State of Washington
Department of Natural Resources
Division of Geology and Earth Resources
Olympia, Washington 98504

# THE AVAILABILITY OF IRON IN WASHINGTON

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# INTRODUCTION

In 1880, a small blast furnace was erected in Irondale near the city of Port Townsend, in Jefferson County, Washington. This furnace soon proved to be unable to operate satisfactorily and by 1882, it had been torn down and replaced by a furnace of improved design. The first iron ores used at Irondale were ferruginous bog ores from Texada Island, British Columbia. Prior to the arrival of the railroad in the Seattle-Tacoma area, Port Townsend was the port of entry for all vessels entering the state from international waters. Inasmuch as the capacity of the Irondale Plant exceeded the supplies of ore from Texada Island, additional ore, as well as some coal, was brought in from China--reportedly as ballast in the sailing ships that were required to stop in Port Townsend and unload their cargos for customs. Despite numerous changes in design and capacity, as well as raw material and ownership difficulties, the Irondale plant continued producing pig iron and later steel, on and off, until it was closed for good and dismantled in 1919.

During the late 1930's, following the initial development of the world's largest hydroelectric generating facilities along the Columbia River of Washington and Oregon, much attention was focused on the industrial potential offered by the seemingly inexaustible and relatively inexpensive supply of electricity. Many private, state, and federal agencies were actively engaged in promoting the rapid utilization of this new energy pool by any and all possible industrial consumers. In an attempt to boost the incentives or savings to industry by this inexpensive energy, numerous studies promoting the availability of local raw materials were initiated. These efforts, of course, included studies relative to the availability of raw materials that were of particular interest to domestic iron and steel producers, most of which

were, at that time, based in the midwestern part of the nation. As a result of this promotional activity, combined with demands for materials to meet the growing threats of the war in Europe, many deposits containing iron minerals were discovered or rediscovered, investigated, and described in the various commodity inventories of the time.

Following World War II, the traditional domestic sources of iron ore were largely replaced by high-grade imported ores or domestic taconite ores. In the northwest, the energy supplies were still plentiful and inexpensive, and a genuine need still existed for the development of a northwest-based iron and steel industry. Consequently, many of the earlier reported occurrences of iron minerals were reexamined by industrial and governmental concerns and, for the most part, the deposits were determined to be of low or marginal value. Nearly all of these deposits appear even less attractive today (1977) when realistically evaluated in light of established systems of world and national economics, trade, consumption, and defense. Without a doubt, the largest single factor against the acceptability of many marginal deposits everywhere is the worldwide shortage of energy. These, when compared to other long-established sources of metallurgically superior iron, are very energy intensive; that is to say, the value of the energy that would be required to mine and refine low-grade ores today would far exceed the worth of the metal recovered. The known domestic reserves of iron ore, unlike those of nickel or chromium, are still both relatively large and capable of being exploited for many years to come by the various industries which have long been established around the traditional source areas. In the event that completely new, inexpensive, environmentally acceptable, and long-term methods of smelting ore and generating electricity are developed, perhaps many of the nation's smaller lower-grade iron deposits can be

utilized.

The iron deposits studied in this report do not include the iron-nickel deposits of Washington's Blewett-Cle Elum area, nor the ferruginous bauxite ores of southwest Washington. These deposits were included in earlier MAS investigations covering the availability of nickel and(or) aluminum with the state.

It is hoped or anticipated that when the time finally arrives to utilize the deposits reported herein that advances in exploration, mining, and beneficiation will not only enhance the size and value of these deposits but also multiply the number of viable new deposits from which iron may be obtained.

## OKANOGAN COUNTY, WASHINGTON
## BUCKHORN MOUNTAIN IRON DEPOSIT

Property location and access: 48°57'00"N., 118°58'26"W., secs. 13, 14, and 24. T. 40 N., R. 30 E.

The iron deposit of Buckhorn Mountain is located at the head of Gold Creek, which intersects Myers Creek at a point approximately 3 miles (5 km) north of the settlement of Chesaw, in northeastern Okanogan County, Washington.

Access into the deposit area can be accomplished best by proceeding east 20 miles (32 km) to Chesaw from the town of Oroville. At Chesaw, turn north 3 miles (4.8 km) toward the Canadian border to the Gold Creek road. Then, proceed eastward on this dirt road for a little over 4 miles (6.4 km). At this point, the road has attained its maximum elevation of 4750 feet (1448 m) on Buckhorn Mountain. The iron deposit and the old pits and tunnels of the Magnetic mine are located a short distance uphill, to the south, and may be reached via an old road which intersects the Gold Creek road a short distance further to the east. The deposit,

which is within the Myers Creek mining district, is surrounded on all sides, except on the west, by the Okanogan National Forest. Where the Gold Creek road passes through National Forest land, it is identified as U.S. Forest Route 4000 and(or) 4002.

History, production, and ownership

Prospecting for gold, copper, and other metals began around 1890 in the area now known as the Myers Creek mining district, and by the early 1900's numerous claims had been located and were in the process of being explored. According to Zapffe (1949), in 1908 a large body of magnetite containing traces of chalcopyrite was discovered near the 5000-foot (1524 m) elevation on the north slope of Buckhorn Mountain. Eight claims, including the Neutral and the Aztec, were staked on the discovery and the property eventually became known as the Magnetic mine. Subsequent exploration of the magnetite deposit, including some diamond drilling, disclosed a large body of magnetite containing insignificant amounts of gold and copper. By 1920, about 8,000 tons (7257 MT) of magnetite had been mined from several pits developed over the deposit.

Production figures from various published and unpublished sources have been assembled and incorporated in a 1960 property evaluation/exploration summary report prepared by Mssrs. Yokota and Tani of the "Nittetsu" Kogyo (mining) Company of Japan. According to this report, a copy of which is included in the MAS backup file, a total of 87,082 tons (79,000 MT) of ore was mined and shipped to various consumers between 1928 and 1950. Part of the total production, 35,273 tons (32,000 MT), was used for ship's ballast.

Several individuals and(or) incorporated groups have controlled various claims over the deposit throughout the years; however, in 1977 the deposit is believed to be held in entirety by the following company:

Sunshine Valley Minerals, Inc.
Marion R. Bumgarner, pres.
Box 327
Manson, Washington 98831
Phone (509) 687-3613

Geology and description of the ore body

The magnetite deposit of the Magnetic mine and other separate and smaller bodies of similar material on Buckhorn Mountain are essentially garnet-epidote skarns or tactite deposits developed at the contact between an intrusive mass of granodiorite and intruded calcareous metasediments. The following interpretation of the regional geology by Umpleby (1911, p. 17) aptly summarizes the various geological features in and around Buckhorn Mountain:

> The oldest rocks in the area are probably of Paleozoic age and consist of quartzites, slates, schists and limestones with intimately associated intrusive and extrusive igneous rocks of basic composition, all of which have been subjected to a great period of diastrophic movement which resulted in their regional metamorphism. At least part of the series is thought to be carboniferous. Intruded into these are two great batholiths of acid granular rock which show no evidence of having passed through a period of intense crustal movement and are for that reason, together with other considerations taken up later, assigned provisionally to the late Mesozoic. Erosion was the dominant feature of the Tertiary with possibly a period of movement resulting in elevation, at about the close of the Eocene. In the Pleistocene a southward extension of the Cordilleran ice sheet covered the entire area leaving a heavy mantle of drift, much of which remains in situ, especially west of Myers Creek.

The intruded sediments, which appear to form the east limb of a northeastwardly trending anticline, generally strike N. 10° E. to N. 65° E., and for the most part dip steeply toward the east or southeast. Shearing, a prominent structural feature along the contact between the sediments and the intrusive granodiorite, does not appear to have played any obvious role in controlling the development of the iron or tactite deposits. The deposit, in which the Magnetic mine was developed, occurs

within a zone of contact metamorphism roughly 1,500 to 2,500 feet (457-762 m) wide and more than a mile long (1600 m); as can be expected, the intensity of the metamorphism decreases away from the intrusive contact.

According to Zoldok and others (1947) some of the sediments, which are assumed to have been limestone, are completely altered to garnet-epidote tactite near the contact. Binon (1959) speculates that the fine-grained massive green rocks within the metamorphic zone south of the Magnetic mine are probably metamorphosed basic dikes. Pearson's (1967) geologic map of the Bodie Mountain quadrangle identifies these rocks as dikes of fine-grained hornblende diorite.

The principal magnetite body (the Magnetic mine), which may best be described as consisting of at least 3 large zones of magnetite enclosed within a mass of tactite, is over 1,200 feet (366 m) long and 250 feet (76 m) thick. The U.S. Bureau of Mines (Zoldok and others, 1947) drilled seven core holes on the property, one of which encountered magnetite to a depth of 957 feet (292 m). The ore body strikes about N. 60° W. and dips at 50° to 70° toward the southwest. The interrelationship or degree of continuity between the various magnetite zones encountered by the drilling is uncertain. Broughton (1943) suggests that the segments identified in the various mine workings and surface exposures may be either faulted blocks of a single body or the result of mineralization of separate calcareous lenses. The drilling performed later by the Bureau of Mines did not produce sufficient evidence to support or suggest any alternate theories regarding the configuration, extent, and (or) continuity between the various magnetite horizons which were intercepted during the drilling operations.

Mineralogical studies performed by the U.S. Bureau of Mines and others

on the tactite ore revealed that the metallic minerals, in decreasing order of abundance, are magnetite, pyrrhotite, pyrite, and chalcopyrite, together with minor quantities of gold and silver. Large compact masses of pyrrhotite up to several tons in weight are not uncommon in the nonmagnetic garnet epidote tactite which in itself forms the principal gangue material.

Description of the Probabilistic Grade-Quantity-Matrix

The Buckhorn Mountain iron deposit (Magnetic mine), like many other marginally explored ore deposits, represents an extremely difficult type of deposit from which to extrapolate or project concealed dimensions to be used to establish a practical estimate or measure of the tonnage of ore present. Deposits, such as these which appear to lend themselves to study and interpretation by relatively unsophisticated, inexpensive, and often innaccurate geophysical devices (like the Lake Superior dip needle), are bound to receive an excessive amount of attention when compared to some other types of mineral deposits. Unfortunately, a dip needle survey performed under anything but ideal conditions can result in a wide variety of interpretations. This has obviously been the case with this deposit where several surveys, made prior to any drilling, were unable to satisfactorily resolve problems such as size and extent of the ore body, its attitude and its relationship to the parent intrusive, its approximate quality or degree of uniformity, etc. As a result of this lack of agreement between interpretations and the reliance by many observers upon data of a questionable value, a wide variety of estimated tonnage values exist for this deposit.

Additionally, the use of apparently different sampling and analytical procedures has resulted in the production of an equally diverse range of analytical results from one report to another. Because of the incon-

sistency between ore reserve estimates and chemical analyses, it is not now possible to assemble a proper or meaningful Grade-Quantity-Matrix with the data on hand. The information tabulated in the matrix is supplied for purposes of comparison only and must therefore not be interpreted as representing a true picture of this deposit.

The sources of the grade-quantity data supplied in the five columns of the matrix are as follows:

| Column 1 | Reference | Remarks |
|---|---|---|
| 1 | Zapffe, 1949, p. 15-16 | Probably the most accurate assessment of the worth of the Buckhorn Mountain iron deposit. Evaluation and analyses performed by and for the iron industry. |
| 2 | Yokota and Tani report in backup file p. 10, p. 10A | May complement item 1, above. |
| 3 | Hodge, 1938, p. 36. | Source and accuracy of data is uncertain. |
| 4 | Glover, 1942, p. 12 | Estimates appear to be based on insufficient data. |
| 5 | Broughton, 1943, p. 18 | Overly optimistic and based upon questionable data. Analyses performed by other industry chemist for property owner. |

The Buckhorn Mountain iron deposit which, despite its present isolation from the industrial market, may at some future date prove to be a valuable, minable deposit. Any attempt to develop this property should however, be preceded by careful mapping and extensive trenching and drilling followed or supplemented with advanced down-the-hole analytical and geophysical techniques and conventional geophysical methods such as IP, resistivity, VLF and sensitive magnetometry.

It is estimated that from 6 months to 1 year will be required to

establish a mining operation on this property. This estimate includes the time required to design and construct beneficiation facilities. Additional time will be needed to carry out exploration and drilling.

## PACIFIC COUNTY, WASHINGTON

### COLUMBIA RIVER BLACK SANDS DEPOSITS

The state's black sand deposits are excluded from this report because they are almost entirely refractory from a metallurgical standpoint. Most of the magnetite and ilmenite in these deposits, rather than occurring as distinct easily separable grains, instead occur together as microscopic intergrowths, which defy separation by conventional mineral dressing techniques (Thorsen, 1964). Many of the black sand deposits are located within environmentally sensitive areas, such as along shorelines and inlets of the Columbia River. Obviously, any attempts to establish mining operations within these areas would first have to overcome considerable public and legal opposition.

## SKAGIT COUNTY, WASHINGTON

### HAMILTON IRON DEPOSIT

Property location and access: 48°29'56"N., 121°56'51"W., secs, 23 and 24. T. 35 N., R. 6 E., and sec. 30, T. 35 N., R. 7 E.

The area, within which numerous small deposits of iron occur that are collectively referred to as the Hamilton iron deposit, begins immediately south of the town of Hamilton and just south of the Skagit River, in northwestern Washington State. Hamilton is located on State Route 20, 23 miles (37 km) east of Mount Vernon, the Skagit county seat.

Since the western end of the iron "zone" is separated from Hamilton by the Skagit River, the least complicated access route would be to follow Route 20 11 additional miles (18 km) eastward along the river from Hamilton to the town of Concrete. At Concrete, a bridge crosses the river

and links Route 20 with the secondary road which parallels the south bank of the river. Turn west on this secondary road and follow it along the south bank of the river for about 11 miles (18 km) to Cumberland Creek crossing, which is due south of Hamilton. The iron deposits are scattered along a zone beginning near the confluence of the Skagit River and Cumberland Creek (see map in backup file). From this point they outcrop along an arcuate line running a few degrees south of east for about 6 miles ( 9.6km).The deposits range in elevation from about 100 feet (30 m) at Cumberland Creek to nearly 3,000 feet (914 m) along the steep northern slopes of Iron Mountain. Some of them lie within the Mount Baker National Forest.

History, Production and Ownership

The Hamilton iron deposits were initially investigated in 1881. Small quantities of copper, gold, and silver were detected in the deposits and this led early prospectors to believe that the enclosing ferruginous material represented the gossan capping over buried, massive sulfide deposits. Subsequent underground exploration in the form of test tunnels, shafts, and pits failed to reveal any significant sulfides, and most of the prospectors soon diverted their attentions elsewhere.

Several unsuccessful attempts were later made to utilize the iron deposits. A small quantity of the ore was shipped to and smelted by the Irondale furnace, which was in operation until 1919 near Port Townsend in Jefferson County. Since that year there has been no ore production of any significance from any of the Hamilton properties.

During the peak of the copper prospecting activity, numerous claims, including 22 patented claims, were located over the iron deposits. Though none of the unpatented ones appear to have been maintained over the intervening years, the patented claims are still held by various

individuals. According to the Skagit County Assessor's office, the mineral rights of the patented claims are held by Seattle Trust and Savings Bank, Seattle, Washington.

Geology and description of the ore bodies

The Hamilton iron deposits consist of thin, discontinuous lens-shaped bodies of hematite and magnetite which crop out or are developed along a narrow arcuate zone within the pre-Jurassic (Easton) schist of west-central Skagit County. As mentioned earlier the mineralized area arcs southeastward from below Hamilton over Iron Mountain then northeastward to below the town of Birdsview which is about 6 miles (10 km) east of Hamilton.

The Easton Schist enclosing the iron deposits consists for the most part of generally massive, dark-green chloritic schists interlaced with thin black zones or members of graphite schist, thin, light-green epidote schist, and light-gray sericitic members. The schistosity throughout the Hamilton-Birdsview area is well-developed and strikes about north with a steep westerly dip.

Sediments of the (Paleocene) Chuckanut Formation are exposed just to the west of Hamilton. The contact between the Chuckanut and the Easton Schist is the result of a large northwest-trending fault, which strikes through the area just west of Hamilton and Iron Mountain cutting off the schist and any westward extension of the iron deposits.

According to Binon (1959) two types of iron ore are recognized in these deposits. The least prominent ore is banded specular hematite, whereas the bulk of the deposits consist primarily of black, massive, slightly schistose hematite. This material is characterized by an unusually high luster which is imparted by the presence of many fine, flattened, and deformed crystals or blades of the amphibole riebeckite

aligned parallel to the planes of schistosity.

Both thin- and polished-section studies and numerous chemical analyses of the typical ore by Carl Zapffe (1944, 1949) revealed that the ore contains 29.7 percent magnetite, 12.3 percent hematite, 19.2 percent riebeckite, 15.4 percent garnet, 11 percent quartz, 5 or 6 percent tourmaline, 5 percent biotite, and 3.4 percent apatite. The iron oxide minerals tend to occur in narrow bands consisting of very small (less than 100 mesh, 0.149 mm) grains of hematite and magnetite carried in a gangue or matrix of silicate minerals; riebeckite is the most predominant. The ratio of magnetite to hematite ranges from 2.4:1 to 3:1.

The chemical analyses of the Hamilton ores reported by Zapffe and others showed that most of the ore contained between 30 and 36 percent iron, with about 20 percent of this total locked up in the silicate gangue minerals. Metallurgical problems may be encountered when dealing with or attempting to reduce or regulate the effects of the Ti, P, Mn, and $SiO_2$ contained in these ores. It may well be that if and when an iron and steel industry is reestablished in the northwest, these ores may be blended or utilized directly through the application of advanced techniques capable of dealing with these impurities on an individual or collective basis.

Zapffe was of the opinion that these deposits originated as the result of hydrothermal replacement of a shear zone developed in the Easton schist. Binon, as well as others who have also studied the deposits, share the opinion that the iron represents the metamorphosed and weathered remnants of ferruginous sedimentary deposits; probably black sands and heavy mineral concentrations along an ancient shoreline, bar, etc. The wide variety of typical black sand components detected during petrographic studies would seem to support a sedimentary rather than a hydrothermal origin.

Description of the Probabilistic Grade-Quantity-Matrix

In 1940, the Works Progress Administration (WPA) sponsored an investigation of the Hamilton iron deposits as part of a statewide "Minerals Survey Project." All of the exposed deposits of iron between Hamilton and Birdsview were located. The best of these, located within the Gladstone and Legal Tender claims on the north flank of Iron Mountain, were mapped and 54 trenches were excavated across the ore bodies.

Zapffe, utilizing WPA and other data, calculated that the combined lengths of ten ore zones amounted to 5,600 feet (1708 m) and that the average width was 12.75 feet (3.87 m). From the same sources Mr. Zapffe determined that the observable depth of some of the well-exposed or deeply incised ore bodies was over 500 feet (152 m). Calculations based on these dimensions and a measured tonnage-volume-factor of 8 cubic feet per ton demonstrated that 4,462,500 tons (4,048,000 MT) of ore should be available from these deposits to a depth of 500 feet (152 m). This figure, which is based on rather questionable dimensions, obviously cannot qualify for a probability level greater than $P_3$ or 50 percent. Since the only really limiting or unreliable dimension is that of depth, the tonnages calculated to exist at the 10 and 25 percent ($P_5$, $P_4$) probability levels were established by increasing the average width in increments of 5 feet (1.5 m) from 12.75 to 17.75 feet (5.4 m) for the $P_4$ level and from 17.75 to 22.75 feet (6.9 m) for the $P_5$ level.

The average ore grades shown in column 1 are again from figures compiled by Zapffe; they represent the average of 59 samples, which he regarded to be both accurate and reliable.

The estimates for tonnage and grade shown in column 2 of the matrix were compiled by Glover (1942) and simply reflect dimensions established by the WPA survey over a more limited area than those used by Zapffe.

Likewise, the grades for the second column represent the same source area as those in column 1, modified by different analysts and a smaller population of results.

No attempt has been made at this time to anticipate the requirements of a developmental program. The nature and location of these deposits is such that the environmental problems posed by open-pit mining would prohibit their development by this method. By the same token, economic considerations would seriously limit the extent to which underground development could proceed using contemporary mining methods. The positive factor, however, which may assure the ultimate development of these deposits is the rapid expansion of mining and extractive research and development aimed at reducing or eliminating the current necessity for manned underground mining: the application of borehole extraction and in situ leaching techniques must eventually lead to the practical development and utilization of many marginal deposits such as these and thereby enhance the possibilities for the establishment of an iron or specialty steel industry in the Northwest.

An additional benefit or side effect resulting from this expanding research and development effort may be the enhancement of the beneficiation and metallurgical potentials of the Hamilton and similar deposits so that all of the useful constituents of the ore may be controlled and(or) recovered.

The lead-time estimated to produce ore from this deposit is 6 months to 1 year which includes the erection of local beneficiation facilities. Considerable additional time will be required to determine the extent and quality of ore, if any, which may exist between the various ore bodies.

## SNOHOMISH COUNTY, WASHINGTON

### LOCKWOOD PYRITE DEPOSIT

It was originally intended that the large Lockwood pyrite deposit in Snohomish County would be included here, along with the state's other minable iron deposits; however, after careful examination of the data compiled on this deposit, no alternative was left other than to exclude it as an available source of iron. At first it appeared that, despite the submarginal grade of the iron contained in the pyrite, perhaps the property may have more economic value from the standpoint of the combined values in iron, gold, and sulfur. Unfortunately, sulfur, which is the most prominent useful constituent of this deposit, has just recently attained what appears to be a long-term position as a ubiquitous and plentiful commodity. This change in known abundance is due primarily to recently enacted antipollution laws, which require consumer or by-product producer industries to recover unwanted sulfur wastes rather than to discharge them into the environment. As a result of these new regulations, sulfur, which previously would have been acquired elsewhere by consumers, is now often being produced and supplied locally from other than traditional sources. Additionally, the Lockwood pyrite deposit suffers from location and transportation problems. The location of the deposit within the city of Everett watershed, plus its considerable distance away from environmentally acceptable mill or processing sites,have been recognized for many years as almost economically insurmountable obstacles to development.

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# APPENDIX

BUCKHORN MOUNTAIN IRON DEPOSIT

# PROBABILISTIC GRADE-QUANTITY MATRIX

U.S. BUREAU OF MINES
MINERALS AVAILABILITY SYSTEM

Reference Number-E

1 2 State: 53 | 3 5 County: 047 | 6 9 Sequence Number: | 10 Record Identification (1st digit): 6

Average Minable Grades (columns)

| Record Identification | Action Code | Commodity | 14 | 1 (15 19) | 2 (20 24) | 3 (25 29) | 4 (30 34) | 5 (35 39) |
|---|---|---|---|---|---|---|---|---|
| 01 | | IRON | | 57.83 | 036.0 | 55.00 | 62.28 | 62.25 |
| 02 | | PHOS. | | 0.026 | 00.05 | | 0.028 | 0.028 |
| 03 | | SULFUR | | 1.62 | 1.97 | | 0.012 | 0.012 |
| 04 | | ALUMINA | | 02.09 | | | 07.60 | 07.60 |
| 05 | | CaO | | 3.80 | | | 1.10 | 1.10 |
| 06 | | MgO | | 2.27 | | | | |
| 07 | | SILICA | | 07.67 | | 10.00 | 06.75 | 06.75 |
| 08 | | | | | | | | |
| 09 | | | | | | | | |
| 10 | | | | | | | | |

Resource Quantity (thousands)

| Record Identification | Action Code | Probability | 14 15 | 16 24 | 25 33 | 34 42 | 43 51 | 52 60 |
|---|---|---|---|---|---|---|---|---|
| 11 | | P 1 | 90 | | | 45 | 198 | |
| 12 | | P 2 | 75 | 9822 | | 90 | 340 | 4378 |
| 13 | | P 3 | 50 | 13966 | 4575 | 136 | 454 | 14706 |
| 14 | | P 4 | 25 | 13966 | 4575 | 136 | 454 | 16893 |
| 15 | | P 5 | 10 | 13966 | 4575 | 136 | 454 | 16893 |

Year of this Evaulation - E 61 62: 77

HAMILTON IRON DEPOSIT

PROBABILISTIC GRADE-QUANTITY MATRIX

U.S. BUREAU OF MINES
MINERALS AVAILABILITY SYSTEM

Reference Number-E

| 1 2 | 3 5 | 6 9 | 10 |
|---|---|---|---|
| 53 State | Ø57 County | Sequence Number | 6 Record Identification (1st digit) |

Average Minable Grades (columns)

| Record Identification | Action Code | Commodity | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 01 | | IRON | 33.19 | 37.77 | | | |
| 02 | | MANGANESE | Ø6.78 | Ø9.75 | | | |
| 03 | | PHOS. | Ø.556 | ØØ.49 | | | |
| 04 | | SILICA | 3Ø.56 | 24.73 | | | |
| 05 | | ALUMINA | ØØ.5Ø | Ø6.Ø1 | | | |
| 06 | | SULFUR | Ø.134 | ØØ.16 | | | |
| 07 | | TITANIUM | ØØ.3Ø | | | | |
| 08 | | | | | | | |
| 09 | | | | | | | |
| 10 | | | | | | | |

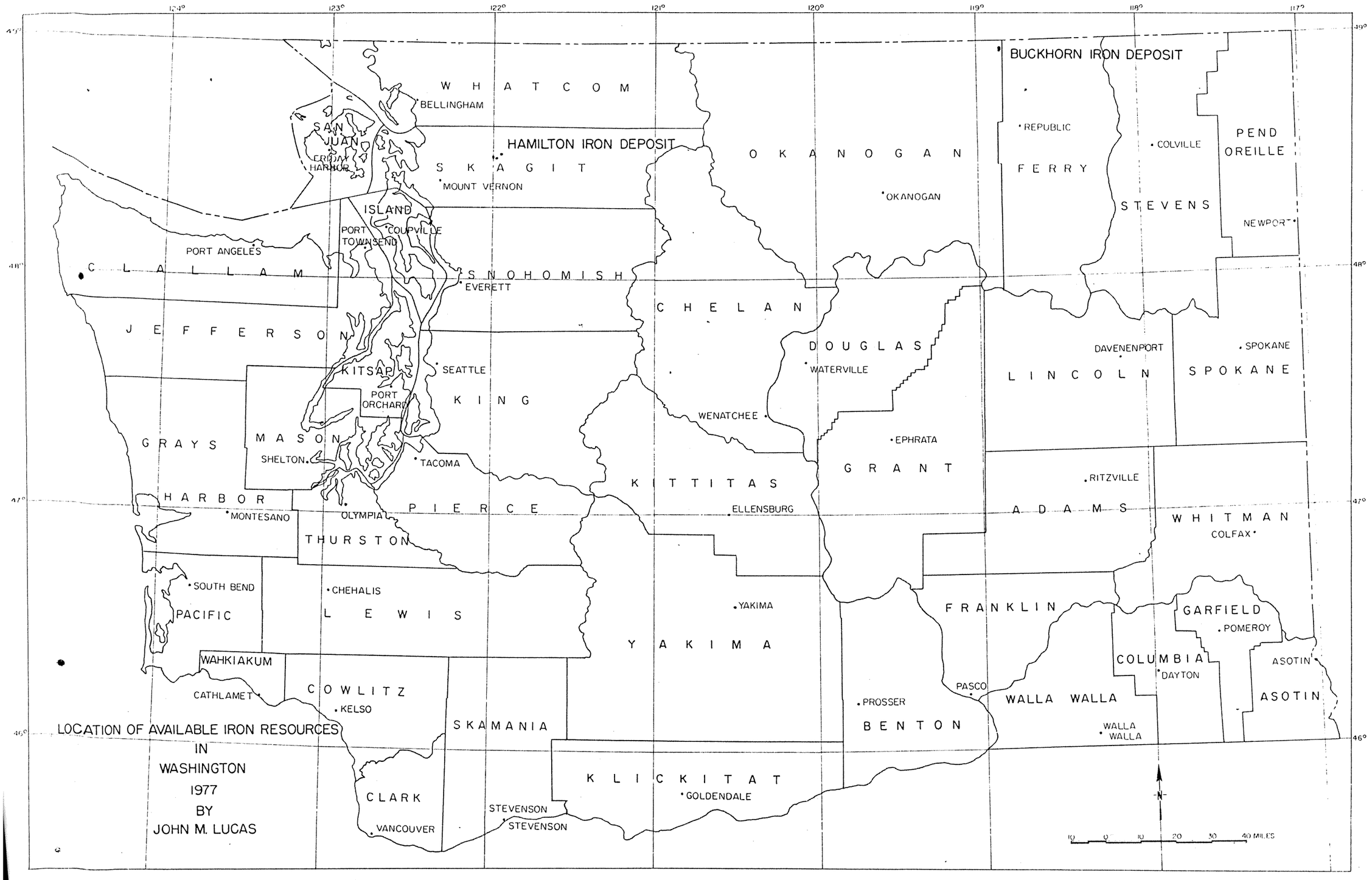
Resource Quantity (thousands)

| Record Identification | Action Code | Probability | 14 15 | 16 24 | 25 33 | 34 42 | 43 51 | 52 60 |
|---|---|---|---|---|---|---|---|---|
| 11 | | P 1 | 90 | | | | | |
| 12 | | P 2 | 75 | | 18 | | | |
| 13 | | P 3 | 50 | 4Ø48 | 9Ø | | | |
| 14 | | P 4 | 25 | 5636 | 453 | | | |
| 15 | | P 5 | 10 | 7224 | 453 | | | |

Year of this Evaulation - E 61 62 77

A-10

20




LOCATION OF AVAILABLE IRON RESOURCES
IN
WASHINGTON
1977
BY
JOHN M. LUCAS