mines and minerals on the Sutherland tract of land situated in the county of Mitchell and State of North Carolina and bounded and described as follows to wit: Beginning on a Spruce

pine on Johnson line and thence west one hundred and Sixty six 166 poles to a white oak on the top of the ridge thence north fifty-50° west two hundred and eight six 286 poles to two large white oaks in the head of a hollow thence west one hundred and twenty six 126 poles to a chestnut thence north one hundred and ninty 190 poles to a sugar tree thence east eighty 80 poles to a birch thence north thirty five 35° East four hundred and fifty 450 poles to a chestnut on or near the top of the ridge thence south thirty 30° East eighty 80 poles to a sugar tree near the top of the Fork Mountain thence East one hundred and thirty eight 138 poles to a hickory on top of said mountain thence North Sixty 60° East one hundred 100 poles to a sugar tree on the top of said Mountain thence south thirty 30° East three hundred and eighty 380 poles to a forked maple on top of ridge thence South eighteen 18° East two hundred and Sixty 260 poles to a white oak in the head of a hollow thence south twenty 20° west one hundred and twenty 120 poles to Johnson chestnut corner thence to the beginning Containing twelve hundred and sixty three 1263 acres more or less, provided however that if the Cranberry lands when connectly submerged shall be found to lap upon the Sutherland tract then the mines and minerals within such overlap included are not conveyed but are hereby specially excepted and excepting further from the lands mines and minerals herebefore described the so called Clark and Braziel lands and the mines and minerals on the Samuel Carpenter eight hundred acre and upon the George W. Franklin fifty acre tract without prejudice or devieation of the acreage above given by reason of any exception herein specified Being the lands mines and minerals aforesaid apart of the tract of land containing fifty nine thousand 59,000 acres granted by the State of North Carolina to William Cathcort by Grant No. 2149 twenty one hundred and forty nine dated the twentieth day of July Seventeen hundred and ninty six recorded in the office in the Secretary of State at Raleigh and recorded in the office of Register of Deeds in the county of Burke within which county the said lands lay at the date of the said grant and conveyed by William Cathcort to Robert. C. Lattimer by deed dated the twenty ninth of April A.D. 1798 and by the said Robert C. Lattimer to William Cathcort George Lattimer Henry Lattimer and Richard Dale by deed dated the thirtieth day of April A. D. 1798 and by virtue of a decree of the Superior Court of Bumcumb County in a suit for partition among the heirs and devisees of the last named Grantee conveyed by Isaac D. Sawyer Clerk and Master of the said court to William J. Brown by deed dated the tenth day of May A.D. eighteen hundred and fifty three 1853 and by the said William J. Brown conveyed to the said John E Brown by deed dated 27th day of June A.D. 1853, All of which said deeds are duly recorded in the proper counties together with all the appurtenances, rights, ways, privileges, and particularly all used and necessary privileges for opening and developing and using the said mines and minerals thereunto appertaining and belong to have

and to hold the afore said land mines and minerals with the appertenances and privileges thereunto belong to the said Alfred H. Bronson his heirs and assigns to his and their only use and behoof. And the said John E. Brown covenants that saving the exceptions hereinbefore expressly made he is seized and possessed of the said land mines and minerals with the appurtenances and privileges that he has the right to convey the same are free from all incumbrances that the party of the second part shall have quiet possession and enjoyment of the same without exclusion or eviction and that he will warrent and defend the title to the same and with the said Alfred H. Bronson his heirs executors and administrators and assigns against the claims and demands of all persons whomsoever in testinomy whereof the parties aforesaid have hereunto set their hands and seals the day and year first above written.

John E. Brown (SEAL)
W. J. Brown & William B.
Carter his Agenst and Attys
in fact.

Witness C. C. Collins
E. E. Hunter

THE ANDREW HIX GRANT[1]

STATE OF NORTH CAROLINA

Know ye, that we for and in consideration of the sum of twelve & a half cents for every acre hereby granted and paid into our Treasury by Andrew Hix have given and granted and by these presents do give and grant unto the said Andrew Hix a tract of land Containing One hundred acres, lying and being in said county of Watauga in the waters of Laurel Creek on the Crop Ridge. Beginning at a chestnut tree, thence running with One hundred and twenty poles to a water oak, thence East twenty poles to a cucumber, thence south twenty poles to a water oak, thence East one hundred and Sixty poles to a locust, thence North Sixty poles to a Stake, thence West one hundred and eight poles to a stake, thence North eighty poles to a stake, thence West seventy two poles to the beginning.

Entered the 3rd day of August, 1857.

As by the plat hereunto annexed doth apper. together with all woods, Waters, Mines, Minerals, Hereditamentsand appurtenances to the said land belonging or appertaining to hold to the said Andrew Hix his heirs and assigns forever: Yielding and paying to us such sums of money yearsly or otherwise as our General Assembly from time to time may direct. Provided always that the said Grantee shall cause the grant to be registered in the Register's office of our County of Watauga within twelve months from date hereof otherwise the same shall be void. In testimony whereof we have caused these letters to be made patent, and our Great Seal to be hereunto affixed.

Witness, Thomas Bragg, Exq. our Governor Captain General and Commander in chief,at Raleigh the 21st day of October in the 82 year of our Independence and in the year of our Lord, one thousand eight hundred and fifty seven.

Thomas Bragg

(Registered Oct. 20, 1888)

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[1] North Carolina, No. 638. Also, Watauga County Deed Book B, p. 544.

CERTIFICATE OF INCORPORATION OF THE CRANBERRY FURNACE COMPANY[1]

STATE OF NEW JERSEY-SS

This is to certify that we the undersigned do hereby associate ourselves into a corporation under and by virtue of the provisions of an Act of the Legislature of New Jersey, entitled "An Act Concerning Corporations (Revision of 1896)" and the several supplements thereto and acts amendatory thereof, for the purpose hereinafter specified, and we do hereby severally agree to take the number of shares of capital stock of said corporation specified opposite our name, respectively. And we do hereby further certify as follows:

First: The name of the said corporation is the Cranberry Furnace Company:

Second: The location of the principal office in this state is at the Prudential Building, No. 763 Broad Street in the city of Newark in the county of Essex. The name of the agent therein and in charge therof, upon whom process against this corporation may be served, is John O. H. Pitney.

Third: The objects for which this corporation is formed are to mine iron ore and other minerals, to buy, sell and deal in iron ore and other minerals; to roast, crush and concentrate iron ore and other minerals, and otherwise to prepare the same for market and for smelting; to quarry limestone, to operate blast furnaces and smelt iron ore and other minerals, and to manufacture pig iron and other materials; to refine pig iron and other minerals and to manufacture the same into other forms and articles; to buy, sell and deal in goods, wares and other merchandise of all kinds; to lease and sub-let dwelling houses and other estate; to conduct and carry on any or all of the objects above specified either in behalf of this corporation or as agent, representative, trustee for other persons and corporations, upon such terms and for such compensations as may be agreed upon for the purpose; and in pursuance of the objects aforesaid to buy and lease mines, quarries, blast furnaces and other real estate in the States of North Carolina and Tennessee, or either of those States, and to conduct and carry on the business aforesaid in said States or either of them.

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[1] Acts of New Jersey, 1896.

Fourth: The total authorized capital stock of the corporation is One Hundred Thousand Dollars, divided into one thousand shares of the par value of One Hundred Dollars each;

Fifth; The names and postoffices of the incorporators and the number of shares subscribed by each, the aggregate of which subscriptions, being the sum of Fifteen Hundred Dollars, is the amount of capital stock with which the Company will commence business, are as follows:

Name	P. O. Address	No. of Shares
Halsey M. Barrett	763 Broad St. Newark, New Jersey	five(5)
Frederick R. Lelhbach	763 Broad St. Newark, New Jersey	five(5)
Frederick A. Lehlbach	763 Broad St. Newark, New Jersey	five(5)

Sixth: The period of duration of the said corporation is limited to twenty years from and after the date hereof:

Provided, however, and it is hereby agreed that said corporation shall be wound up and dissolved at any time after five years from said date, when required by the demand in writing of a majority in interest of the stockholders of the corporation.

Seventh: The stockholders of this corporation shall not be entitled to dividends out of the profits of the business until after the lapse of three and a half years from the date hereof, unless dividends shall before that time be ordered by the Board of Directors in their discretion. The directors shall have power and authority at any time (with the consent in writing and pursuant to the vote of majority in interest of the stockholders) to sell, assign, transfer and otherwise dispose of all the assets and property of the corporation.

IN WITNESS WHEREOF we have hereunto set our hands and seals the sixth day of September A. D. nineteen hundred and one.

Signed, sealed and)
delivered in the)
presence of)
(Signed)Mahlon Pitney)

(Signed) Halsey M. Barrett (L.S.)
(Signed) Frederick R. Lehlbach(L.S.)
(Signed) Frederick A. Lehlbach(L.S.)

State of New Jersey)
County of Essex)

BE IT REMEMBERED that on the sixth day of September, A. D. 1901, before the subscriber, one of the Masters of the Court of Chancery of the State of New Jersey, personally appeared Halsey M. Barrett, Frederick R. Lehlbach and Frederick A. Lehlbach, who, I am satisfied, are the same parties mentioned in the foregoing certificate of incorporation

and whose names are thereunto aubscribed: and having first made known unto them the contents thereof, they did severally acknowledge that they signed, sealed and delivered the same as their voluntary act and deed for the uses and purposes therein expressed.

(Signed) Mahlon Pitney
Master in Chancery
of New Jersey

Endorsed:

"Received in the Clerk's Office of the County of Essex, on the 17th day of Sept., A. D., 1901, and recorded in Book 22 of Incorp Bus Cos for said county, Page 418 &c

(Signed) William O. Kuebler
Clerk."

"Filed Sept. 9, 1901

(Signed) George Wurts
Secretary of State."

STATE OF NEW JERSEY

DEPARTMENT OF STATE

I, GEORGE WURTS, Secretary of State of the State of New Jersey, do hereby Certify, that the foregoing is a true copy of the Certificate of Incorporation of the Cranberry Furnace Company and the endorsements thereon, as the same is taken from and compared with the original filed in my office on the ninth day of September A. D., 1901, and now remaining on file therein.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my Official Seal, at Trenton, this ninth day of September, A. D., 1901.

(SEAL)

(Signed) George Wurts
Secretary of State.

I, F. P. Howe, Secretary and Treasurer of the Cranberry Furnace Company, do hereby certify that the foregoing is a true copy of the Certificate of Incorporation of the Cranberry Furnace Company and the endorsements thereon, as the same is taken from and compared with the original Certificate of the Secretary of State of the State of New

Jersey and the certified copy of the Certificate of Incorporation of the Cranberry Furnace Company and the endorsements thereon, filed in my office.

In TESTIMONY WHEREOF, I have hereunto set my hand as Secretary and Treasurer of said corporation and have affixed hereto its corporate seal, at Philadelphia, Penna., the Eleventh day of October, A. D., 1901.

F. P. Howe
Sec'y & Treas.

CORPORATE SEAL

THE CRANBERRY FURNACE COMPANY.

CHARTER OF THE EAST TENNESSEE AND WESTERN NORTH CAROLINA RAILROAD COMPANY[1]

Sec. 23. Be it further enacted, That R. W. Smalling, S. A. Cunningham, Harrison Hardries, Peter Slaugh, James R. Scott, Henry Johnson, R. Love, M. D. L. Boren, John Hughes, S. W. Williams, P. P. Williams, N. T. Williams, John W. Cameron, Nat T. Crouse, John S. Snodgrass, J. T. Fuller, James D. Smith, C. C. Wilcox, A. J. Tipton, William B. Carter, Col. John K. Miller, James G. Smith, J. H. Hyder, H. G. Smith, B. M. G. Obien, C. P. Tonckrey, R. C. White, Samuel P. Scott, John M. Smith, L. W. Hampton, John W. Hyder, William D. Jenkins, H. H. Ray, F. M. Hampton, James M. Cameron, A. Jobe, T. H. H. Lusk, A. T. Buck, E. J. Smith, Dugger Pearce, Ezekiel Smith, William Lewis, Joshua Perkins, Joseph Wagner, S. W. Howard, N. G. Robinson, S. E. Worthington, George J. Walker, Joseph Shown, Thomas Smith, Joseph Wagner, R. R. Butler, Abram Murphey, Mathias Wagner, R. A. Donnelly, Andrew Wilson, W. S. Allen, J. T. Shown, A. L. McQueen, and R. L. Robinson, and their associates, be, and they are, hereby constituted a body corporate and politic, by the name and style of the "East Tennessee and Western North Carolina Railroad Company," for the purpose of constructing a Railroad from the East Tennessee and Virginia Railroad, commencing at either Carter or Johnson Depots on said road, running by the way of Elizabethton, Doe River Cave and Crab Orchard, to the North Carolina line, near Cranberry Iron Works; and said company, when formed, shall, by their corporate name, have power to sue and be sued, plead and be impleaded, in all the Courts in this State, or the United States; have and enjoy all the rights and privileges secured to the East Tennessee and Virginia Railroad Company, by an act passed January 27, 1848, and be subject to all the restrictions and liabilities contained in the act chartering the East Tennessee and Virginia Railroad; and shall be built and constructed to the requirements of aforesaid charter.

Sec. 24. Be it further enacted that the capital stock of the said Company shall be thirty thousand dollars, with the privilege of increasing it to a sum sufficient to complete said road, said capital stock to be divided into shares of twenty-five dollars each; and books for subscription of stock in said road shall be opened on the first Monday in October 1866, and kept open for three months, every day, (Sunday excepted,) from ten o'clock, A. M., until four o'clock, P. M., at the following places, and by the following persons, to wit; at Elizabethtown, by William B. Carter, D. P. Wilcox, A. J. Tipton, James M. Cameron, James G. Smith, J. G. Fellows, J. W. Hyder; at Carter Depot by Harrison Hendries, R. W. Smalling, S. A. Cunningham; Johnson's Depot, Henry Johnson, John W. Cammeron, M. D. L. Boren; at Doe River Cave, by L. W. Hampton, John W. Hyder; at Crab Orchard, William D. Jenkins,

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[1] Tennessee Acts 1865-1866, Chapter 88.

H. H. Ray, and A. T. Buck; at Taylorsville, R. R. Butler, Joseph W. Wagner, Frederick Stimp, Abram Murphy, R. A. Donnelly, Thomas Smith, W. S. Allen, and Geroge J. Walker, and they, or a majority of them, be, and they are hereby constituted a Board of Commissioners to superintend and manage all the affairs of the said company, until it shall be fully organized by the election of a Board of Directors for said company, as prescribed by the charter of the East Tennessee and Virginia Railroad Company.

Sec. 25. The said Commissioners, or a majority of them, at each of the places aforementioned, shall receive subscription for stock in the said Rail Road Company, during time said books are directed to be kept open; and on each share so subscribed, shall demand and receive the sum of one dollar, without which the subscription shall be void.

Sec. 26. As soon as the time for receiving subscription as aforesaid , shall have expired, the Commissioners shall respectively deposit all the money so received by them in some bank (incorporated) in east Tennessee, to the credit of said Company, and subject to the order of the President of the Board of Commissioners hereinafter appointed, and shall also forward a correct list of the subscribers to the said stock, with the number of shares of each subscriber, to a Board of Commissioners to be composed of the following persons: John W. Hyder, R. C. White, L. W. Hampton, S. E. Worthington, Joshua Perkins, George I. Walker, E. J. Smith, Frederick A. Skink, John W. Smith, R. R. Butler, S. W. Howard, Dugger Pearce, A. Murphrey, A. J. Tipton, Peter Stagh, R. W. Smalling, H. C. Smith, John K. Miller, A. T. Buck, Henry Johnson, C. C. Wilcox, C. P. Tonckrey, James G. Smith, William B. Carter, Doct. A. Jobe, R. Love, M. D. L. Bowen, Col. John Hughes, S. W. Williams, T. H. H. Lusk, and J. S. Snodgrass, a majority of them, who may establish rules to govern their proceedings, choose their own President, and appoint any other such officers and agents as they may think proper; and who, or a majority of whom, shall meet in Elizabethtown on or before the first Monday in May, 1867, and if the number of shares subscribed shall amount to one hundred twenty thousand, on each of which there shall have been paid the sum of one dollar, the East Tennessee and Western North Carolina Rail Road Company shall be considered as formed; and thenceforth and from the day of closing the books of subscription as aforesaid, the said subscribers to the stock shall form a body politic and corporate, in deed and in law, by the name and for the purpose aforesaid, in all things to be represented by the Board of Commissioners aforesaid, until an election of a Board of Directors as hereinafter prescribed.

Sec. 27. If on closing the books aforesaid, the number of shares aforesaid shall not have been subscribed, then the said Board of Commissioners, by themselves or their agents, may receive subscription until the number of one hundred and twenty shares be taken; and whenever, that number shall be subscribed, the Company shall be regarded as formed; to have a corporate existence as aforesaid, and of which notice shall be given as hereinbefore directed; may proceed to survey the route for the road; and to make an estimate of its cost of construction. Nevertheless, no

conclusive and binding location of the road shall be made by the Commissioners ; but the same be left to the determination of the first Board of Directors chosen by the stockholders; Provided that said Board of Directors shall be required to locate said road by the places hereinbefore mentioned and specified.

Sec. 28. So soon as the number of shares before mentioned, shall have been subscribed, it shall be the duty of the Commissioners appointed, to declare the same, and to appoint a time for the stockholders to meet in Elizabethtown, and give notice thereof in some newspaper; at which time and place the said stockholders, either in person or by proxy, shall proceed to elect the Directors of the Company, and shall enact all such regulations, rules, and by-laws as may be necessary for the government of the corporation, and the transaction of its business. The persons elected Directors at this meeting, shall serve for such period, not exceeding one year, as the stockholders may direct; and at this meeting, the stockholders shall fix on the day and place or places, where the subsequent elections of Directors shall be held; and such elections shall thenceforth be annually made; but if the day of annual election pass without any election of Directors the corporation shall not thereby be dissolved; but it shall be lawful on any other day to hold and make such election in such manner as may be prescribed by a by-law of the corporation.

Se. 29. The Board of Directors may fill up vacancies which may occur in it during the period for which their Board shall have been elected; and in the absence of the President, may fill his place by electing a President pro tempore.

Sec. 30. Be ir further enacted, That said company shall have power, if desired by the stockholders to extend a branch of said road to Taylorsville, Johnson City, Tennessee.

Sec. 31. All contracts and agreements, authenticated by the President of the Board, shall be binding on the Company without seal; or such other mode of authentication may be used as the Company by their laws may adopt.

Sec. 32. Be it further enacted, That after the route of such railroad and branch railroad shall have been accurately surveyed and adopted, and a plat thereof deposited in the office of the Secretary of State, and upon its being satisfactorily shown to the Governor of the State, that there has been a sufficient amount of bona fide and good and solvent subscriptions of capital stock, to an amount sufficient to grade, bridge, and prepare for the iron rails, the whole extent of the main trunk line, proposed to be constructed by the foregoing Company, and have graded the entire route in Tennessee of the road for the iron, the Governor is authorized to issue to the Company Coupon Bonds of the

State, to the amount not exceeding ten thousand dollars a mile. Such bonds shall not have more than forty nor less than thirty years to mature; shall be payable at some point in the United States, to be designated by the President of the Company, and bear interest at the rate of six per cent. payable semi-annually.

Sec. 33. No Bonds to be issued except upon the affidavit of the President of the Company, and a resolution of the Board of Directors, that they are not to be used for any other purpose, nor in any other way, than that prescribed by the law of this State granting State aid to Internal Improvements.

Se. 34. Be it further enacted, The East Tennessee and Western North Carolina Rail Road Company shall have two years from the passage of this act to commence work on said road, and shall complete said road within five years from and after the passage of this act.