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This thesis presents a mineral geography study of the Riddle nickel development, which is the largest known nickel deposit, and the only nickel producing mine in the United States. The study appraises conditions for development, including character of the deposit, spatial relationships to the market, and the influence of government in establishment of the industry. The economic impact of the project on the national, state, and local level is appraised.

"Ore" on Nickel Mountain was recognized in 1864, but its identity as nickel was not confirmed until 1882. Early development attempts all failed chiefly because of the unfavorable location of the deposit and the difficulty of smelting the complex ore.

Following World War II, the Hanna Development Company carried out extensive geological and metallurgical testing to determine the possibility of economically exploiting the Riddle nickel deposit. On January 16, 1953, the Government and Hanna negotiated a contract whereby the Government supplied the needed capital to construct the smelter, and agreed to purchase the ferronickel produced by Hanna. The contract was partially terminated on April 20, 1962, at which time Hanna purchased the smelter, and sales of ferronickel to the Government were terminated. Hanna now sells ferronickel in competition with other nickel producers.

Hanna production at Riddle supplies 13% of the United States' demand, resulting in a decrease of United States dependence on imports. Company purchases of raw materials, payrolls, and employee influx has stimulated the local, state, and national economy. However, distance to the market has been and continues to be a major problem.

The Riddle nickel enterprise demonstrates the importance of government activity in mineral geography, and exemplifies results that can be obtained through cooperation between government and private industry.

THE RIDDLE NICKEL ENTERPRISE- A STUDY IN RESOURCE GEOGRAPHY

by

TERRY VINCENT McINTYRE

A THESIS

submitted to

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APPROVED:

Signature redacted for privacy.

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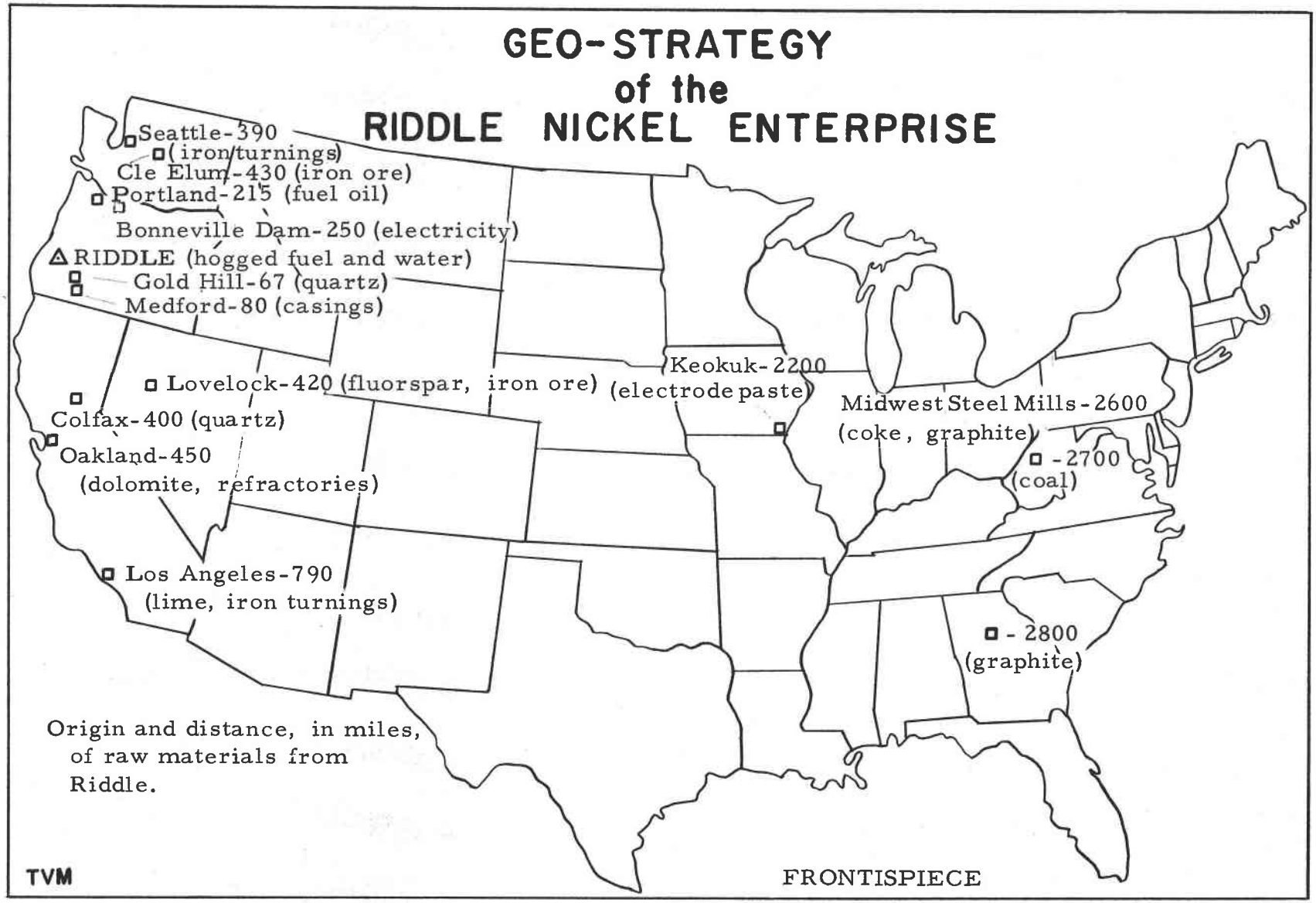
GEO-STRATEGY
of the
RIDDLE NICKEL ENTERPRISE
Seattle-390
(iron turnings)
Cle Elum-430 (iron ore)
Portland-215 (fuel oil)
Bonneville Dam-250 (electricity)
RIDDLE (hogged fuel and water)
Gold Hill-67 (quartz)
Medford-80 (casings)
Lovelock-420 (fluorspar, iron ore)
Colfax-400 (quartz)
Oakland-450
(dolomite, refractories)
Los Angeles-790
(lime, iron turnings)
Keokuk-2200
(electrode paste)
Midwest Steel Mills-2600
(coke, graphite)
-2700
(coal)
-2800
(graphite)
Origin and distance, in miles,
of raw materials from
Riddle.
TVM
FRONTISPIECE

THE RIDDLE NICKEL ENTERPRISE - A STUDY IN RESOURCE GEOGRAPHY

CHAPTER I

INTRODUCTION

Riddle, Douglas County, Oregon, is the site of the only nickel mine in operation in the United States, and the Hanna Nickel Smelting Company located here is the only producer of ferronickel in the Nation.[1] The Nickel Mountain deposit, which is the largest known reserve of nickel in the United States, had attracted interest in the past, but sporadic interest in the deposit finally culminated in the development of the present nickel mining and smelting facilities in 1953. It was due largely to the cooperation between government and private industry that the enterprise was established.

Nickel Mountain is an example of an ore deposit that was known for almost a century before it was developed. The conditions of geography, which long inhibited the utilization of the deposit, and changes that finally resulted in development form an interesting study in resource geography. Past attempts at developing the deposit resulted in failure, mainly due to the lack of a suitable smelting process to recover the metal from the complex nickel ore. There were also other inhibiting factors

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[1] In addition, primary nickel is produced as a byproduct of other mineral smelting.

such as (1) difficulty in bringing the ore down the mountainside because of the rugged terrain, (2) distance from the markets which placed the site in an unfavorable competitive position in relation to the large Canadian nickel producers that are located close to the industrial core of our Nation, (3) the ore was low-grade (1.5%), and (4) the ore body was not considered large enough to support the required investment. Thus it appears that the risk involved in developing the project was considered too great to warrant investment by a private company.

Development of Nickel Mountain was finally fostered through government action. As a result of World War II, government action was stimulated to promote the development of a domestic nickel source. Government capital and markets were assured Hanna and this cooperation between Federal and private industry resulted in the realization of the Riddle nickel enterprise. Previous to the establishment of the Nickel Mountain project, the Nation was almost entirely dependent on imports, but as of 1960, Hanna was supplying 13% of the United States consumption.

PURPOSE OF STUDY

The purpose of this thesis is to present a mineral geography study of the Riddle nickel enterprise. The mineral geographer

is concerned with an objective study and interpretation of the interrelated factors of environment and man which foster or inhibit mining or mineral industry activities at a particular place, and the interrelationships of mineral industry activity and an area's economy. Thus this study appraises the reasons for the final development and the factors that appear to have inhibited development, notably character of the deposit, spatial relationships to the market, and the influences of government. The economic and social impact on the area, as a result of mining activity, is also part of the overall analysis.

The Riddle nickel deposit was known for a century before it was exploited. Why wasn't the nickel mined earlier, and what factors contributed to the eventual use of the ore? These questions will be analyzed in this study. The economic implications and significance of the nickel industry in the Nation, State, and Douglas County, will be appraised. An important factor to be considered is the locational relationship of the deposit to the markets for the product. What is the significance of the problems faced by Hanna in marketing the nickel? What does the future hold for Hanna since the partial termination of the government contract? Can Hanna continue operating the mine and smelter and compete

favorably with the nickel suppliers who are larger and closer to the market? A review of the past history of development attempts will also be considered.

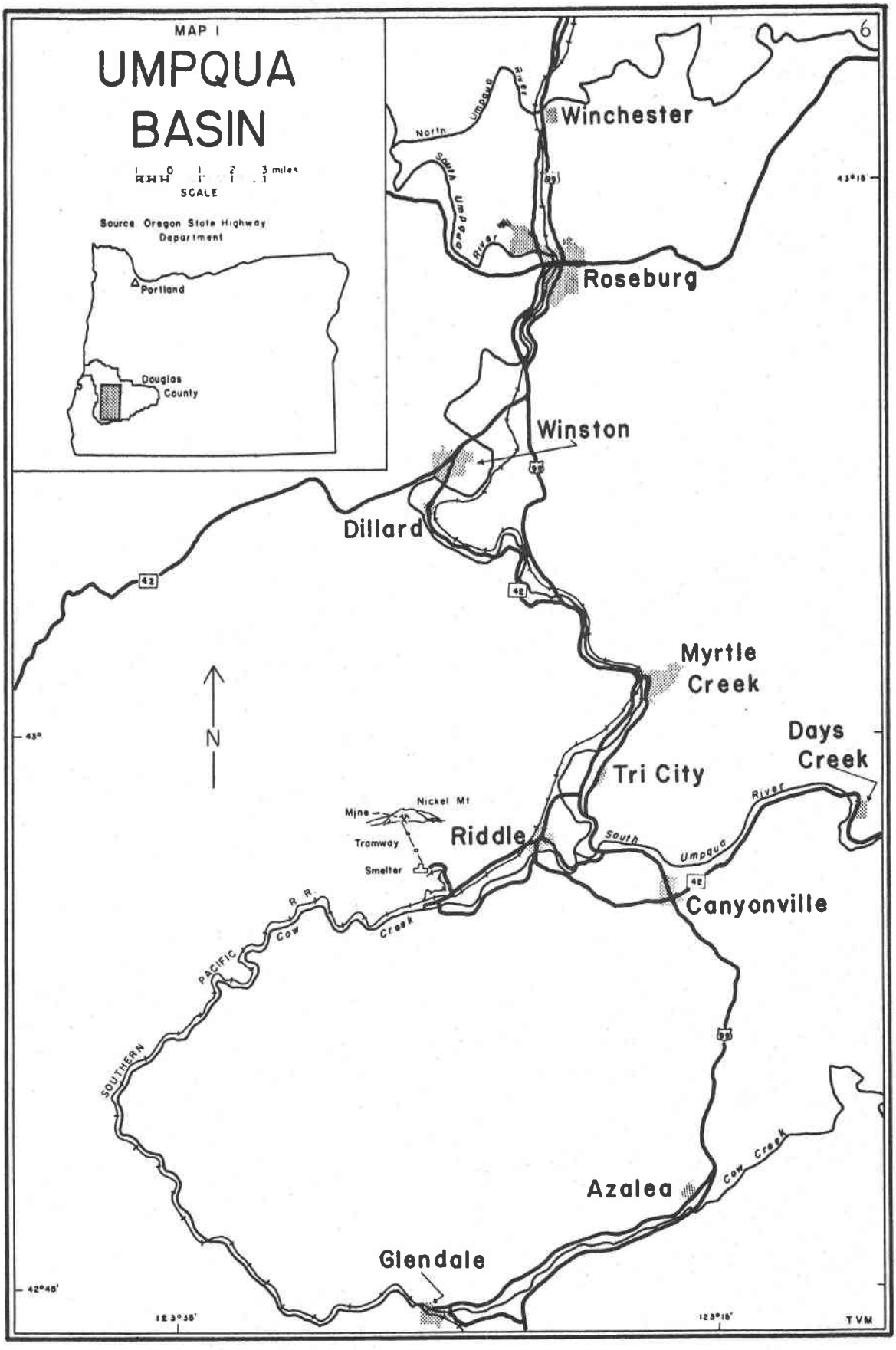
RESEARCH METHODS

Basic background on the nickel deposit was obtained by researching many mining and engineering periodicals and Federal and State publications. Among the periodicals perused were Mining World, Journal of Metals, Engineering and Mining Journal, Mining Engineering, and Mining Congress Journal. Federal and State publications reviewed were those of the State Department of Geology and Mineral Industries, United States Bureau of Mines, United States Geological Survey, Bureau of the Census, and the Oregon Department of Employment.

Consultations and conferences were held with R. S. Mason of the State Department of Geology and Mineral Industries in Portland, A. J. Kauffman, Jr. of the Bureau of Mines in Albany, and with Dr. Donald Watson of the Bureau of Business Research at the University of Oregon in Eugene.

Several trips were made to the area and a complete tour of the mine and smelter facilities was taken. General Manager

E. E. Coleman and Personnel Manager Robert S. Taylor, of the Hanna Nickel Smelting Company, were very helpful by granting interviews, and through them Company data was obtained for the study. Bankers and other businessmen of Riddle, Roseburg, and Myrtle Creek were also interviewed. Consultations were also held with various Douglas County officials and the Roseburg Chamber of Commerce. The maps and charts in the study are the result of the compilation of data that was gathered through these above sources. The photographs are the courtesy of the Hanna Nickel Smelting Company.


MAP I
UMPQUA BASIN
0 1 2 3 miles
SCALE
Source Oregon State Highway Department
Portland
Douglas County
North Umpqua River
South Umpqua River
Winchester
Roseburg
Winston
Dillard
Myrtle Creek
Days Creek
Tri City
Riddle
Nickel Mt
Mine
Tramway
Smelter
South Umpqua River
Canyonville
Cow Creek
PACIFIC R.R.
SOUTHERN
Azalea
Cow Creek
Glendale
N
42
99
43°
42°45'
123°30'
123°15'
TVM

CHAPTER II

EARLY ACTIVITY AT NICKEL MOUNTAIN

The existence of "ore" on Nickel Mountain was first recognized by sheepherders in 1864, but the material was thought to be tin. The first excavations, however, yielded a green "ore" which was believed to be copper instead of tin. William Q. Brown, one of the leading mining experts of the area determined that the ore was nickel. After identifying the ore, Brown and a few associates bought the Nickel Mountain property in 1882. This property, part of the present developed deposit, is located at 2,000-3,000 feet elevation on the southside of Nickel Mountain, about five miles northwest of the town of Riddle.(34, p. 61).

PIONEER PERIOD 1850-1890

The first owner of the Nickel Mountain tract was John Smith, who located a donation land claim in 1852. This claim was purchased in 1866 by Abner and J. B. Riddle. The town of Riddle had been settled in 1851 and named after William H. Riddle, who with his family, was the first settler in this part of the Cow Creek Valley (34, p. 59-61).

It was from J. B. Riddle, that William Q. Brown purchased a portion of Nickel Mountain. A thorough exploration project then was launched on the mineral deposit. Exploration consisted of sinking several shafts and exploration adits. Ore samples were shipped to eastern smelters for experimental purposes. As a result of these experimental smeltings, the ore was recognized to have a serious metallurgical problem. The nickel ore was very complex making it very difficult to smelt. In addition, the ore was low-grade and this necessitated moving large volumes of earth material to extract a relatively small amount of nickel. It was to be some 72 years before the metallurgical problem was solved.

THE PERIOD FROM 1890-1920

After confirming the presence of a nickel deposit, Mr. Brown placed the mine on the market for sale. In 1891, International Nickel Mining Company of Chicago, purchased 200 acres from Mr. Brown and J. B. Riddle, who owned land adjacent to the mine. The Company improved the property and expended $100, 000 on surface improvements which included a hotel, houses for the workmen, and a sawmill. In 1893, International brought in a large amount of smelting equipment, but according to early accounts, this equipment was never even removed from a railroad siding in

Riddle. The equipment was to construct a facility with a 150-ton smelting capacity. The local newspaper stated that the stockholders of the Company got into litigation, and as a result, activity came to a halt.

The accomplishments of the International Nickel Mining Company were meager. Perhaps the most important accomplishment was the planting of 60 acres of prunes. At this time, prune growing was a thriving industry in the Cow Creek Valley. Sometime near the end of the 1890's, the International Nickel property was purchased by Edson F. Adams of Oakland, California (34, p. 61).

The failure of the International Nickel Mining Company in developing the nickel deposit resulted in almost complete cessation of activity on Nickel Mountain. Renewed interest occurred in the 1914-1918 period, associated with wartime needs for minerals. Chromite was discovered in the ore body and many ore samples were taken, but there was no mining recorded.

THE PERIOD FROM 1930-1950

The next period of interest in the deposit began in the late 1930's when Freeport Sulphur Company became interested in Nickel Mountain. Much of their field work and laboratory studies were more or less kept secret, probably as a result of the

impending World War. The exploratory work was primarily concerned with metallurgical testing. As a result, in 1941, Freeport Sulphur Company leased the property from Edson F. Adams. Freeport then explored the deposit extensively and also began to mine ore from the upper deposit of the mountain. This was a new development since most of the work done previously had been concerned with development of the lower-level deposit.

Freeport ceased their operations in 1943. While the reasons for the Company's decision were not precisely published, it is probable that they were unable to develop an economical smelting process. Moreover, nickel was selling for only 35¢ a pound, a notably low price. Furthermore, the Freeport Company had acquired the working rights to the Nicaro nickel deposit in Cuba, and this must certainly have contributed to their decreased interest in the Riddle ore.

After World War II, the M. A. Hanna Company of Cleveland, Ohio, became interested in the deposit, and in 1948 a subsidiary leased the property from the Adams' estate. In 1951, the Freeport Sulphur Company turned over to the Hanna Company, the results of its field work. . At this time, Hanna began a program of extensive geological surveying and metallurgical testing leading to the realization of the industry. This current stage will be appraised in the

following chapter.

The failure to develop the deposit, in large part, resulted from the inability to economically smelt the complex Riddle ore. An economical smelting process had to be developed to bring the nickel ore into commercial production, so as to enable the producer to market the product on the distant markets.

CHAPTER III

REALIZATION OF THE INDUSTRY

The Hanna Mining Company is in the business of developing, managing, and operating industrial enterprises, most of which produce basic raw materials for the use of heavy industry, and as a result, it was logical that the Company became interested in the potentialities of Nickel Mountain.

HANNA'S EARLY ACTIVITY

Hanna's initial interest occurred in 1943, shortly after the Freeport Sulphur Company discontinued their exploratory operations at Nickel Mountain. It was not until after World War II, that the Hanna Company took an active interest in developing the ore deposit. Hanna owned a nickel property, and was interested in selling ore to the Government, but was not interested in smelting the ore. However, since the Government had no smelting facilities, Hanna agreed to operate a government financed smelting facility.

In preparation for the beginning of a mining operation, an extensive exploration program was undertaken to determine the nature of the deposit. Exploration consisted of churn drilling and

trenching throughout the whole of the mountain. Test shafts were sunk to determine the ore volume and moisture factors, and the gathering of bulk samples for the pilot plant. The Hanna Company spent about $441,000 for preliminary exploration of the deposit (67, p. 4). Upon completion of geologic exploration, there still existed the problem of developing a smelting process that would foster the development of a successful mining and smelting venture.

Before a government contract could be obtained, the Hanna Company had to make some assurance that they would be able to operate a suitable processing facility, and that the operation would be capable of continual production during the contract period. Many processes were investigated before it was decided that a French process offered a solution to the metallurgical problem.

Technically, the smelting process is known as the Ugine Process, but it is also known as the Perrin Process, after Rene Perrin who patented the discovery. The Ugine Process was originally developed to smelt complex chromite ores, and it had been used successfully to smelt the nickel ores from New Caledonia. It was necessary to make some modifications of the process to adapt it to the smelting of the Riddle ore.

It is clear that the development by Hanna was stimulated by programs of assistance from the Federal government, and because of this it is important to analyze the nature of government activity that led to a successful Hanna enterprise.

ROLE OF THE FEDERAL GOVERNMENT

The culmination of 5 years of intensive geologic exploration and metallurgical testing was on January 16, 1953, when the M. A. Hanna Company, through its subsidiaries the Hanna Nickel Smelting Company and The Hanna Coal and Ore Corporation (the name was changed to The Hanna Mining Company in 1958), negotiated a contract with the United States Government.

The contract with the Defense Materials Procurement Agency awarded $3,750,000 to the Hanna Nickel Smelting Company for working capital and $22,875,000 for the construction of the smelting facilities. The DMPA also negotiated a contract with The Hanna Mining Company, whereby The Hanna Mining Company was to supply the ore for the smelter, but Hanna developed and equipped the mine at its own expense (68).

CREATION OF GOVERNMENT AUTHORITY

During President Truman's Administration, The Defense Production Act of 1950 was passed. This Act gave the General Services Administration (GSA) the responsibility of expanding the Nation's productive capacity and supply of materials that are in critical shortage and are vital to the National Defense. At the start of the Korean War, shortages of nickel appeared because of the increased demand of military and civilian concerns. This necessitated Government controls over the use of nickel, and programs to increase the supply available to the United States.

In 1951, steps were taken to alleviate the nickel shortage, when the Munitions Board instructed the Defense Minerals Administration to reactivate the Nicaro Nickel Plant, Oriente Province, Cuba, which had been built by the Reconstruction Finance Corporation during World War II, and held in the National Industrial Reserve. The Nicaro Plant went into production in 1952 with a capacity of 32 million pounds of nickel annually. In addition to the Cuban development, every effort was being made to develop a nickel source on the Mainland, and this need furnished the needed impetus for the development of the Riddle nickel enterprise.

PURCHASE CONDITIONS

The ore was mined by The Hanna Mining Company, and the Government purchased the ore for $6 per dry ton. The Government in turn sold the ore to the Hanna Nickel Smelting Company for the same price. Such a sales agreement was enforced because The Hanna Mining Company did not wish to be directly connected with the smelting operation.

The contract stipulated that a minimum of 95, 000, 000 pounds and a maximum of 125, 000, 000 pounds of nickel was to be supplied to the Government in the form of saleable ferronickel between January 16, 1953, and June 30, 1962 (68). The ferronickel produced must contain at least 25% nickel and not more than 75% iron.

The actual price the Government was to pay for the ferronickel was not to exceed 79.35¢ per pound of contained nickel on the first 5 million pounds of nickel produced (68). After this, the ceiling price was reduced, but under no conditions was the Government to pay more than the actual production costs.

The original contract was to be terminated as of (1) June 30, 1962 or (2) upon delivery of 125, 000 pounds of nickel to the government stockpile. In addition, the value of the smelter, $22, 875, 000,

was to be amortized at a rate of 85%, and after 95, 000, 000 pounds of contained nickel had been produced, Hanna would be able to purchase the smelter for 15% of the construction cost of the smelter (68). Such amortization clauses are common in many government contracts.

With the acquisition of the government contract, Hanna began the development of Nickel Mountain. The contract placed the bulk of the risk of the undertaking on the Government, but this did not relieve Hanna from the possibility of considerable financial loss.

CHAPTER IV

MINERAL GEOGRAPHY OF NICKEL MOUNTAIN

The Riddle nickel enterprise is an example of a mineral industry that was developed in the face of many disadvantages. The main deterent was the lack of a suitable smelting process to treat the complex ore, but in addition other barriers existed. Among other obstacles to development were, the deposit was small and low-grade, location of the deposit in rough terrain, and far removed from the market centers. The adequacy and nearness to the market of the Canadian nickel suppliers was also a competitive deterent.

Government aid and the developement of a suitable smelting process were the main stimulants to the realization of the industry, and in 1953 with the cooperation between Federal and private interests, a successful development was realized.

The following pages briefly analyze the factors that inhibited and fostered development. The analysis will show how the inhibiting factors were overcome and the resulting status of the development will be appraised.

INFLUENCES OF THE CHARACTER OF THE DEPOSIT

The deposit is best developed on terraces, flats, and gentle slopes above an elevation of 2, 000 feet, and two distinct ore levels exist on the south slope of Nickel Mountain, which has a summit with an elevation of 3, 533 feet above sea level. At present, the mining activity is concentrated on the upper level between 3, 000 and 3, 500 feet. Formation of the deposit occurred in the late Tertiary period by laterization. As the mountain was eroded, the ore body was concentrated during periods of excessive precipitation (43, p. 221-224).

The ore body consists of three layers; the top layer being a brick-red soil layer, the middle layer is composed of a thick yellow-limonitic layer that contains some quartz-garnierite boxwork, and a bottom layer composed primarily of quartz-garnierite boxwork which occurs in nearly fresh bedrock. The bedrock forms the transitional stage between the weathered material and the fresh periodotite (43, p. 214-221).

Nickel is contained in olivine and enstatite, which are the two main minerals in the peridotite. The nickel-bearing ore is called garnierite and it ranges in color from light to dark green.

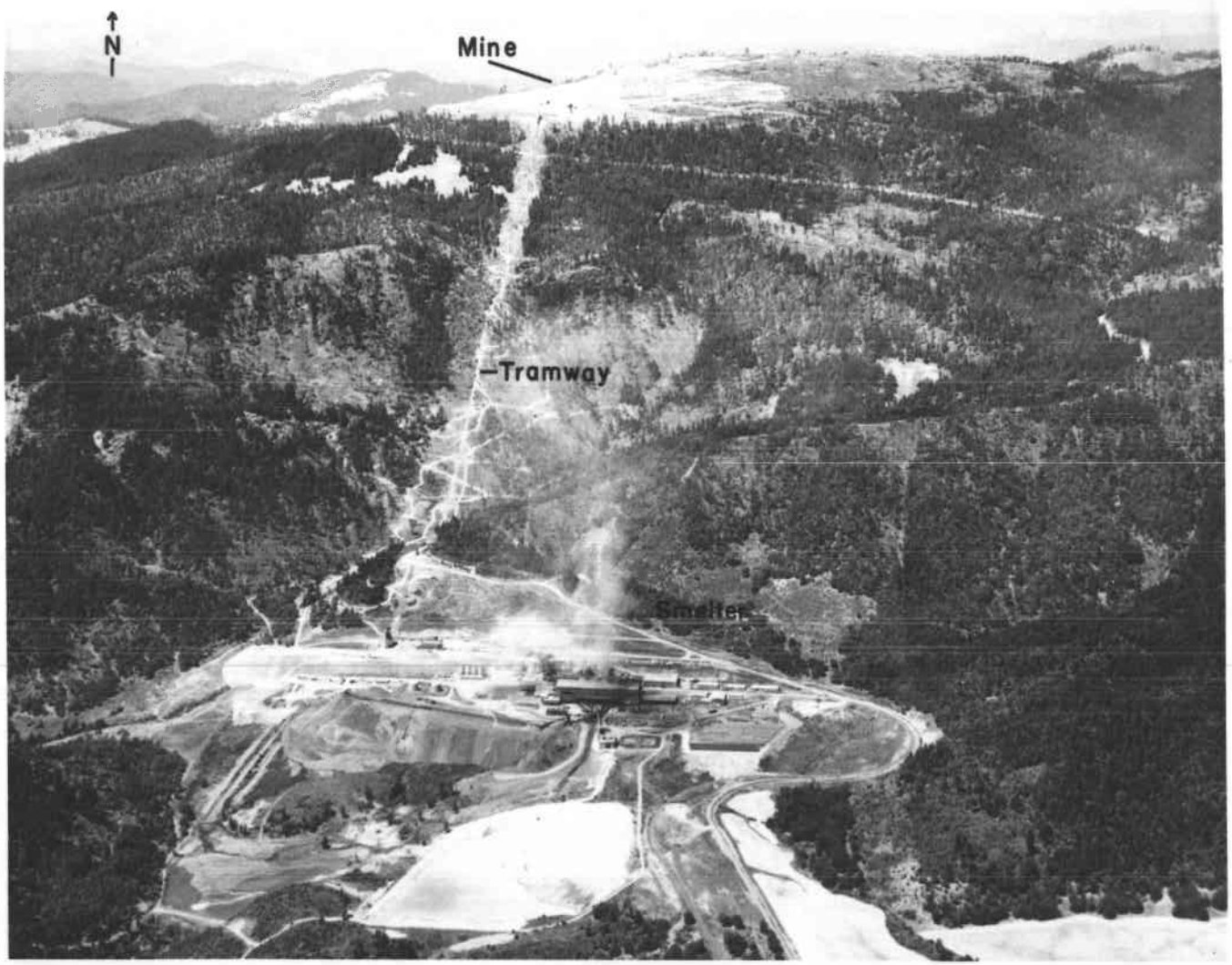


Figure 1

The Hanna nickel mine and smelter at Riddle, Oregon (Hanna Nickel Smelting Co.)

The darkest ore is the richest in nickel content. The nickel is dispersed throughout all three layers of the deposit, but it is most abundant in boxwork veins that are rich in garnierite (43, p. 205).

SIZE OF ORE BODY

The ore body is roughly 3, 000 feet by 6, 000 feet and the deposit is about 60 feet deep. About 162 acres of the mountain is overlain by the nickel-bearing material. The deposit is very small in comparison to the Sudbury District. In 1958, the reserves at Sudbury were estimated at 307, 660, 000 short tons of ore containing an estimated 4, 636, 000 short tons of contained nickel (60, p. 558), while the Riddle deposit had an estimated 17, 000, 000 short tons of reserves containing an estimated 257, 000 short tons of contained nickel (60, p. 558).

At present rate of use, the Riddle deposit should last for 20 years from the beginning of the mining operation in 1953. However, improved technology in recovering lower grade nickel could lengthen the life of the deposit.

QUALITY OF THE ORE

The deposit at Riddle is a low-grade nickel body containing about 1.5% nickel, but the deposit does compare favorably with the Sudbury District, which also has an average nickel grade of 1.5%. The Riddle nickel ore is garnierite, a complex magnesium silicate of nickel associated with iron, cobalt, chromium, and aluminum (8, p. 263).

The metallurgical problem encountered in smelting the nickel ore has been the major deterent to the development of Nickel Mountain. The nature of the silicate deposit is such that the ore could not be satisfactorily smelted by fuel-fired smelting and melting the ore was a problem. Because the ore was not conducive to fuel-fired smelting, it was necessary to obtain electrical power at an economical rate, and this was solved by arrangements with the Bonneville Power Administration, whereby a contract to purchase power was negotiated. The difficulty or ease in melting the ore is related to the ratio of the acid to base constituents of the ore, which vary from one location to another in the mine, and this compounds the problem. The basic materials are the iron and magnesia, while silica is the main acid constituent (58).

The Ugine Process, using ferrosilicon as the reducing agent, has solved the metallurgical problem. A prime requisite of the Ugine Process is the availability of a large supply of electrical energy, and this has been made available.

LOCATION FACTORS

The location of the ore body high on the flanks of the mountain created a transportation problem in that a means of getting the ore to the smelter economically had to be devised. Trucking the ore was not the solution because of the tortuous nature of the road traversing the mountainside. Thus an aerial tramway system was constructed to haul the ore from the mine (3, 064 feet elevation) to the smelter (1, 058) feet elevation).

LOCATION WITH REFERENCE TO MARKETS

The location of the Riddle nickel enterprise in relation to the industrial markets of the Nation, also afforded an inhibiting factor to development. The nearest large market for ferronickel is 2, 300 miles to the east, and because of this distance factor, Hanna is faced with larger freight rates than the Canadian producers which are located close to the market. Table 1 compares the distance to

markets of the Hanna Company as opposed to The International Nickel Company of Canada, Limited. The distances for Canadian markets is figured from Port Colborne, Ontario, because this is the city that serves as the port of entry for all Canadian nickel.

TABLE 1

DISTANCES TO MARKET

Destination	From Riddle	From Port Colborne
Chicago	2,300 miles	518 miles
Pittsburgh	2,750 "	240 "
Detroit	2,650 "	225 "
Baltimore-Philadelphia	3,000 "	390 "

TRANSPORTATION

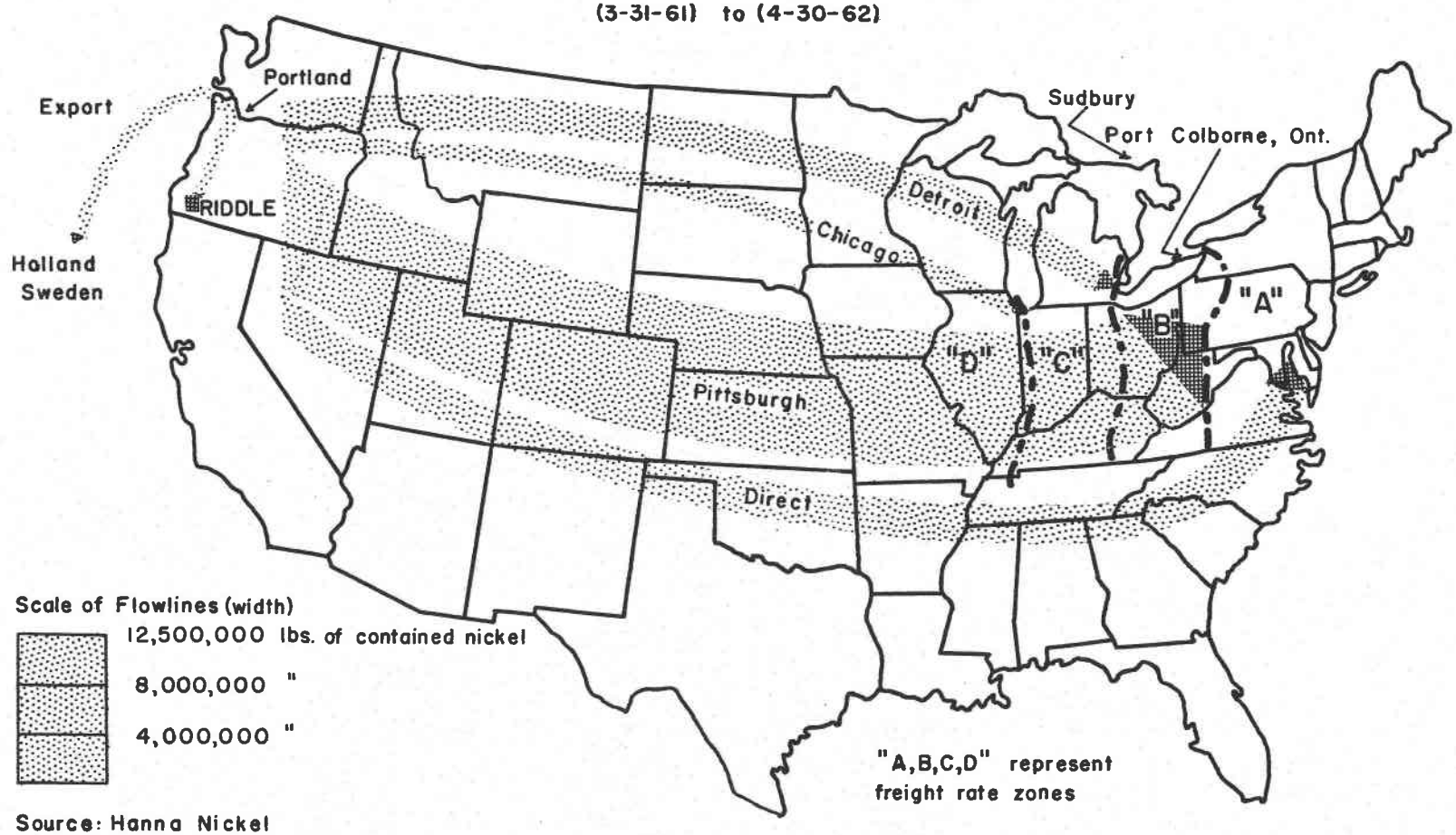
In the face of many adversities, Hanna is now competing with other nickel suppliers on the open market. Map 2 plainly shows the adversity of the Riddle location in relation to the market and it also demonstrates the favorable location of Hanna competitors.

Hanna markets the ferronickel through three warehouses outside of Riddle, and also make sales directly to steel companies. Most of the direct sales are to companies on the Atlantic Seaboard.

MAP 2

FERRONICKEL SHIPMENT DESTINATIONS

(3-31-61) to (4-30-62)



Source: Hanna Nickel
Smelting Co.

TVM

In addition, exports are made through the Port of Portland.

Hanna has three eastern warehouses through which the bulk of the ferronickel is marketed. The warehouses are located at Pittsburgh, Detroit, and Chicago, and each warehouse services a given area as delimited on Map 2.

Shipments to the various Hanna warehouses are all made by railroad. Each warehouse is situated in a different freight-rate zone and these freight-rate zones are enumerated A through D on Map 2. Table 2 shows the freight rates to each zone, and in addition the Table shows the percentage of the sale price attributed to freight charges, and the consumer price for one ton of ferronickel. The price of the ferronickel is based on the nickel content, and the value of ferronickel containing 55% nickel was 75 1/4¢ per pound, as of May 24, 1962 (33).

TABLE 2

FREIGHT RATES FROM RIDDLE
(as of May 1, 1962)

Zone	Freight rate per net ton	Ferronickel sale price per net ton	Freight rates as a % of sale price
A	$41.16	$827.75	4.96
B	37.06	827.75	4.48
C	35.02	827.75	4.23
D	30.92	827.75	3.74

Source: (71)

The International Nickel Company of Canada, Limited is the largest producer of nickel in the World. Table 3 shows the freight rates for electrolytic nickel from the port of entry at Port Colborne, as well as the percentage of the sale price attributed to freight charges, and the consumer price of one ton of electrolytic nickel. As of May 24, 1962, the f. o. b. price of electrolytic nickel at Port Colborne was 79¢ per pound.

TABLE 3

FREIGHT RATES FROM PORT COLBORNE
(as of June 25, 1962)

Destination	Freight rate per net ton	Electrolytic nickel price per net ton	Freight rates as a % of sale price
Chicago	$20.00	$1580.00	1.27
Pittsburgh	14.80	1580.00	0.94
Detroit	13.40	1580.00	0.85
Baltimore-Philadelphia	18.80	1580.00	1.19

Source: (27)

On Map 2, there appears to be no northern or southern boundaries to the freight zones, or a western boundary to Zone D. This is because the nickel is marketed in highly centralized areas such as the industrial complexes around Chicago, Detroit, Pittsburgh, and

Baltimore-Philadelphia.

Exports of the ferronickel through the Port of Portland are destined either for Rotterdam, Holland, or Goteborg, Sweden. The metal is transported to Portland by either rail or truck and then put on cargo ships.

The distance from the market and the high freight rates do impose a formidable barrier in the path of the progress of the Hanna Company, but in spite of the adverse conditions, Hanna appears to be competing on the open market successfully at this time. A decrease in freight rates would be very beneficial to Hanna, but such a reduction is unlikely because a single company occupies an unfavorable bargaining position, especially when its freight volume is insignificant when compared to other industrial enterprises.

Hanna could improve its marketing position if it were able to establish larger overseas markets that would enable it to utilize water transportation, which is a cheaper mode of hauling the product. Such a condition is unlikely to occur on the Pacific front because Japan is the leading refiner of nickel in the Far East, and the Japanese get their ore from deposits in New Caledonia, and deposits they control in Rhodesia. Thus, it appears that Hanna will have to cope with the present marketing situation, at least for the forseeable future.

LOCALIZING FACTOR OF RAW MATERIALS

Many of the accessory raw materials for the operation of the mine and smelter are purchased locally, but the bulk of the Company's purchases are made outside of the State. The supplies are brought in mostly by rail, but a significant amount of freight is carried by truck lines. The smelter has access to the Southern Pacific Railroad in Cornutt, by a 2 1/2 mile track spur. Hanna has its own diesel locomotives and crew that haul freight to and from the mainline.

A list of the materials required for the operation of mine and smelter appears in Table 4. The source and annual consumption of the various raw materials is also shown. In addition, the frontispiece of this study presents the geostrategy of the Riddle development, which shows the raw material flow to the facility.

ELECTRICITY

A large quantity of available electrical energy was a prerequisite to the use of the Ugine Process in the smelting of the complex Riddle ores. Hanna has a contract with the Bonneville Power Administration which supplies the needed power for the

TABLE 4

RAW MATERIALS FOR RIDDLE DEVELOPMENT

Materials	Origin	1961 Purchases
Coal	West Virginia	2, 225 tons
Coke	Midwest steel mills	4, 700 tons
Diesel fuel	Portland	200, 000 gals. (est)
Dolomite	Oakland, California	425, 000 lbs.
Electricity	Bonneville Dam	551, 565, 000 Kwh
Electrode cases	Medford, Oregon	1850 cases[1]
Electrode paste	Keokuk, Iowa	3490 tons
Fluorspar	Lovelock, Nevada	164, 000 lbs.
Graphite electrodes	Midwest or Georgia	245, 000 lbs.
Grinding Balls(steel)	Oakland, California	91, 000 lbs.
Heavy Bunker oil	Portland	4, 912, 927 gals.
Hogged Fuel	Riddle	55, 900 units[2]
Iron ore	Washington & Nevada	1, 796, 000 lbs.
Iron turnings	West Coast steel mills	3, 300 tons
Lime	Los Angeles	1, 977, 000 lbs.
Quartz	Gold Hill, Oregon and Colfax, California	15, 335 tons
Ramming material	Oakland, California	828,000 lbs.
Refractories, brick	Oakland, California	675 tons
Water	Cow Creek	1, 500 gals/min.

[1] each case weighs 150 lbs a piece.

[2] each unit is 200 cubic feet.

smelting facility. The Hanna smelter is the single largest industrial user of electricity in the State, except for the aluminum plants. In 1961, Hanna purchased more than one million dollars of power from Bonneville Power Administration, at the rate of $17.50/kw year (7). It is interesting to note that the City of Roseburg used 58,000,000 kwh of electricity in 1961, and this is 10.5% of Hanna's consumption during the same period (42). Table 5 and 6 show Hanna power consumption in relationship to other Bonneville Power Administration customers in the State.

The outside purchases of power by Hanna are from Pacific Power and Light Company (formerly COPCO), for use outside the smelter. Bonneville Power electricity operates the electric furnaces, of which there are seven.

WATER

The smelter uses large quantities of water to cool the melting furnaces. Over 2,000,000 gallons are used daily at a rate of 1,500 gallons per minute. Four separate circulating systems furnish water to the smelter, and every effort is made to recover the used water and reuse it in the cooling system. Hanna has obtained State water rights to Cow Creek, and it is from here that the water is drawn (7).

TABLE 5

BONNEVILLE ENERGY DELIVERIES
Fiscal Year ended June 30, 1961

Customers	Thousands of kwh of energy delivered	Location
Industrial		
Harvey Aluminum	1, 286, 044	The Dalles
Reynolds Metals Co.	718, 334	Troutdale
Hanna Nickel Smelting Co.	550, 273	Riddle
Pennsalt Chemicals Corp.	253, 334	Portland
Union Carbide Metals Co.	97, 932	Portland
Pacific Carbide & Alloys Co.	45, 134	Portland
Others		
Eugene, Oregon	425, 690	
Springfield, Oregon	90, 208	
Douglas Electric Coop	43, 164	Douglas County, Ore.

Source: (66, p. 9)

TABLE 6

SUMMARY LOAD DATA FOR B.P.A. INDUSTRIAL CUSTOMERS
(as of June 30, 1961)
MW-megawatts

Company	Total plant capacity (MW)	BPA sales (MW)	Outside sources (MW)	Total power used (MW)
Harvey Aluminum	161.3	161.2	.0	161.2
Reynolds Metals	189.0	70.7	56.0	126.7
Hanna	71.0	68.2	2.0	70.2
Pennsalt Chemicals	30.0	29.9	.0	29.9
Union Carbide	30.1	22.7	.0	22.7
Pacific Carbide	6.5	6.5	.0	6.5

Source: (66, p. 23)

OTHER RAW MATERIALS

The frontispiece of this study shows the distances from which the various raw materials come to be used at Riddle, and Table 4 shows the variety of materials that are needed to operate the facilities. The bulk of the materials are used in the smelting process which entails all operations from the melting of the ore to the casting of the ferronickel ingots. A brief look will be taken of some of the materials that are used here at Riddle.

Hogged fuel: This wood waste product is used by Hanna to add carbon to the ferrosilicon and it is burned in the dryers and rotary kilns. The hogged fuel is purchased under a contract agreement from three local lumber companies in Riddle.

Quartz: The quartz is used in the making of ferrosilicon, and it is purchased from Gold Hill, Josephine County, Oregon and Colfax, California. One shipment of quartz was purchased at Quartz Mountain in Douglas County, but inaccesability makes this source almost useless.

Electrodes: The electrodes are used in the refining furnaces and Hanna manufactures its own. Electrode cases are purchased from a steel company in Medford, Oregon, and the electrode paste is

purchased in Keokuk, Iowa. It is less expensive for Hanna to make its own electrodes than to purchase the finished product, thus the reason for electrode manufacturing by Hanna.

The raw material flow to the Hanna smelter exemplifies the dependence of industrial operations on other sources to supply auxillary needs in producing a finished product. This concept is termed the geo-strategy of an industrial enterprise.

THE CHARACTER OF THE NICKEL MOUNTAIN DEVELOPMENT

The satisfactory results obtained with the Ugine Process in the experimental smelting of the complex nickel ores, paved the way for the construction of a smelting facility that would utilize the Ugine Process. At the time the contract between Hanna and the Government was negotiated, January 16, 1953, a definite smelting process had not been decided upon, but it was thought by most that the Ugine Process would be the solution to the metallurgical problem. Work on the development of Nickel Mountain was begun in the Spring of 1953, at which time Hanna subcontracted the construction of the smelter facilities to the Bechtel Corporation.

MINING FACILITY

Hanna spent about $3,500,000, including $441,000 for exploration and research, in the development of the mining facilities which included construction of the tramway system (67, p. 16). The mining operation can be divided into three phases; (1) mining and hauling, (2) crushing and screening, and (3) shipping (9, p. 263-267).

Open-cut mining is employed because of the nearness of the ore to the surface, in fact, the ore reaches the surface in many places. The highly fractured state of the deposit necessitates little blasting, and as a result the ore is quite easily dug from the walls of the bench terraces.

The ore body is mined by a series of bench terraces, and the ore is dug from the face of the terraces by 2 1/2 yard shovels and then loaded into 22-ton trucks. The trucks then haul the ore a short distance to the crushing and screening plant.

At the screening and crushing plant, the ore is crushed to pieces with a diameter of 5" or less and then conveyed to a hopper where it is then loaded into the tramcars that will take the ore down the slope to the smelter.

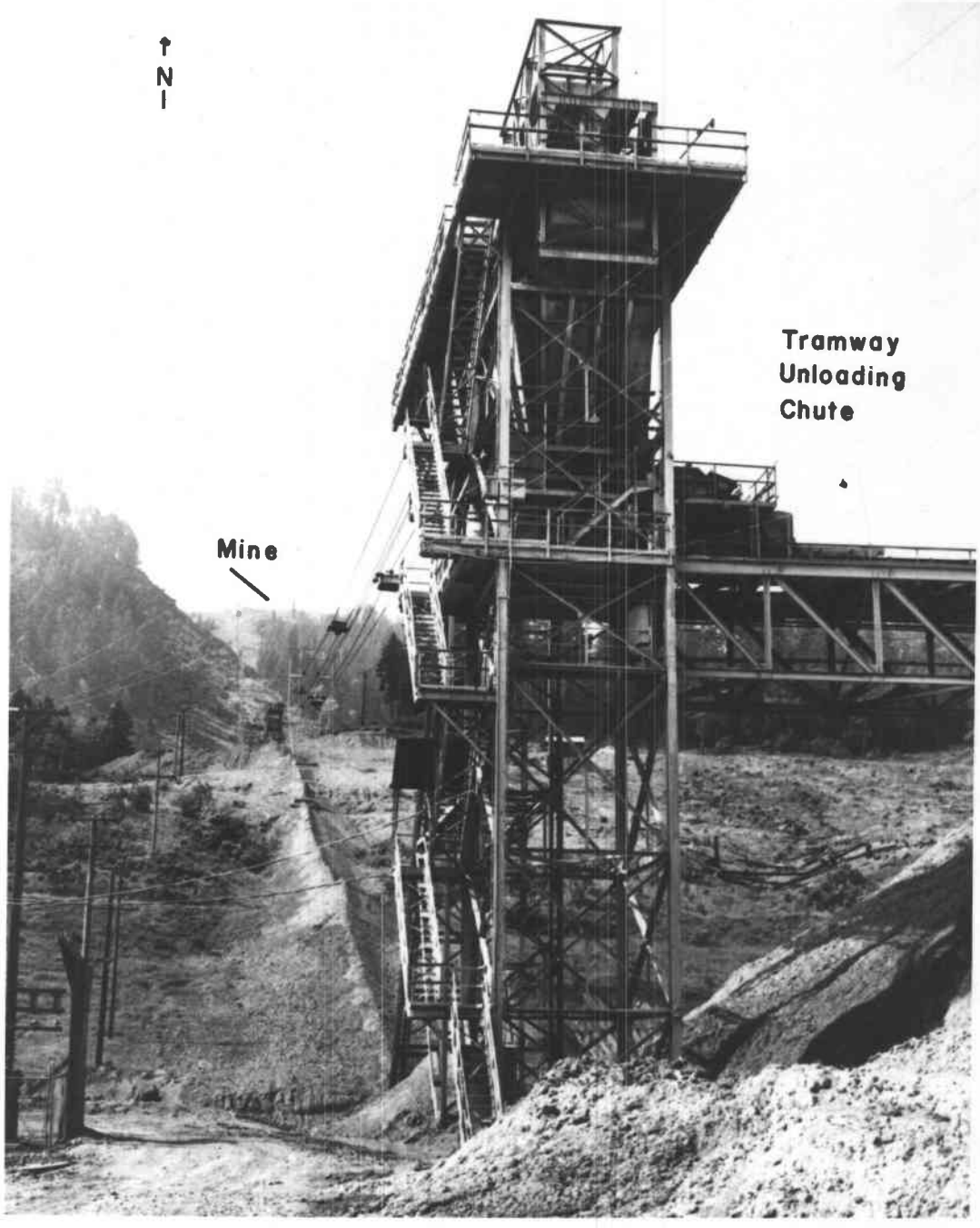


Figure 2

Tramway unloading chute at the end of 8, 306 foot track cables
(Hanna Nickel Smelting Co.)

A major problem of the mining operation is controlling the grade of ore going to the smelter. To assure that the average grade of the ore going to the smelter is 1.5% nickel, sampling of the deposit is carried out on a daily basis to determine the grade of the various cuts that are being mined. Maintenance of the desired grade of ore is accomplished by mining areas containing less than 1.5% nickel and other areas that are richer in the ore, and the two cuts supply an average grade of 1.5% nickel.

SMELTING OPERATION

Basically, processing the ore for the smelter consists of drying and crushing the ore and then calcining it in a rotary kiln. From the kilns, the ore is transported to the furnaces where it is melted.

There are three basic steps to the Ugine Process that are used in the production of ferronickel (9, p. 271-272).

(1) The nickel oxide ore is melted in the electric melting furnaces.

(2) Ferrosilicon is added to the molten nickel oxide.

(3) The pour of molten metal is agitated rapidly causing the ferrosilicon to react with the nickel oxide and the end product is nickel and iron in metallic form. Following is the reaction:

$$2\,NiO + FeSi \text{ -------} > 2\,Ni + SiO_2 + Fe$$

The end product of the smelting process is a high-grade ferronickel that contains from 50%-55% nickel, and the bulk of the remainder is iron. The product is very low in sulphur, phosphorus, and carbon. Table 7 lists the ferronickel specifications as established by the Government. The ferronickel produced by Hanna has always contained less than the established maximum of each impurity, and this is further proof of the success obtained by using the Ugine Process.

TABLE 7

GOVERNMENT SPECIFICATIONS FOR FERRONICKEL

Element	Percent	
Nickel	Over	25.00
Phosphorous	Less than	0.05
Sulphur	Less than	0.05
Chromium	Less than	0.25
Carbon	Less than	0.20
Iron	Less than	75.00

Source: (9, p. 278)

The mining and smelting facilities at Nickel Mountain have proven to be quite satisfactory in spite of the adverse locational aspect of the ore body in relation to the smelter, and in spite of the ever present metallurgical problem faced in melting the complex nickel ore. The aerial tramway has proven to be quite adequate for

transporting the ore down the mountainside to the smelter, while the Ugine Process is ever being improved to handle the complexities posed by the nickel ore.

The present stature of the Riddle development would not likely have been attained without the aid supplied by the Government, but also, credit must be given to the Hanna Company for the successful operation of the mining and smelting facilities. The factor of Government in the establishment of the industry is the topic of the following section.

FACTOR OF GOVERNMENT

Cooperation between the Federal Government and the Hanna Company resulted in the establishment of a successful mining and smelting venture. Such cooperation stemmed from the needs of each of the parties who negotiated the contract.

The Government wanted to promote development of domestic sources of strategic minerals, nickel being one, and to do this the Government was willing to make available capital loans to private companies to aid them in exploiting a resource. In addition, the Government agreed to purchase the bulk of the strategic minerals and put them into a government stockpile or assume the responsibility of marketing the product.

Hanna was interested in developing the Nickel Mountain ore body, but it did not want to operate the smelting facility. Hanna later agreed to operate the smelter providing that the Government supply the necessary capital for the construction of a smelter. Thus the stage was set for the negotiation of a contract which had an original termination date of June 30, 1962, but this was not the case as the following section will show.

RECENT CONTRACT CHANGES

The original contract was partially terminated on April 20, 1961, when Amendment Number 5 was added to the initial contract. As of April 20, 1961, Hanna had supplied all but 19, 500, 000 pounds of nickel stipulated by the original contract. Hanna was given until June 30, 1965, to supply the remainder of the nickel because it was the general consensus of government officials that the nickel stockpile was becoming too large and that some means should be taken to decrease the flow of nickel into the reserve (68).

Also, in the original contract it was stated that Hanna would be given the opportunity to purchase the smelter after a minimum of 95, 000, 000 pounds of nickel had been delivered to the stockpile. Hanna exercised the purchase right on April 20, 1961, at which time it purchased the capital facilities for about $1,700,000 (67, p. 30).

As a result of the partial termination of the contract, Hanna is no longer assured of a market for the ferronickel as was the case when the Government purchased the entire plant production. Hanna must now seek its own markets.

MARKETING SITUATION

The Hanna Company has been continually producing ferronickel since 1954, but it is only since April, 1961, that Hanna has had to seek its own market for the product. When the contract was such that the Government was purchasing all of the ferronickel, Hanna had little to be concerned about the price of ferronickel on the open market, but now the picture has been altered greatly. Now that Hanna has no assured market, price fluctuations will play a very important part in the success of the continued operation of the Riddle nickel enterprise. The sale price of ferronickel must remain high enough so that Hanna can economically get the product to the distant markets.

Hanna is the only producer of ferronickel in North America, and the product is widely used in the production of stainless steel. In 1960, the American steel industry used 60, 172, 000 pounds of pure nickel in the production of stainless steel (63, p. 837). Hanna has a plant capacity of 22, 000, 000 pounds of nickel contained in

TABLE 8

FERRONICKEL SHIPMENTS FROM RIDDLE
(March 31, 1961 through April 30, 1962)

	lbs. of contained nickel
Pittsburgh, Pa. warehouse	11, 255, 000
Detroit Mich. warehouse	2, 578, 000
Chicago, Ill. warehouse	1, 255, 000
Steel Companies-direct	3, 741, 000
Export	1, 006, 000
Total	19, 835, 000

Source: (56)

saleable ferronickel, and this capacity is enough to supply the stainless steel industry with one-third of its needs.

Twenty five different steel companies purchased ferronickel from Hanna in 1961 (55), and these purchases are mostly made directly at Hanna's various warehouses, although some ferronickel shipments are made directly to steel companies. This method of purchasing eliminates the necessity of steel companies maintaining large inventories of ferronickel.

Exports of ferronickel are currently made through the Port of Portland, and these shipments are made to Rotterdam, Holland, or Goteborg, Sweden. Rotterdam is the gateway to Europe, and from here nickel is distributed on the Continent. The shipments to Goteborg are used in the Swedish iron and steel industry.

Hanna's foreign transactions are handled through an export company in New York City, and this company purchases the ferronickel from Hanna and in turn sells to the European concerns.

HANNA COMPETITORS

The Hanna Company is the only producer of ferronickel in the United States, a product used chiefly by the steel industry in the production of stainless steel. However, being the only producer of ferronickel offers no decided advantage because electrolytic nickel can be used interchangeably with the ferronickel.

Hanna's marketing position is aided because ferronickel undersells electrolytic nickel on the market. As of May 24, 1962 ferronickel containing 55% nickel was selling at 75 1/4¢ a pound, whereas Canadian electrolytic nickel was selling at 79¢ a pound, f.o.b. Port Colborne (33). It is more desirable to use electrolytic nickel, which is almost pure nickel, instead of ferronickel in the production of stainless steel because it is easier to control the nickel content of the steel produced. An advantage to using ferronickel is that it cuts down the amount of iron that must be added in producing the stainless steel. The iron contained in the ferronickel is a much better grade of iron than is scrap iron that

is otherwise added, and no charge is made for the iron contained in the ferronickel.

The chief competitors to Hanna are the large Canadian nickel companies, The International Nickel Company of Canada, Limited being the largest, that are located on the fringe of the Great Lakes. These companies occupy an excellent marketing position, as shown by Map 2 and Table 1, because of their proximity to the large United States industrial centers. Most of the Canadian nickel moves to the market by rail or truck and Tables 2 and 3 compare the freight costs of nickel from Port Colborne and Riddle to the market centers. As was previously mentioned, Port Colborne, Ontario is the port of entry of Canadian nickel.

The Canadian nickel companies have long been the chief suppliers of nickel to the United States, and even with the development of markets by the Hanna Company, the bulk of United States nickel will come from Canada.

It is unlikely that any great change will occur in Hanna's competitive position in marketing the ferronickel as there will always be the factor of distance to the market to be overcome. West Coast market expansion is unlikely at present because there are only a few steel companies in the area and none produce

stainless steel. Overseas expansion in the Pacific is hampered by the dominant position of Japanese nickel producers. Thus it appears that Hanna's marketing situation will remain the same, at least for the present.

CHAPTER V

HANNA'S IMPACT ON THE ECONOMY

The development of the Riddle nickel enterprise by the Hanna Company has had a favorable impact on all sectors of the economy, from the national level through the local level. The nickel supplied by Hanna has lessened the Nation's dependence on foreign sources for nickel and as of 1960, Hanna was supplying 13% of United States consumption. However, the greatest impact of the Riddle nickel enterprise has been felt in the Inland Umpqua Basin, with the center of activity being in Riddle and Myrtle Creek.

NATIONAL STATUS

Hanna is the only producer of ferronickel in North America, and it is also the largest producer of primary nickel in the United States. There are however, other domestic producers of nickel, but the nickel is produced as a byproduct of other smelting processes.

In 1960, there were six other producers of nickel in the United States. The National Lead Company of Fredericktown,

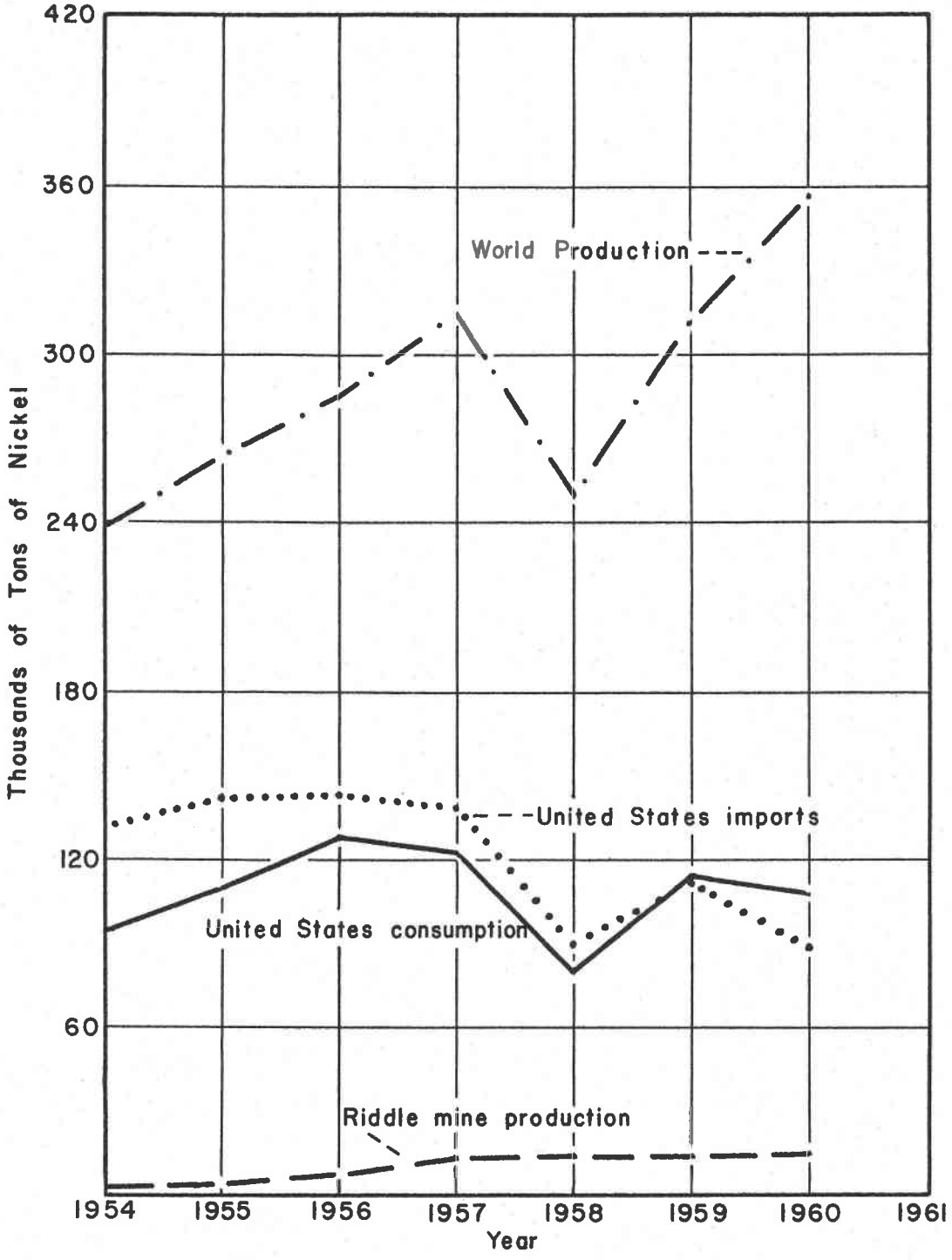
Missouri was producing a pyrite concentrate containing nickel and cobalt. Copper refineries at Carteret and Perth Amboy, New Jersey; Laurel Hill, New York; El Paso, Texas, and Tacoma, Washington, were producing nickel as a byproduct of the copper refining process (63, p. 834).

Graph 1 shows the position of Riddle nickel on the World and National scene. Since the beginning of Hanna's operation, United States imports remained fairly constant until 1958 when there was a rapid decline in nickel imports. The 1958 decline was due to the prolonged steel strike and the increase in imports in 1959 was probably due to renewed steel production. In 1960, there was a decrease in the imports because of the existence of a huge nickel reserve in the government stockpile. The abundance of nickel on the domestic scene was partly attributable to Hanna's production of ferronickel.

Nickel production at Riddle has leveled off to the point where about 22,000,000 pounds of nickel in the form of saleable ferronickel are produced annually (20, p. 1). Whether the future will see an increase in nickel production at Riddle since Hanna has begun to market the nickel on the open market, cannot be determined at this time.

GRAPH I

NICKEL STATISTICS



Source: U. S. Bureau of Mines

TVM

As a result of the nickel stockpiling program, whereby the Government purchased nickel from Hanna as well as other Canadian sources, the Nation's nickel stockpile has risen to the point where 125, 365, 000 pounds of nickel were in reserve at the end of 1960 (63, p. 834). It appears that the Government stockpile will be sufficient for some time to come barring any international crisis; in fact, it is probably much too large for the Nation's immediate needs.

OREGON'S ECONOMY

Nickel is the only primary metallic mineral mined that contributes significantly to the economy, and since 1955, nickel has been the fourth most valuable mineral in the State. Table 9 shows the total value of Oregon's minerals, and also the proportion of the value that is contributed by nickel ore. The value of the nickel ore is calculated at $6/dry ton, as set forth in the government contract. A ton of ore as it is mined contains 21% moisture (7), but Hanna is not paid for the wet weight.

Other than the contribution made by Hanna nickel to the State's economy, the purchases of the Company have had an impact on the business sector of the economy. In 1961, the Company

TABLE 9

OREGON MINERAL VALUE

Year	State Value	Nickel ore value ($6/dry ton)	Percent of State value contributed by nickel
1953	$24,449,000		0.0%
1954	32,268,000	$ 539,275	1.6%
1955	31,736,000	1,226,797	3.9%
1956	34,021,000	1,886,316	5.5%
1957	42,480,000	3,370,632	7.9%
1958	45,053,000	3,651,293	8.1%
1959	49,831,000	3,553,535	7.1%
1960	54,520,000	5,214,000	9.6%
1961	48,089,000	5,024,400	10.4%

Source: (64)

spent $2.6 million in Oregon (56). The tax payments of Hanna have totaled $1,047,000 in property taxes from 1954 through 1961 (56), and this sum has benefited the State and Douglas County alike.

DOUGLAS COUNTY MINERAL PICTURE

In 1954, when nickel production was begun, nickel became the second most valuable mineral in the County, exceeded only by sand and gravel, and in 1955 and since, nickel has been the leading mineral in value. Table 10 shows the dominant role played by nickel in the County's economy. With the rise of nickel production,

Douglas County advanced from the fifth ranking mineral county, to the second ranking county in 1956, a position it has held since (64).

TABLE 10

DOUGLAS COUNTY MINERAL VALUE

Year	County Value	Nickel ore value ($6/dry ton)	Percent of County value contributed by nickel
1953	$1, 219, 732		0.0%
1954	2, 088, 283	$ 539, 275	25.8%
1955	2, 859, 423	1, 226, 797	42.9%
1956	4, 140, 573	1, 886, 316	45.6%
1957	7, 395, 255	3, 370, 632	44.2%
1958	6, 830, 000	3, 651, 293	53.5%
1959	6, 576, 000	3, 553, 535	54.0%
1960	7, 011, 000	5, 214, 000	74.4%
1961	7, 001, 000	5, 024, 400	71.8%

Source: (64)

HANNA'S EMPLOYMENT IMPACT

The Hanna development has resulted in a population influx into the Inland Umpqua Basin, especially the communities of Myrtle Creek and Riddle. The Hanna payroll has also stimulated business activity in the area, as have the local purchases of the Hanna Company.

HANNA EMPLOYEE INFLUX

Employment levels of the Hanna Company since 1955, are shown in Table 11. Mine employment has averaged about 60, but at present 67 workers are employed at the mine. Smelter employment has varied, but it has now leveled off at between 360 and 365 workers.

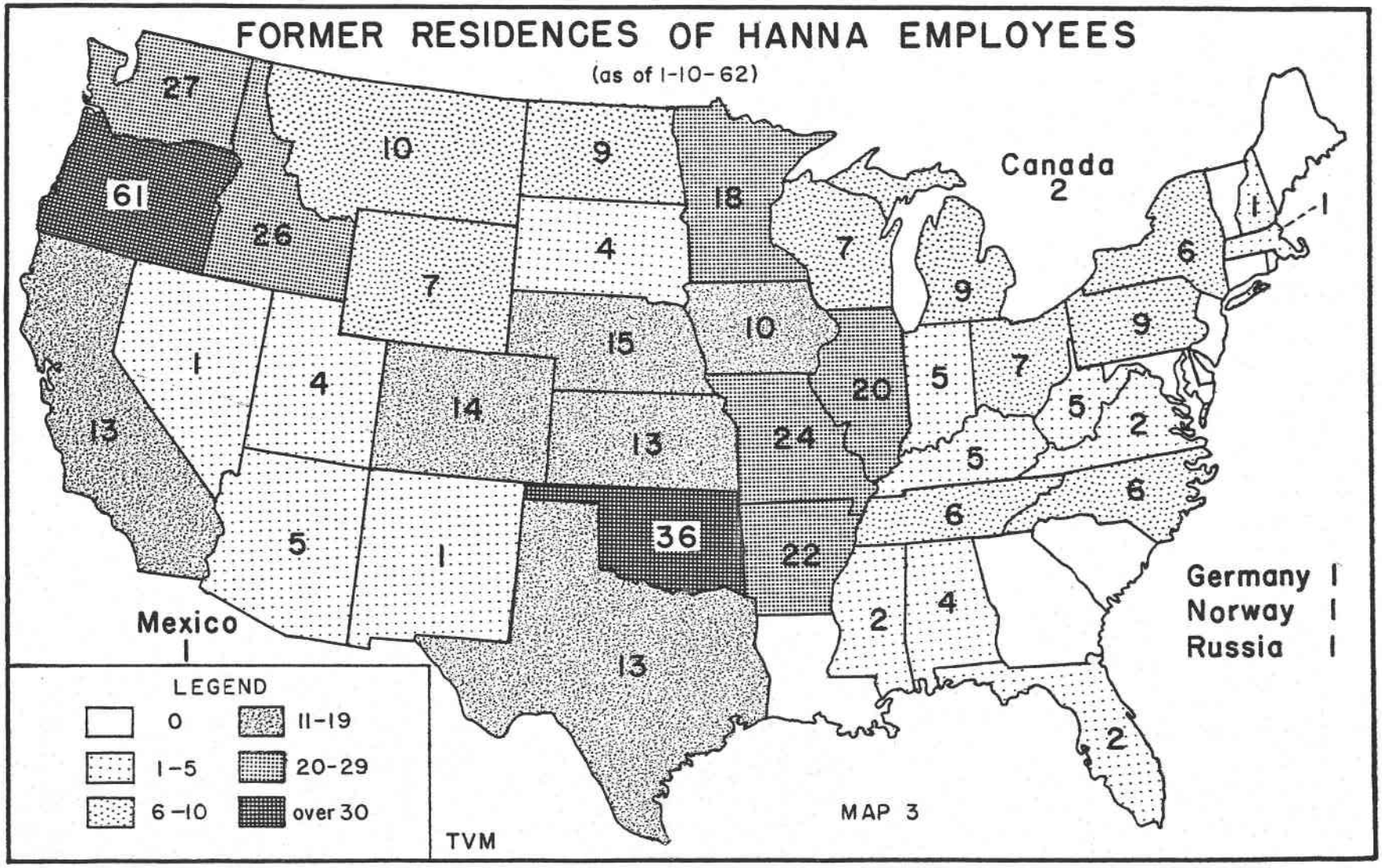
TABLE 11

HANNA EMPLOYMENT

Year	Mine	Smelter	Total
1955	60	295	355
1956	60	400	460
1957	60	439	469
1958	60	421	481
1959	60	387	447
1960	60	362	422
1961	60	361	421
1962	67	365	436 (as of 1/10/62)

Source: (57)

Employees of the Hanna Company came from far and wide to seek job opportunities when the development began, and from Map 3 it can be seen that many of the people came from states where mining is important. Fourteen percent of the present employees are native Oregonians, and the bulk of the remainder are from the mining states of Oklahoma, Washington, Idaho, Missouri,


FORMER RESIDENCES OF HANNA EMPLOYEES
(as of 1-10-62)
27
10
9
18
61
26
7
4
7
15
10
1
4
14
20
5
7
13
13
24
5
5
2
5
6
6
36
22
5
1
2
4
Mexico
1
13
2
Canada
2
1
1
6
9
9
Germany 1
Norway 1
Russia 1
LEGEND
0
11-19
1-5
20-29
6-10
over 30
TVM
MAP 3

Arkansas, Illinois, and Minnesota. Many of the Minnesotans previously worked for Hanna at the Mesabi iron mines.

The Hanna labor force consists primarily of people who were not previously employees of the Company. Some of the employees originally worked with the Bechtel Corporation when it built the smelter facilities, and upon completion of construction, many of the workers transfered to Hanna. Every effort was made to hire people who intended to remain with the Company for some time, and as a result, labor turnover is minimal.

DOUGLAS COUNTY EMPLOYMENT PICTURE

The latest complete data for the County is for the year 1960, and from this data, Table 12 was compiled. Selected industries are shown so as to relate Hanna employment to the rest of the County. The Table shows that in 1960, Hanna employed 2.8% of the labor force, and the Hanna payroll was 3.9% of the County total. Employment at Hanna has contributed to stability in the Douglas County employment picture because the largest percentage of the labor force is employed in the highly cyclical forest industry. In 1960, average monthly employment was 15,303 and the annual payroll was $75,844,197 for Douglas County (38).

TABLE 12

EMPLOYMENT AND PAYROLL PERCENTAGES
BY INDUSTRY (1960)

Industry	Employment	Payroll
Lumber & wood products	53.3%	57.5%
Wholesale & retail trade	16.9%	12.9%
Service industries	5.0%	3.3%
Transportation, communications, public utilities	4.6%	4.8%
Contract construction	3.5%	4.4%
Hanna employees	2.8%	3.9%
Finance, insurance, & real estate	2.0%	1.8%
Miscellaneous	11.9%	11.4%

Source: based on (38).

LOCAL RESIDENCES OF HANNA EMPLOYEES

Most of the employees reside in Riddle and Myrtle Creek because of the proximity of the communities to Nickel Mountain. The percentage of the population of each town that is comprised of Hanna familes is shown in Table 13 and on Map 4, also the total town populations are shown. The total number of people affiliated with the Hanna Company was calculated by multiplying the number of employees by the size of the average household in Douglas County, which is 3.38 people (37). It can be seen that Riddle has felt the greatest impact from the influx of Hanna employees. The impact at Azalea is rather great, but then Azalea is a rather

MAP 4

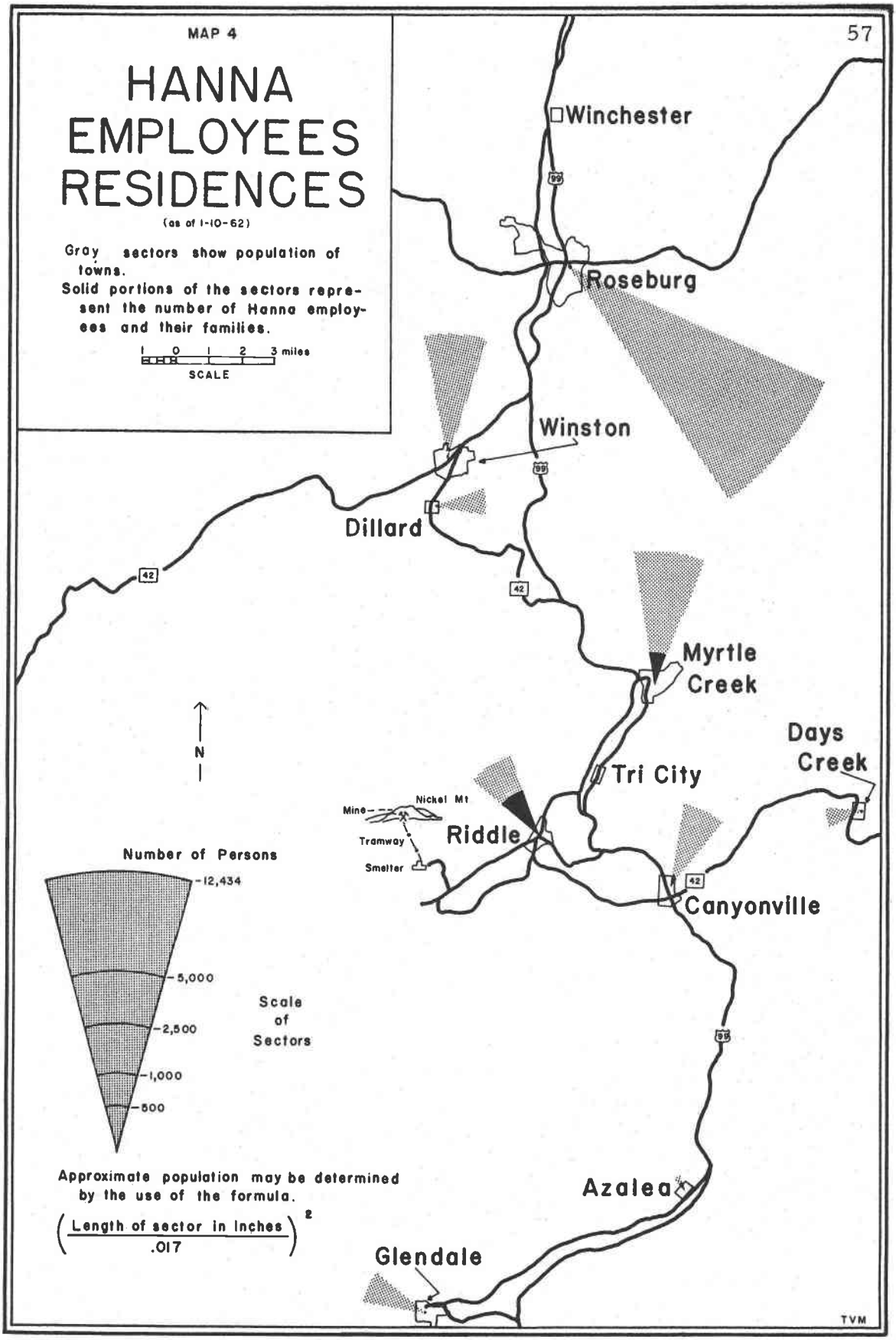
HANNA EMPLOYEES RESIDENCES

(as of 1-10-62)

Gray sectors show population of towns.

Solid portions of the sectors represent the number of Hanna employees and their families.

1 0 1 2 3 miles
SCALE



small community.

TABLE 13

POPULATION ATTRIBUTED TO HANNA
(as of January 10, 1962)

Town	Total town population	Residing[1] employees		Avg. Size[2] family	Total	% of town population
Myrtle Creek	2,637	192	X	3.38	649	24.6%
Riddle	1,087	183	X	3.38	619	56.0%
Canyonville	1,025	37	X	3.38	125	11.2%
Roseburg	12,434	12	X	3.38	41	.3%
Azalea	30	4	X	3.38	14	47.0%
Days Creek	225	3	X	3.38	10	4.0%
Glendale	714	2	X	3.38	7	1.0%
Dillard	400	2	X	3.38	7	2.0%
Winston	2,395	1	X	3.38	3	.1%

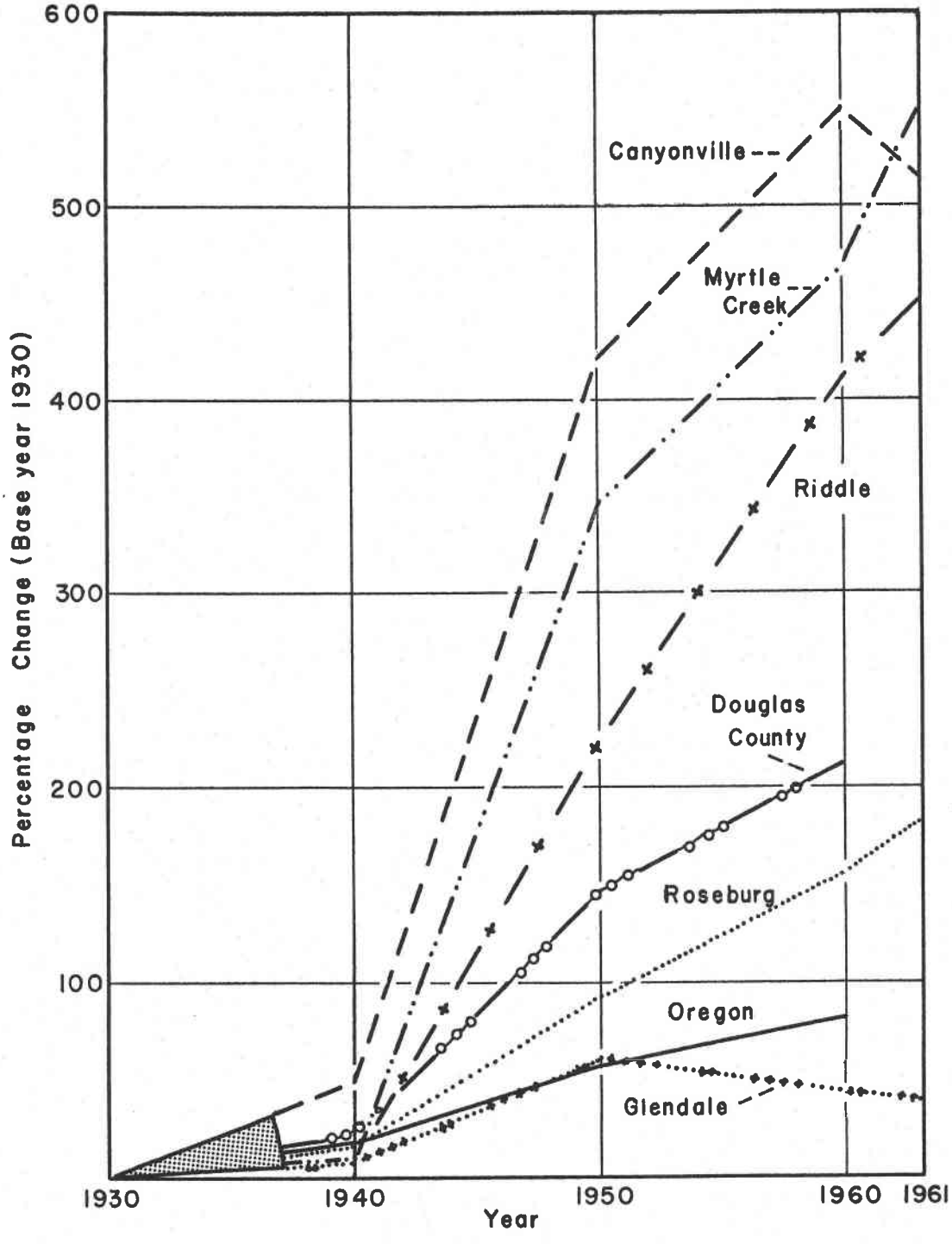
[1] Source: (55)

[2] Source: (37)

Population changes that have occurred in the area since 1930 are shown on Graph 2. Most of the communities experienced rapid growth during the period from 1940 to 1950 because of increased lumbering activity. Growth from 1950 to 1960 was still rapid in Canyonville, Myrtle Creek, and Riddle, but again this was due to continued lumbering activity. But, some of this growth is definitely connected with the coming of the Hanna Company.

GRAPH 2

POPULATION CHANGES



Source: U. S. Bureau of Census

TVM

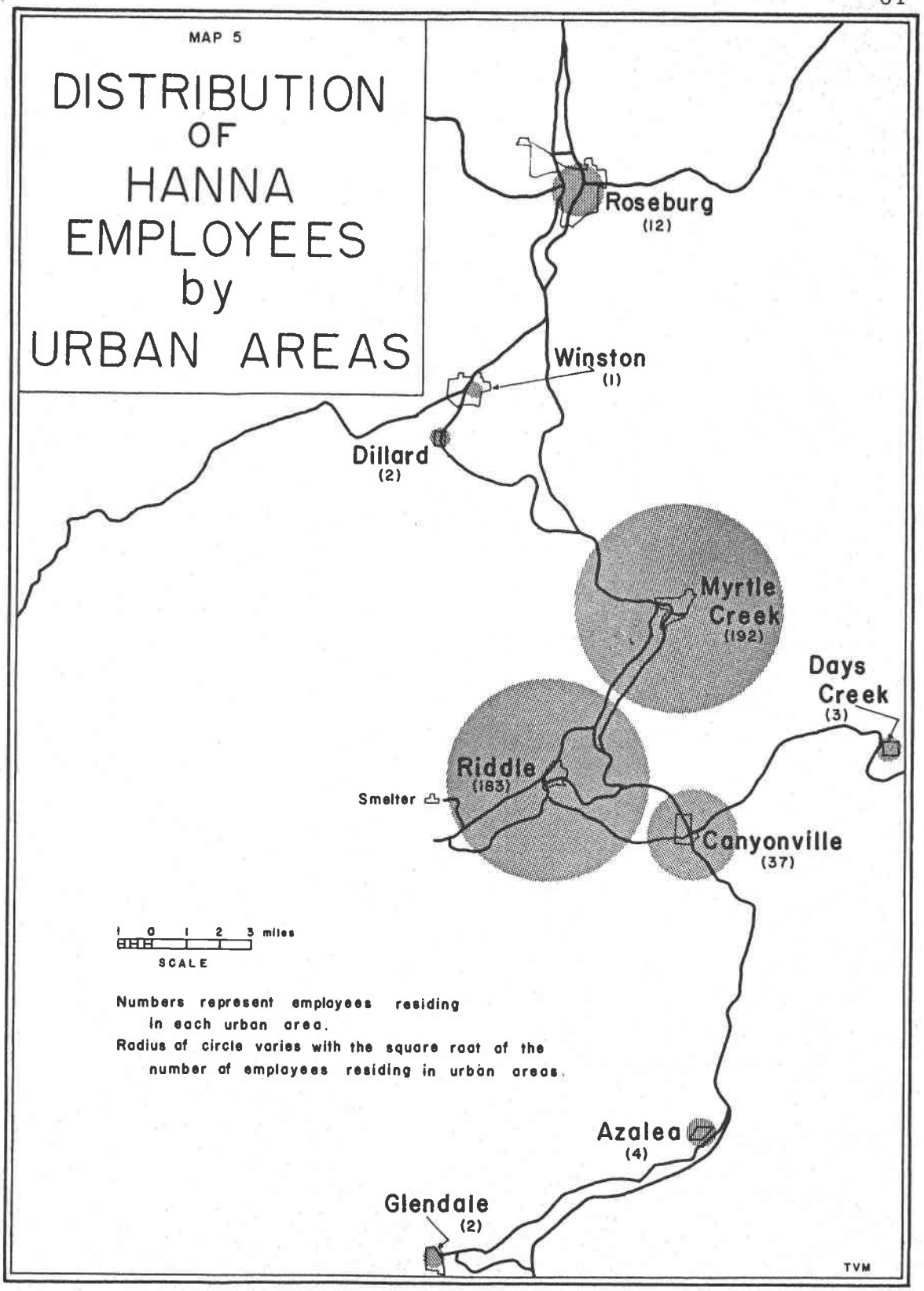
The graphic distribution of the Hanna employees is shown on Map 5. Most of the workers live within 15 miles of the plant, and others commute distances of 28 miles.

ECONOMIC IMPACT OF HANNA

The Hanna payroll gave major stimulus to the local economy. In 1960, the Hanna payroll was approximately $3,000,000 with a labor force of 422, and the Company spent $715,000 on local purchases (55). Local purchases consisted primarily of light hardware supplies, and office supplies and equipment.

The influx of employees, along with their payrolls, creates employment opportunities for other people, and the impact of such developments is studied by the use of regional multipliers. A paper dealing with the Oregon economy (47, p. 9), states that each job in the basic industries, including mining, supported 2.2 other jobs in various service industries. Another study consulted listed multipliers running from 1.6 to 3.5 (1, p. 259) but these figures were for cities with a large non-basic employment sector. Thus, 2.2 will be used as the multiplier in this study.

Using 2.2 as the multiplier, shows that 422 Hanna employees have created employment for 928 other persons in non-basic industries, and these 928 persons comprise 19% of the average


MAP 5
DISTRIBUTION OF HANNA EMPLOYEES by URBAN AREAS
Roseburg
(12)
Winston
(1)
Dillard
(2)
Myrtle Creek
(192)
Days Creek
(3)
Riddle
(183)
Smelter
Canyonville
(37)
Azalea
(4)
Glendale
(2)
1 0 1 2 3 miles
SCALE
Numbers represent employees residing in each urban area.
Radius of circle varies with the square root of the number of employees residing in urban areas.
TVM

monthly employment total. Table 14 was compiled with the aid of Oregon State employment data. The average monthly employment was multiplied by 19% to calculate the stimulus of the Hanna Company to areal employment, as 19% was shown to be the percent of the labor force in non-basic industries who are theoretically employed because of Hanna's development. Hanna's effect on the County payroll is calculated by attributing 19% of the annual payroll in each service industry to the Hanna Company.

TABLE 14

LOCAL IMPACT OF HANNA PAYROLL
(1960)

Non-basic industry	Avg. monthly employment	Hanna's Stimulus To Employment	Hanna's Stimulus To Annual Payroll
Wholesale & Retail Trade	2584	491	$1,855,002
Service Industry	762	145	470,771
Transportation, Communication, Utilities	700	133	688,055
Contract Construction	541	103	635,158
Finance, etc.	302	57	257,064
Totals	4889	928	$3,906,050

Source: Based on (38)

The Hanna Company has contributed significantly to the tax base of the County. From 1954 to 1961, Hanna paid $1,047,000 (56) in property taxes. Hanna is the second largest taxpayer in the County, exceeded only by the California Oregon Power Company (now Pacific Power and Light Co.). In 1960 COPCO paid $719,167.16 (48, p. 3).

IMPACT ON LOCAL INSTITUTIONS

Many changes have occurred in the area since the coming of the Hanna Company, and many of the changes are directly attributable to Hanna's influence. The school districts have experienced about as much change as any local institutions.

School Districts: The two school districts that have felt the greatest impact from the Hanna project are Riddle and Myrtle Creek. Since 1952, enrollment figures have not continued to rise because of the decline of the lumbering activity. However, in 1954 and 1955 both districts experienced an enrollment increase, and this can be correlated with the arrival of the Hanna labor force. Table 15 shows the enrollment changes in the two aforementioned districts, as well as in Canyonville.

TABLE 15

SCHOOL ENROLLMENT

District	1952	1953	1954	1955	1957	1959	1961
Myrtle Creek	1407	1552	1820	1924	1857	1679	1801
Riddle	506	537	605	681	704	670	691
Canyonville	414	514	529	549	520	491	442

Source: (16)

A peculiar phenomena has arisen in the Riddle and Myrtle Creek school districts. Myrtle Creek received the greatest number of new students and Riddle received the largest increase in school tax revenues. Thus Riddle has become the sixth richest district of the 24 districts in Douglas County, and it also has the fourth lowest millage rate in the County for districts that include both elementary and high schools in their district tax levy (14, p. 46). Table 16 shows the District's assessed valuation over the last few years, and it is readily seen that the development of Nickel Mountain resulted in increased valuation for the Riddle School District. Hanna pays over 49% of the Riddle District taxes (7). In addition, money from Hanna taxes goes to the Myrtle Creek and Canyonville districts by equalization of county school taxes.

TABLE 16

RIDDLE SCHOOL DISTRICT DATA

Year	Assessed Valuation	Average daily membership	Total school
1951-52	$2,685,334	409	35.5
1952-53	2,958,702	436	37.8
1953-54	3,267,155	531	42.1
1954-55	3,410,067	594	36.4
1955-56	5,281,324	592	36.1
1956-57	5,936,825	588	42.1
1957-58	6,433,025	607	43.5
1958-59	6,969,349	585	41.4
1959-60	6,635,192	583	50.5
1960-61	6,481,343	628	52.3
1961-62	8,494,950	647	43.2

Source: (51)

Local Business Changes: Slag from the smelter has resulted in the development of a new business venture. The Mining-Minerals Manufacturing Company is processing the slag for sand blasting purposes and use in gunite for furnace lining. The Company, sizes, packs, and distributes the new product.

Hanna purchases hogged fuel locally for use in adding carbon to the ferrosilicon. Hogged fuel is wood waste that has been chopped into small particles.

Stomar Lumber Company, C & D Lumber Company, and Johnson Lumber Company of Riddle convert wood waste into

hogged fuel for Hanna's use. In the face of declining lumber sales, Hanna's purchases are valuable to the above lumber concerns.

The Southern Pacific Railroad depot in Riddle ranks fourth in the County in volume of rail shipments. The majority of the freight is lumber, but ferronickel is the second most important freight commodity. Since Hanna began shipping ferronickel to their eastern warehouses on April 1, 1961, and including shipments through April 30, 1961, 339 carloads of ferronickel have been shipped with an average carload weight of 1,000,000 pounds (54). This compares to 3604 carloads of lumber, average weight 73,000 pounds, during the same period (54).

The Hanna development has definitely been an asset to the local economy in particular, but the development has also had an impact on the State and National economy. It is hoped that Hanna will continue to operate at Riddle because of the stimulating effect the Company has had on the businesses of the area. Many job opportunities have been made available in the non-basic sector of the economy and these jobs take care of the needs of the Hanna Company, as well as those of Hanna's employees. Hanna has also aided in stabilizing the local economy, which at present is in a rather depressed state because of the decline in the lumber and

wood products industries.

What does the future hold for the Hanna Company? This is the topic of the concluding chapter of this study.

CHAPTER VI

OUTLOOK

Hanna's progress at Nickel Mountain is an example of the success that can be achieved through cooperation between government and private industry. The contract between Hanna and the Government afforded the needed stimulus for a private company to develop the complex ore deposit.

As of April 20, 1961, Hanna lost its assured market because of partial termination of the Government contract, and as a result, Hanna must now seek its own markets. Now that Hanna is on its own, what does the future hold for the success or failure of this mineral enterprise?

HANNA'S FUTURE

The production of ferronickel has progressed to the point where the smelter has a capacity of producing 24, 000 tons of ferronickel annually. Table 17 shows the output of the mine and smelter since the beginning of the operation in 1954. Initial production of ore and ferronickel is low because the Ugine Process

TABLE 17

RIDDLE PRODUCTION

Year	Ore mined (net tons)	Value of ore ($6/dry ton)	Ferronickel (net tons)	Value of Ferronickel	Nickel Content
1954	113,750	$ 539,275	387	$ 211,592	45%
1955	258,818	1,226,797	7,609	4,160,220	45%
1956	397,957	1,886,316	11,264	7,121,644	45%
1957	711,104	3,370,632	20,564	13,001,589	45%
1958	770,315	3,651,293	23,793	14,903,935	45%
1959	749,691	3,553,535	22,631	14,176,057	45%
1960	1,100,000	5,214,000	23,580	19,518,345	55%
1961	1,060,000	5,024,400	17,727	14,673,524	55%

Source: in part (7), (60, p. 561)

was still in the testing stage, but as the Process was improved production increased.

In Table 17 the value of the ferronickel is based on the amount of contained nickel.

RESERVES

The Bureau of Mines in 1958, stated that the estimated reserves of the Riddle deposit were 257,000 short tons of contained nickel (60, p. 558). Thus the reserves to production ration indicate a 20 year life. Improvements in technology may make it possible to recover still lower grade nickel and this would lengthen the life of the deposit. Moreover, exploration has been and is still being carried out in the surrounding area in search of new nickel deposits. Woodcock Mountain and Eight Dollar Mountain in Josephine County, and Red Flat in Curry County are the sites of additional low-grade nickel deposits in the State.

In 1948, Woodcock Mountain was prospected and was found to contain ore samples ranging from 0.29% to 2.02% nickel (31, p. 19). The deposit is located a mile west of the town of Cave Junction, 35 miles south of Grants Pass. Nearby Eight Dollar Mountain is part of the same laterized area and samples

have been found containing 1.6% nickel (7).

Red Flat is located near the headwaters of the Pistol River. Nickel content of the lateritic deposit ranges from 0.27% to 1.46% (29, p. 23). With the present technology in nickel recovery, these two deposits cannot be exploited economically, so it appears that the Riddle deposit offers the only source of nickel in light of present mining and smelting technology.

MARKETS

Presently, Hanna is involved in a vigorous campaign to expand its markets, both at home and abroad. It will be some time yet before an appraisal can be made of Hanna's success on the open-market.

The unfavorable location of Riddle in relationship to the market centers continues to be a problem. Hanna has a distinct disadvantage in marketing the ferronickel because it is distant from the market, and dependent on rail transportation which is an expensive form of conveyance. It would be very helpful to Hanna if freight-rate concessions could be obtained.

It seems that it may become very important for the Hanna Company to establish West Coast markets to overcome the unfavorable marketing position now held. Increased exports may be the

answer, as exporting the ferronickel gives Hanna the benefit of using cheaper water transportation, thus Hanna becomes more competitive with other nickel suppliers.

COMPETITION

The Canadian nickel companies enjoy a great advantage in marketing their product because of their proximity to the market. However, Hanna is the only producer of ferronickel, but this offers no real advantage because other forms of nickel can be substituted for the ferronickel in any of the industrial processes. Presently, Hanna ferronickel is competitive because nickel contained in ferronickel undersells Canadian electrolytic nickel by 3 3/4¢ a pound.

The Hanna Company is optimistic about future developments of the Nickel Mountain Enterprise. On April 24, 1961, Hanna Mining Company President, W. A. Marting stated (20, p. 4),

> "Our experience has shown that we can produce nickel of dependable high quality at a competitive price and we now have sales agreements with major alloy steel producers. We are confident that the demand for alloy steels in this Country will continue to grow and that our nickel business will benefit accordingly."

Hanna will be able to continue selling its product in competition with other companies as long as the sale price of

ferronickel is sufficiently high to cover the cost of shipping the product to the eastern markets.

CONCLUSION

It is difficult to forecast the future of the Hanna Company at Riddle, as it has been too short a time since the partial termination of the Government contract.

On the surface, it appears that the Company is doing quite well since it went on its own in April 1961. However, this does not assure continued success. As shown in the analysis, the Riddle enterprise operates in spite of serious competitive handicaps, which are only a little lessened by the successful years with Government participation. The continued operation of the enterprise will depend a great deal on non-geographic factors notable on the international political scene, on the price that can be obtained on the market for ferronickel and still give Hanna a reasonable profit, on the ability of the Hanna Company to improve efficiency of the operation to offset the locational disadvantages, and with the success enjoyed in developing new markets. Nevertheless, the Riddle nickel enterprise does demonstrate the significance of government participation in an appraisal of comparative advantages that localize mineral industries. In

addition, Hanna's perserverance in overcoming developmental obstacles demonstrates the success that can be achieved by the private enterprise system in developing resources, in conjunction with governmental assistance.

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