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Chromite Deposits Near Red Lodge and Silver Star, Montana

Edmond F. Smigel

Smigel, Edmond F.

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NEAR

RED LODGE AND SILVER STAR, MONTANA

By

EDMOND F. SMIGEL

A Thesis

Submitted to the Department of Geology
in Partial Fulfillment of the
Requirements for the Degree of
Bachelor of Science in Geological Engineering

MONTANA SCHOOL OF MINES
Butte, Montana
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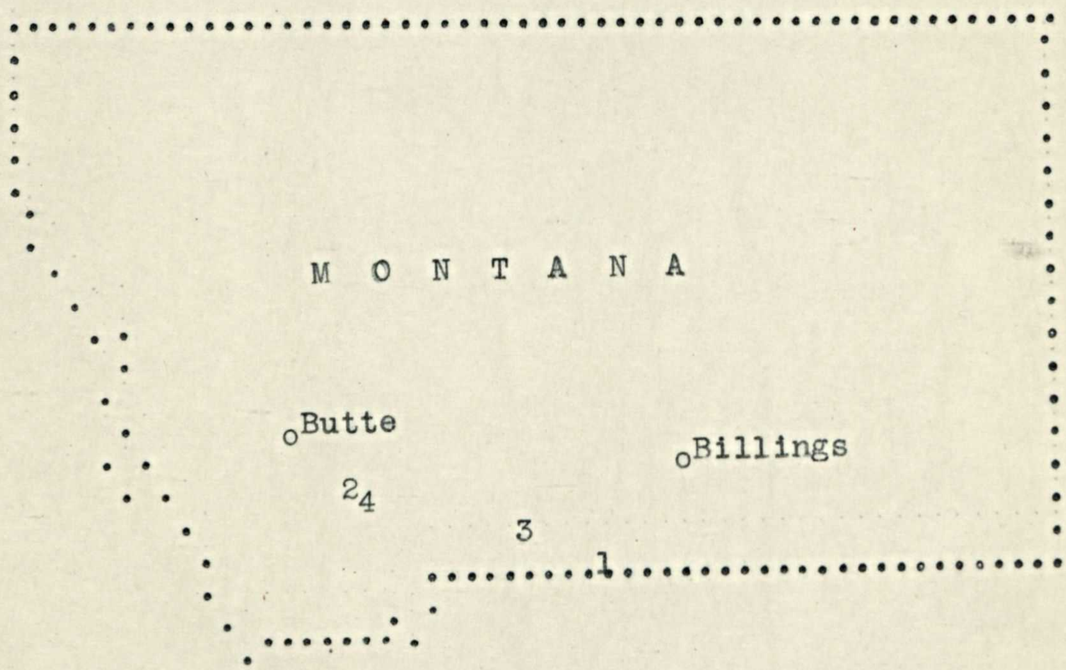
ABSTRACT

The Red Lodge and Silver Star chromite deposits of Montana have stimulated much interest during periods of war. The Red Lodge deposit is 25 miles southwest of Red Lodge which is also the nearest railroad point. Several workings are scattered throughout the area, exposing lense-like ore bodies averaging 33% chrome oxide. Silver Star is a much smaller deposit 5 miles west of Silver Star, Montana, which is its nearest railroad point. Lenses of chromite are exposed by pits and trenches, which average approximately 36% chromic oxide.

The deposits are syngenetic in origin and appear to represent a concentration of chromite due to magmatic segregation. Lenses of chromite occur in ultra basic rocks, namely, peridotite which is altered to serpentine. The gangue minerals include, olivine, chlorite, serpentine, magnetite and enstatite.

MONTANA CHROMITE DEPOSITS



Index map of Montana showing location of chromite deposits.

1. Red Lodge
2. Silver Star
3. Boulder-Stillwater
4. Sheridan

CHROMITE DEPOSITS

NEAR

RED LODGE AND SILVER STAR, MONTANA

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INTRODUCTION

The rapid development of chrome alloy steel and the urgent need for chromite in the United States has created interest in the low grade chrome ores. The demand for the low grade ores has been intensified by the complete shut-off, due to war conditions, of foreign imports of high grade ores. Many deposits of chrome ore in the United States are now below marketable grade, and therefore adjustments in metallurgical plants must be made to handle these low grade ores.

The aim of this report is to present a description of the geology and ore deposits of the Red Lodge and Silver Star chrome districts, and to discuss the future possibilities of each district. The Red Lodge and Silver Star area afford an opportunity to study different phases of geology, including stratigraphy, petrography, structure, and economic geology. This report is based upon field work conducted during the summer of 1941, while working under the direction of the Mineral Resources Survey. The preliminary field work was accomplished by use of a telescopic alidade and plane table. Specimens and samples were collected from the deposits for laboratory studies and assay. Channel sampling was the method employed; however, some float material was also assayed.

During the progress of the field work and laboratory study the writer became indebted to many persons for courtesies which made possible the preparation of this report. Acknowledgement is due to the supervisory staff of the Mineral Resources Survey, and to the Montana Chrome Corporation, for contributing all possible help and the facilities in the mapping and examination, and also in collecting information and in the use of maps and records. Also especial thanks are due to Dr. Eugene S. Perry, head of the Department of Geology of Montana School of Mines,for his many helpful suggestions and criticism; to Dr. George F. Seager, professor of geology, for help and advice in mineral determination; to Dr. S.R.B. Cooke, head of the Mineral Dressing Department, for spectroscopic analyses of the ore samples; to A.F. Carper,field geologist for the U.S. Vanadium Company, whose cooperation and help in gathering field data and mapping of the Red Lodge Highline area is greatly appreciated; to Mr. Edwin Bride for valuable information concerning the concentration of the Silver Star ore; to Mr. Roy H. Earhart for negatives of the Red Lodge and Silver Star deposits.

GENERAL OCCURENCE OF CHROMITE

Chromite is associated with ultra basic igneous rocks of deep seated origin, namely, peridotites, and their metamorphosed equivalents of serpentine and talc. Alteration of olivine is generally to serpentine, the serpentinization occuring along the borders of the grains of olivine and increasing further until finally the entire crystal of olivine may be replaced by serpentine. Chromite does not occur as well defined continous veins, but usually as tabular-shaped bodies called lenses; also small disconnected masses, pockets, kidneys, and chimneys which are scattered throughout the serpentine. The lenses generally occur on the outer portions of the serpentinized body, however in small isolated patches of peridotite this may not be the case. During the cooling of magmas the chromite, as a rule, crystallizes out early in the cooler portion of the mass. Chromite also occurs disseminated throughout the serpentine, but generally in insufficient quantities to be of commercial value.

There has been much discussion as to whether or not chromite is a product of late magmatic differentiation or early magmatic differentiation. Three classes of chromite occurrences as proposed by Fisher[10] and Sampson[26] are as follows: first, chromite earlier than olivine or at the same time; second, chromite later than the olivine; third, chromite from hydrothermal solutions plus metamorphism.

CHROME DEPOSITS OF UNITED STATES

The chromite industry in the United States was unimportant until the advent of war when foreign supplies are cut off. Although the mineral is strategic, very little has been done under normal peace time conditions about the domestic deposits, because of their low grade, and the adequate supply of high grade chrome which can be imported from foreign sources; however, when engaged in war the foreign supplies are reduced or perhaps completely cut off and our low grade deposits consequently become valuable and necessary to the steel industry. Such is the case of the low grade deposits in Montana. The Boulder-Stillwater and the Red Lodge deposits are excellent examples.

California has several small deposits of chromite and has produced in recent years nearly all the chromite mined in the United States. Montana will soon be the important chromite producer in the United States; however, small deposits are known in Maryland, Pennsylvania, North Carolina, and Wyoming.

Principal foreign sources of chromite are: New Caledonia, Rhodesia, Turkey, Greece and the Phillippine Islands. The foreign ores are considerable higher in chromic oxide content and also have a higher chrome to iron ratio.

CHROME DEPOSITS IN MONTANA

Montana has several low grade deposits which are scattered throughout the south central portion of the state. The Boulder-Stillwater deposit in Stillwater county has stimulated much interest, and at present is being worked by the U.S. government under the management of the Anaconda Copper Mining Co. Production is underway and the product will be shipped to metallurgical plants in the east.

The Red Lodge chrome area of Carbon County, although much smaller than the Stillwater, is producing under the mangement of the United States Vanadium Company. Two very small occurrences of chromite are in Madison County, near Silver Star and Sheridan, respectively. These deposits, however small, could be worked and stock-piled. Shipment of the ore could be made from rail centers near each deposit, namely Silver Star, and Sheridan, Montana.

Other small deposits are within the state, but are so small and low grade that at the present time are not commercially important.

ECONOMIC USES OF CHROMITE

During normal conditions chromite finds its chief use in metallurgical products such as ferrochrome alloys, stainless steels, and castings; however, during periods of war chromite is important in the manufacture of war material, such as guns, tanks, planes, and army vehicles. Chromite, when alloyed with steel yields a product which is tough, durable, and stain-resisting, and thus its importance in the above uses. A second important use is in refactory brick, used as a basic lining for furnace, especially in smelting operations. Other uses are in the manufacture of chromium salts, and also in paint pigments.

The content of chromic oxide governs the price fixed for chromite, however, the chrome-iron ratio is also a factor which must be considered. Low silica is desirable. The ores containing a high content of chromic oxide are used in the steel industry, while the low grade ores are used for refractories and pigments.

The United States is an important consumer of chromite, yet has only a small domestic production. At the present time, domestic production is being greatly increased. During 1939 the United States consumption was approximately 321,000 long tons and its domestic production about 3500 long tons. During 1942 the United States expects to increase her production to many several thousands of tons, a great portion of this tonnage coming from Montana, namely the Stillwater, and the Red Lodge deposits.

THE RED LODGE DEPOSIT

LOCATION, TOPOGRAPHY, AND ACCESSIBILITY

The Red Lodge deposit is approximately 25 miles southwest of the town of Red Lodge, Montana, in Carbon County. The chromite occurs in patches, or isolated areas, usually from two to three miles apart. Chromite is observed at each deposit as float or in place. Some development work has been carried on since the beginning of the World War I (1914) in the form of pits, trenches, and tunnels. The deposits are on plateaus which range from 9,000 to 10,000 feet in elevation, and have been named after local geographic features, namely the Hellroaring, Highline, and Silver Run deposits. The Highline deposit is on the plateau adjoining the nationally known switchbacks of the Cooke City Highway thus making this deposit quite accessible. The present production of chromite is from the Highline from which it is trucked to the mill operating in Red Lodge under the supervision of the U.S. Vanadium Company. This company operates under contract with the Montana Chrome Corporation.

The Hellroaring and the Silver Run plateaus are across the canyon and northwest from the Highline area. Accessibility to the Hellroaring deposit is by a road constructed by the U.S. Vanadium Company, which joins the Cooke City Highway approximately 4 miles east of the deposit. The Silver Run deposit, however, is inaccessible at the present time, except by foot or horseback. It requires approximately 3 hours to ride over the rough and steep mountanious trail from the highway to this deposit. One full day from Red Lodge should be planned for a visit to the Silver Run Deposit.

The area as a whole is very rough and the plateaus are divided by Rock Creek and its tributaries. The valleys are U-shaped and glaciated, have very steep walls, and are filled with much talus. The plateaus are spotted with lakes which were formed by morainal dams, and some contain fish. The source of the water for these lakes is from the thawing snow and glaciers. The high peaks in the area are covered with snow throughout the entire year.

GENERAL GEOLOGY

The pre-Cambrian ultra basic rocks in this area occur as irregular, isolated masses which have under-gone intense metamorphism after igneous intrusion. The chromite occurs in serpentine, quite lenticular in form and is covered with from 2 to 6 feet of overburden. Trenches and pits are necessary to expose chromite in place. The chromite lenses range from a few inches to 25 feet in width and are generally steeply dipping. Research work of the Princeton Research Project and Schafer[30] indicates that probably the Red Lodge area may be a portion of the Stillwater Igenous Complex about 25 miles to the northwest which has undergone folding, faulting, and intense metamorphism. Also present in the area are granite, amphibolite and hornblende gneiss. Granodiorite porphyry dikes and sheets with about 45° dips are numerous and particularly noted in the Highline area. Schafer, in his description on the Red Lodge area, pictures the chromite areas as a great "sea" of granite with roof pendants and inclusions of the ultra basic rocks and also with portions of the former rocks adhering to it in places.[30]

Isolation of these serpentinized areas is probably due to the major faulting. The vertical displacement on the Mt. Maurice fault has been calculated to be approximately 2 miles. Numerous minor secondary faults are also noted, but are relatively simple and the faulted rock can be reconstructed.

The ultra basic rocks were probably injected in the form of sills. Magmatic differentiation occurred during the cooling of the bodies, resulting in a separation of acidic and basic rock types, and the concentration of chromite in lense-like bodies in the basic portions.

Since chromite occurs in serpentine, mapping was confined to such areas, and during the trenching program of the Highline and Hellroaring deposits under the supervision of the Montana Mineral Resources Survey, lenses were exposed ranging in width from 1 to 25 feet; however, the lenses were not continuous and could not be traced over 250 feet along their strikes.

GEOLOGY OF ORE DEPOSITS

Particular study of the Highline and Hellroaring deposits was made by the writer, but due to the inacessibility of the Silver Run deposits a detailed examination of this area was practically impossible. However, specimens were collected from Silver Run and a comparison was made with the ore of the Highline and Hellroaring deposits. The specimens indicated a close similarity of the deposits. The average grade of the ore from Silver Run was 32% chromic oxide.

The Highline deposit lies in an irregular serpentinized zone approximately 1000 feet in length and 250 feet in width. Hornblende gneiss, which dips about 65° north occurs on the south side of the serpentine, can be traced for about 1500 feet to the east where it is lost under thick overburden.

The gneiss can be traced in the westward direction considerably further, and is exposed in the road cut of the Cooke City Highway. The contact of the gneiss and serpentine is rather sharp and some chlorite schist was noted within the gneiss. The width of the outcrop of the schist and gneiss is quite uniform, approximately 250 feet. Making contact on the gneiss is a small patch of serpentine lying south of the main serpentinized zone. Pits and trenches disclosed no chromite in this zone. Quartzites are found in contact with the gneiss and schist and extend to the south for a great distance, nearly to the Wyoming line about 1½ miles from the deposit. On the northern portion of the serpentinized zone occurs a quartz feldspar pegmatite with a very sharp contact with the serpentine and it can be traced along the strike to the edge of the plateau in each direction that is to the northwest and southeast.

The ultra basic mass was probably intruded as a sill, differentiated, much metamorphosed, and which later through folding and faulting isolated from its original position.

The chromite occurs in the serpentine in the form of chromite lenses which are very blocky, erractic, and steeply dipping. Octahedral crystals of chromite are conspicuous in the ore. The serpentine structure dips 65 to the north and strikes N.80 E. Serpentine float with minor amounts of chromite disseminated through it was found on the surface of the deposit and served as a guide in prospecting the area. Several pits and trenches exposed chromite lenses on the Highline deposit. This work was a part of the program under the supervision of the Mineral Resources Survey which the writer had an opportunity to direct. No chromite float was found near this deposit; however, this is probably due to the fact that the ore is in such a form that the matrix is readily weathered leaving only a few residual crystals of chromite on the surface.This is probably the reason for the lack of chromite float on the surface of the deposit. Serpentine float containing disseminated chromite serves as a guide in prospecting this area. In contrast the ore of the Silver Star deposit is massive and contains very little silicate mineral, and therefore chromite float is abundant. The chromite float found near the latter deposit occurs as blocks ranging from small sizes up to masses weighing 200 to 300 pounds.

Samples were collected from the lenses in the Highline area, and analyzed. The map of the Highline area shows the geology, location of pits, trenches and samples taken, also the relative size of lenses and associated serpentinized zone.

PLATE I

Fig. 1. View from the Highline plateau looking east toward Red Lodge. Pit and trenches in the foreground. Chromite broken from lenses are shown by arrow.

Fig. 2. View looking south toward Wyoming line from the Highline plateau. Pits and trenches contain chromite lenses and chromite broken from lenses is indicated by arrow.

MINEROLOGY

Samples and specimens were collected from the Red Lodge deposit and the ore constituent is chromite which occurs with serpentine and enstatite, and in most cases altered to antigorite. Microscopic study revealed that the serpentine in most cases was altered; however, associated with small unaltered grains of olivine. In thin section study the chromite occurred as euhedral crystals, sometimes being fractured and surrounded by enstatite which in most cases was altered to antigorite.

The writer pulverized some of the chromite from the lenses and with the use of a magnet found that the chromite lenses contained very little magnetite, in fact when running the magnet through approximately 2 grams of the material, it was found that only 3 or 4 grains of magnetite would appear on the magnet.

Also noted in the chromite ore was calcite which was found as very small veinlets and in most cases noticeable only with the use of a pocket lense.

Spectographic analysis of the ore revealed that it contained very minor amounts of nickle, vanadium, manganese, titanium, and zircon. The gneiss or wall rock adjoining the serpentinized zone was also studied microscopically and found the gneiss was cheifly composed of hornblende, quartz and plagioclose feldspar.

Analysis of Chromite from the Red Lodge Deposit

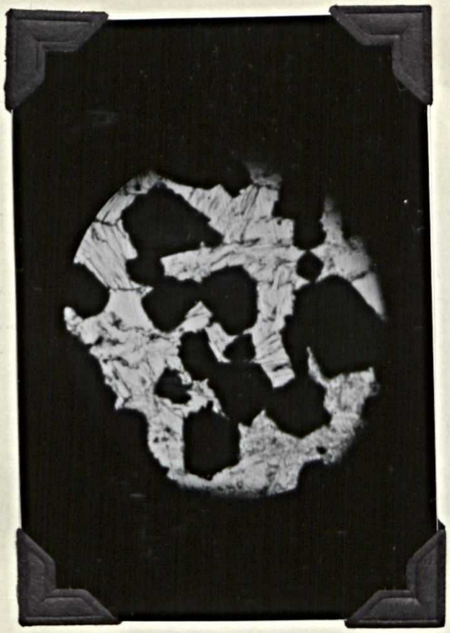
Channel sampling was the method employed. From 5 to 7 pounds were taken per foot of channel and assayed by the Anaconda Copper Mining Company. (See Plate I for Location of Samples)

Field No.	Cr_2O_3 %	Fe	SiO_2	Description
236	2.34*	8.5	35.6	5½' cut in serpentinized rock. Chromite disseminated-42' N.of stake No.8. 20'N. of lense.
235	28.70	13.75	16.3	6' cut in chromite lense. 15'N.of stake No.8. Lense approximately 8' in width.
232	30.0	15.40	15.8	5' cut in chromite lense. 20' So. of stake No.5 20' lense.
231	27.8	14.95	15.6	5' cut in chromite lense. 25' So. of stake No. 5. 20'lense.
233	31.0	15.65	15.8	6' cut in chromite lense. 14' So. of stake No.5. 20'lense.
234	31.8	12.7	16.7	6' cut in chromite lense in trench No.4. 8' lense.
239	31.2			5' cut in chromite lense in trench No. 9.
238	34.80			6' cut in chromite lense in large pit near 1-c. North wall.
240	32.40			6' cut in chromite lense in trench No. 10.
241	30.40			Pick sample in trench No. 11. No width. Very blocky and spotted with chromite.
237	33.30			4' cut in chromite lense in large pit near 1-c. South wall.

* Sample taken in serpentine rock near the chromite lenses.

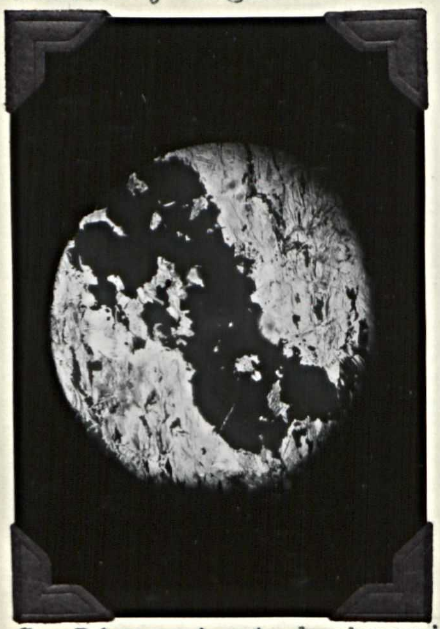
The chrome to iron ratio is approximately 1.5 to 1.

PLATE 2

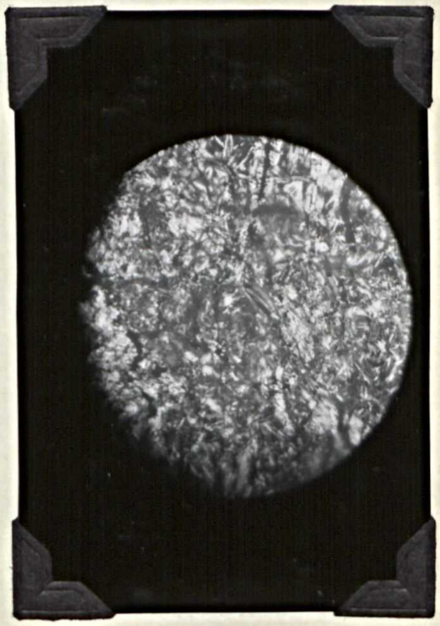


A. Enhedral chromite crystals surrounded by enstatite which is partly altered to antigorite.
Ordinary light x 25

B. Chromite crystals in antigorite.
Ordinary light x 25



C. Disseminated chromite in serpentine and antigorite.
Ordinary light x 25



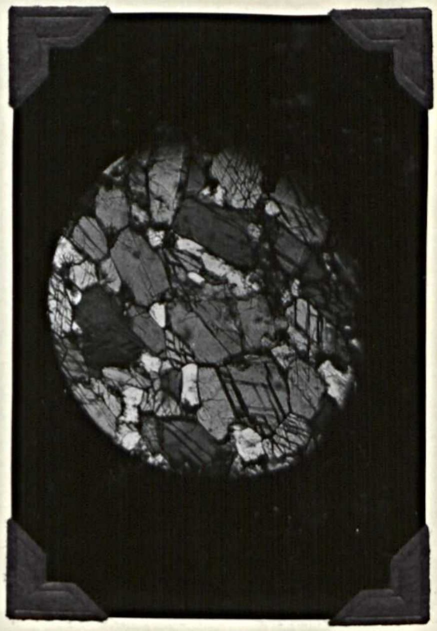
D. Minor amounts of chromite disseminated in antigorite.
Ordinary light x 25

PLATE 3

E. Euhedral chromite, greatly fractured associated with antigorite.
Ordinary light x 25

F. Chromite cut by serpentine and antigorite.
Ordinary light x 25

G. Hornblende gneiss, wall rock of the serpentinized rock.
Ordinary light x 25



H. Hornblende gneiss, wall rock of the serpentinized rock.
Crossed nicols x 25

ECONOMIC ASPECT

Chromite ore should contain from 45 to 50% chromic oxide to be of commercial value; however, few deposits in the United States are of such grade. The ore should be low in silica and iron.

Samples taken by the writer from the Red Lodge deposit show 32 to 34% chromic oxide, about 15% iron and a low silica content. The Highline area was estimated to contain approximately 200,000 tons of ore. The above tonnage was estimated when the area was exposed by pits and trenches as shown on the map of the Highline deposit. Lenses of chromite range from a few inches to 23' in width, but are discontinuous and could not be traced for more than 250' along the strike.

The chromite lenses of the Hellroaring deposit have the same characteristics as those of the Highline, and from the survey made, the Hellroaring is a much larger deposit, covering considerably more area. Due to the erratic distribution of the lenses, and the fact the area was not completely trenched, the writer is unable to estimate the approximate tonnage.

At the present time the U.S. Vanadium Company is working both of these deposits. Roads are being constructed to the Hellroaring deposit. Open pit mining is the method now employed on the Highline, but later when the company is assured of some depth a shaft will be sunk. At present the ore is hauled by trucks to the Red Lodge mill which was constructed by the U.S. Vanadium Co, and concentrates have shown that the ore can be concentrated to a product containing 42 to 45% chromic oxide.

Although the weather during the winter months is severe and considerable snow falls, which generally lasts year-round, the United States Vanadium Co. has endured the winter season (1941-42) successfully.

PLATE 4

General view of Silver Star chromite area looking west. Arrow indicating location of serpentinized rock and chromite.

View looking southwest from bottom of hill. Inked line is the boundary of the serpentinized zone. Dotted inked line indicating gneiss and quartzite contact. (1) gneiss (2) quartzite

View from chromite area looking northwest toward the Aurora mine.

T H E S I L V E R S T A R D E P O S I T

LOCATION, TOPOGRAPHY, AND ACESSIBILITY

The Silver Star chromite deposit is 4 miles west of Silver Star, Montana, Madison County, and in the north half of section 10, T.2.S., R.6.W.

The deposit is approximately one quarter of a mile southeast of the Aurora gold and silver mine which is a well known property in the Silver Star district. Access to the chrome deposit and also the Aurora mine is by a country road which was constructed about 1900. The rough and narrow road has been used to haul ore from the Aurora property for many years and with very little difficulty, however, during the winter months a snow plow must be used to keep the road open. During the spring thaws run off occurs in the area which although damaging the road, does not render it impassible by truck.

The Silver Star chromite deposit discovered during the last world war(1917) consists of several unpatented claims owned by Mr. James Gordon of Silver Star, Montana.

The district lacks timber, but there are good stands of timber 6 miles from the chrome deposit. The mountains rise to approximately 6000 feet of elevation, are gently-sloped, and are cut by many gulches which contain running water only a few months of the year.

The climate is semi-arid, but in common with other mountainous sections of Montana the temperature is generally low and occasional showers may be expected in the summer. Snow can be expected in October, following which it may atain considerable depth and remain until late spring.

There is no electric power near the chromite deposit, but power is available from the Broadway mine approximately $2\frac{1}{2}$ miles northeast of the area, from where a branch line could be run without much difficulty.

GENERAL GEOLOGY

In the Silver Star district the sedimentary formations are of Paleozoic, Mesozoic, and Cenozoic age, although some of the Mesozoic and Paleozoic formations are missing. Also present is a contact metamorphic area which is developed in a block of Paleozoic sedimentary rocks measuring $2\frac{1}{4}$ miles in length, and approximately $\frac{1}{2}$ mile in width. The block is limited on the north and east by granitic rocks of the Boulder batholith; on the west by pre-Cambrian metamorphic complex; and on the south and southeast by alluvium of Jefferson River valley. The granitic rock is easily recognized by its blocky outcrops which weather dark, in contrast to the lighter colored outcrops of limestone. The gneisses and schists in the area have been identified as pre-Beltian in age; however, it is not known whether the formations are Pony or Cherry Creek. There are no Belt rocks in this area, but they are found within eight miles, both to the east and west, and, therefore, it appears probable that they were deposited on these gneisses and schists, and have since been removed by erosion.

Prior to the close of the pre-Cambrian, erosion had reduced the surface to one of low relief. Later followed the marine submergence and sedimentation of the Paleozoic era which resulted in deposition of approximately 2,000 feet of limestone, shales, and quartzites in the Silver Star area. Ordovician and Silurian formations are missing, indicating that emergence and erosion must have destroyed the record of these two periods.

The Livingston agglomerates, of late Cretaceous age, are found in fault contact with the Paleozoic formations, and it is possible that although Jurassic or Triassic sediments cannot be seen they may underlie the Livingston. Following the deposition of the Livingston formation there occurred a period of folding and mountain building in late Cretaceous known as the Rocky Mountain or Laramide orogeny. At a later period wide-spread erosion took place which lowered the land surface. Block faulting occurred in the Miocene, and during this time, the Jefferson River which, had drained to the south, was blocked and the valley filled up to form a lake, resulting in a mature topography as can be seen today on the gently sloping foothills of the Highland Mountains. The Tertiary terrace gravels may have been laid down on the lower portion of these hills during the Pliestocene period.

Gray to black Cambrian (Dry Creek) shales occur, these being about 75 feet in thickness, and resembling those found elsewhere in the state. Above are the Jefferson limestones of Devonian age, which are sugary in texture, and although generally dark gray are locally quite light. The Three Forks shale, of the Devonian, is found along the south side of the Green Campbell Creek, where it is comformably overlain by the Madison limestone. The Amsden formation appears in the area, being very limited and spotty in occurrence. The Quadrant quartzite overlies the Amsden forming a prominent ridge, and is followed by the Phosphoria formation of the Permian age, which here is very thin.

GEOLOGY OF ORE DEPOSIT

The Silver Star deposit lies in a irregular lenticular serpentinized zone approximately 800 feet in length and ranging in width from 50 to 150 feet. Small isolated masses of serpentine were found about 1½ miles southeast of the deposit. These masses are quite small and pits and trenches revealed very little chromite.

The main zone of serpentine lies on the slope of the hill and is bounded by hornblende gneiss, pre-Beltian in age, on the east side and quartzite on the west side. The gneiss dips 34° to the east, striking N 25° E, and is the hanging wall of the serpentine. The quartzite has approximately the same dip and strike and is the footwall of the serpentine. It is the writer's belief that the ultra basic rocks were probably intruded between the contact of the gneiss and quartzite which acted as a plane of weakness. The gneiss can be traced for a considerable distance along its strike and is approximately 1500 feet wide. The formation is quite uniform in dip and strike, and is easily traced on the surface. The massive quartzite which conforms to the dip and strike of the gneiss is quite uniform and easily traced, although much narrower than the gneiss. The width is estimated to be approximately 800 feet. To the west beyond the quartzite pre-Beltian gneiss recurs. The complete area is a repetition of quartzite and gneiss until the Boulder batholith is encountered to the northwest. Eastward there is a similar repetition of gneiss and quartzite until the Paleozoic rocks are encountered about 2 miles from the deposit. The serpentine is much metamorphosed and the chromite occurring in this zone is in the form of lenses which are small and blocky. The chromite is massive and contains 36% chromic oxide.

The zone is well exposed by pits and trenches, which was part of the development work completed by the Mineral Resources Survey in May and June of 1941. While trenching, four lenses were exposed and several samples were taken from the lenses and also from the serpentinized rock surrounding the lenses. From the pits and trenches the lenses appear to be quite continuous and range in width from 1 to 12 feet.

There is considerable chromite float on this deposit, which served as a guide in prospecting the area. As earlier mentioned, some of the float occurs as large boulders weighing from 200 to 300 pounds. The overburden near the top of the hill will average approximately 1½ feet, whereas near the lower end of the zone on the slope of the hill there is about 5 feet.

PLATE 5

Showing 3 foot lense of chromite exposed in a pit surrounded by serpentine. (c) chromite.

View looking east from chromite area. Arrow showing chromite. (1) Highland foothills and the Jefferson River Valley. (2) Snow-capped Tobacco Root Mountains.

PLATE 6

View looking east showing trench in the foreground.

View looking east showing trench in the foreground and the gneiss capping in the background. (c) Chromite from lense in the trench.

MINEROLOGY

The Silver Star chromite is black, massive, non-magnetic, and occurring in lenticular lenses. The serpentine enclosing the lenses is very light colored, and grades into a darker green near the chromite.

Thin section study revealed only very small amounts of silicate mineral, namely, antigorite, and also a few euhedral crystals of pyrope garnet. Owing to the fact that the Silver Star ore contains so little silicate material it is not certain that the ore can be concentrated to a grade higher than it is at present.

Near the surface of the pits and trenches which are in the serpentinized zone, olivine crystals were visible, and where shear zones appeared chrysotile and sericite occurred. Sericite was also visible between the grains of chromite.

Spectrographic analysis of the massive chromite ore revealed such minerals as: zircon, nickle, titanium, manganese, vanadium, and ilmenite.

Analysis of Chromite from the Silver Star Deposit

Channel sampling was the method employed and approximately 5 pounds were taken from each foot of channel; however, where samples were cut in the lenses of chromite the weight was from 8 to 10 pounds per foot. Sampling was carried out on the serpentinized rock as well as the lenses, and were assayed by the Anaconda Copper Mining Company.

Field No.	Cr_2O_3%	Fe	SiO_2	Description
217	36.9			3' cut in chromite lense in bottom of trench No.6. 24' N of stake No. 6.
221	2.25*			4' cut in serpentined rock in bottom of trench No. 5. 4' N of stake No. 5.
220	2.57*			3' cut in serpentinized rock in bottom of pit No. 6 A.
219	37.00			2' cut in chromite lense in bottom of trench No.6. 30' N of stake No.6.
228	22.3	20.0	14.00	3' cut in chromite lense in bottom of trench No.5. 30'N of stake No.5.
216	37.00			4' cut in chromite lense in bottom of trench. 16'N of stake No. 6
218	38.10	21.6	3.12	2' cut in chromite lense in bottom of trench No.6. 30' N of stake No. 6.
226	14.20			5' cut in lense zone in bottom of trench No. 4. Chromite diseminated. 41'N of stake No. 4.

* Samples taken in serpentinized rock. Remaining samples were taken in the chromite lenses.

The chrome to iron ratio is approximately 1.1 to 1.

PLATE 7

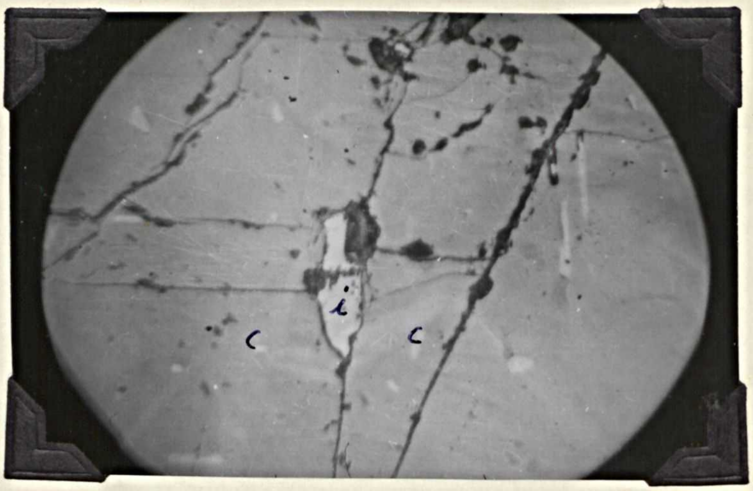


Figure A. Massive fractured chromite showing inclusions of ilmenite(i).x 200.

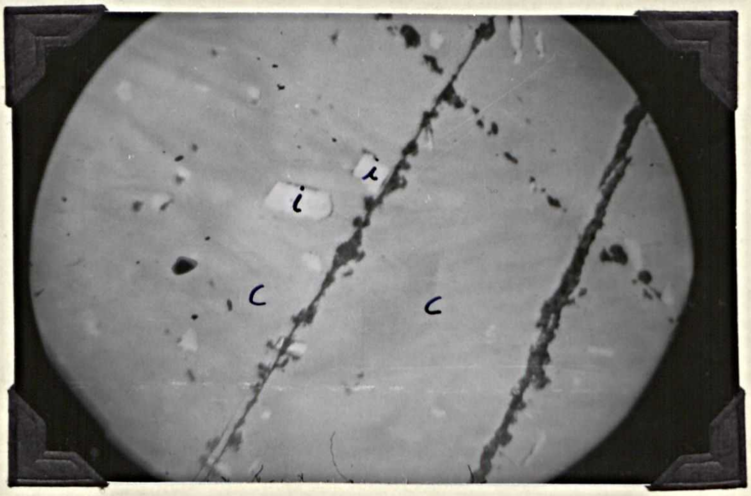


Figure B. Massive chromite showing parallel fracturing with (i) ilmenite inclusions. x 200

PLATE 8

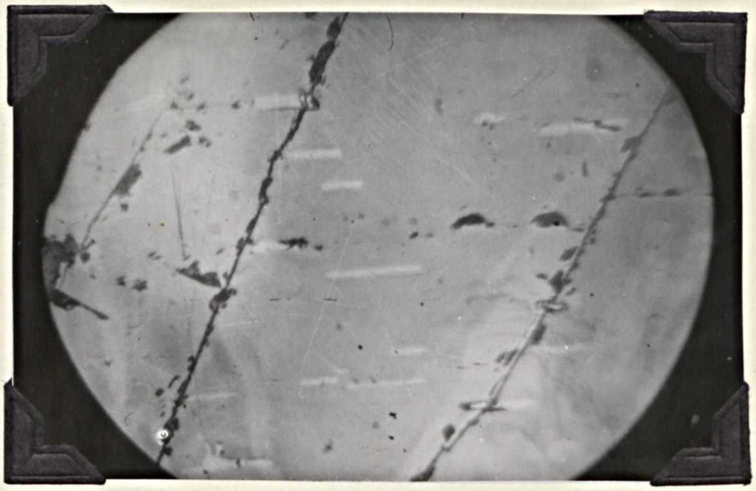
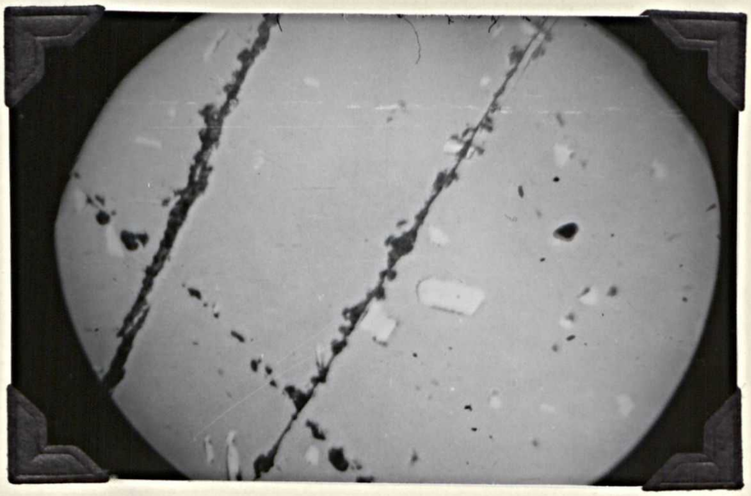


Figure C. Lenticular inclusions of ilmenite in massive fractured chromite. x 200



Serpentine in the parallel fractures within the massive chromite. x 200.

ECONOMIC ASPECT

The Silver Star deposit is small, consisting of small lenticular bodies of blocky, massive, chromite. While trenching the serpentinized zone, four lenses were exposed, and several samples were taken from the lenses, and also from the serpentine near the lenses. The grade of the chromite is 36% chromic oxide, 21% iron and 14% silica.

No depth was determined on the deposit; however, from the nature of the deposit and the geological conditions which exist, it is safe to assume that the lenses in the serpentinized zone should have as much depth as length.

Tonnage on the Silver Star deposit was estimated by the writer to be approximately 10,000 tons. The ore is fairly high grade and probably would have to be shipped directly to the steel companies, as it seems that concentration by hydraulic methods and tabling raises the product 3 or 4 per-cent. This is due to the low silicate content. Experiments have shown that a concentrate could be produced containing approximately 40% chromic oxide. The ore, as mentioned above, contains 36% chromic oxide.

For future development the writer suggests diamond drilling so as to produce information on its depth, as depth seems to be the only factor left in prospecting the deposit.

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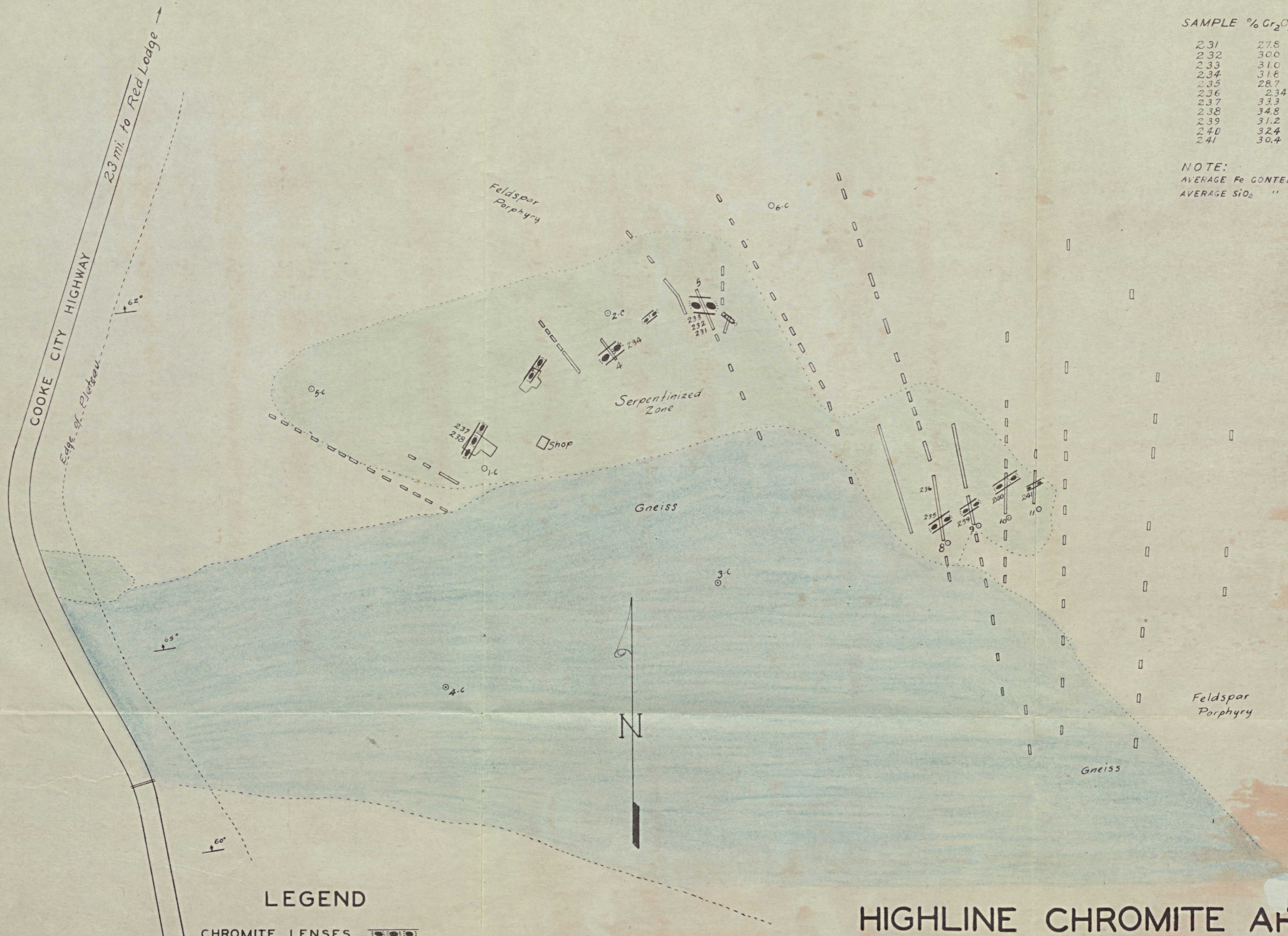
SAMPLE	% Cr_2O_3	WIDTH
231	27.8	5'
232	30.0	5'
233	31.0	6'
234	31.8	6'
235	28.7	6'
236	2.34	5.5'
237	33.3	4'
238	34.8	6'
239	31.2	5'
240	32.4	6'
241	30.4	

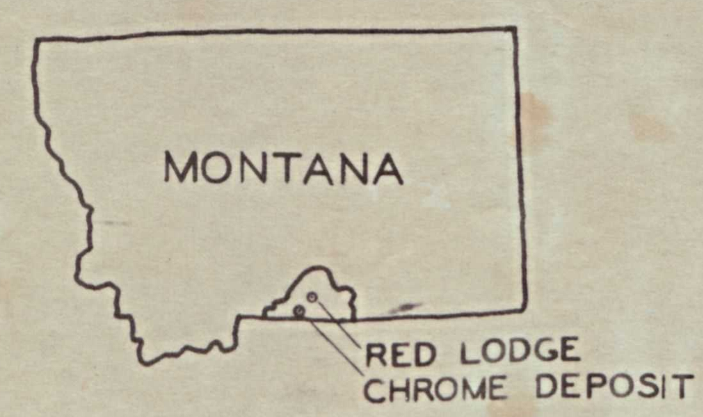
NOTE:
AVERAGE Fe CONTENT EQUALS 14.94 %
AVERAGE SiO_2 " " 16.00 %



LEGEND

CHROMITE LENSES
TRENCH & PIT
SAMPLE NUMBER 231
STATIONS ○ 4-C
STRIKE & DIP 62°

SERPENTINE
PORPHYRY
GNEISS



HIGHLINE CHROMITE AREA

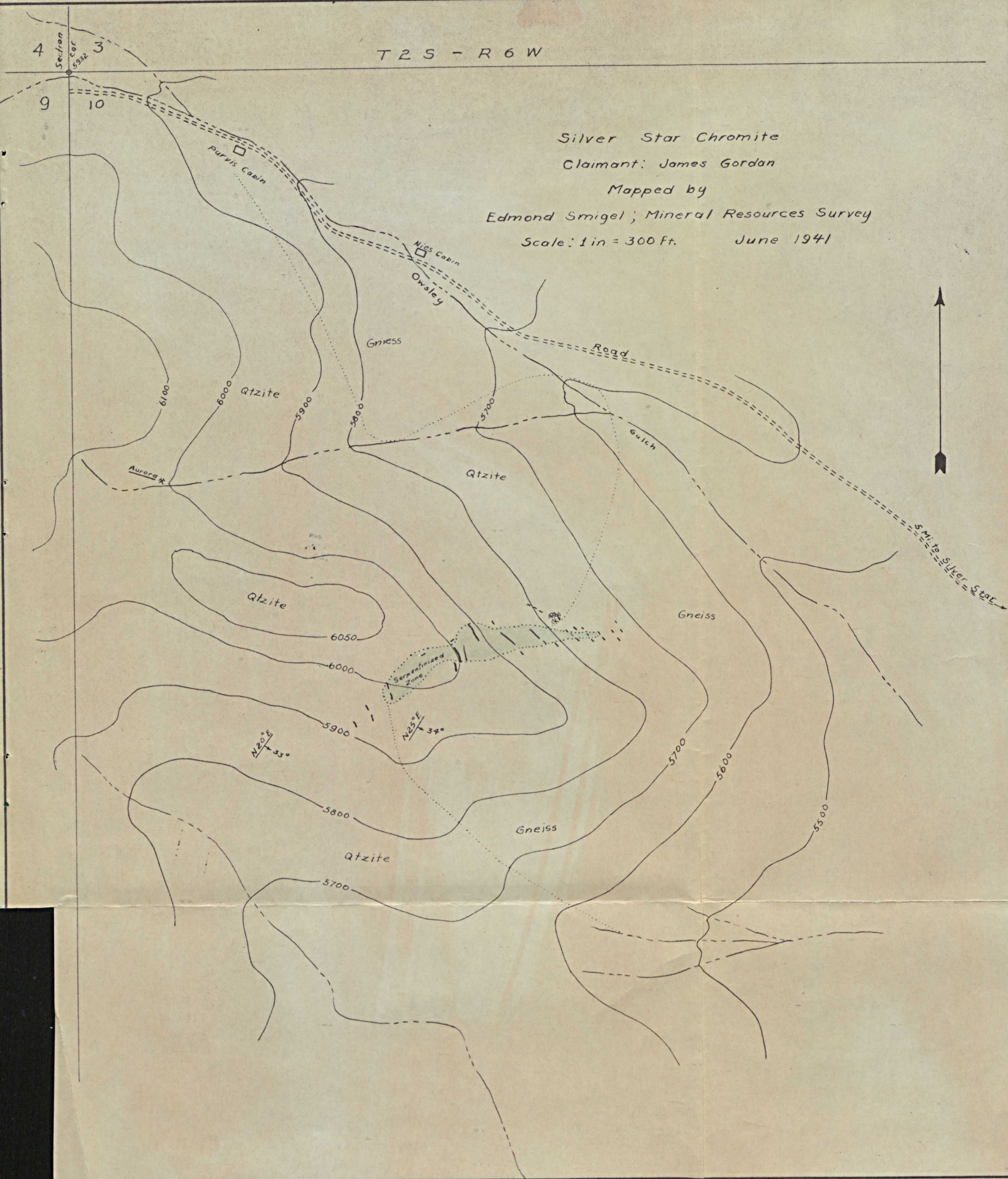
CARBON COUNTY

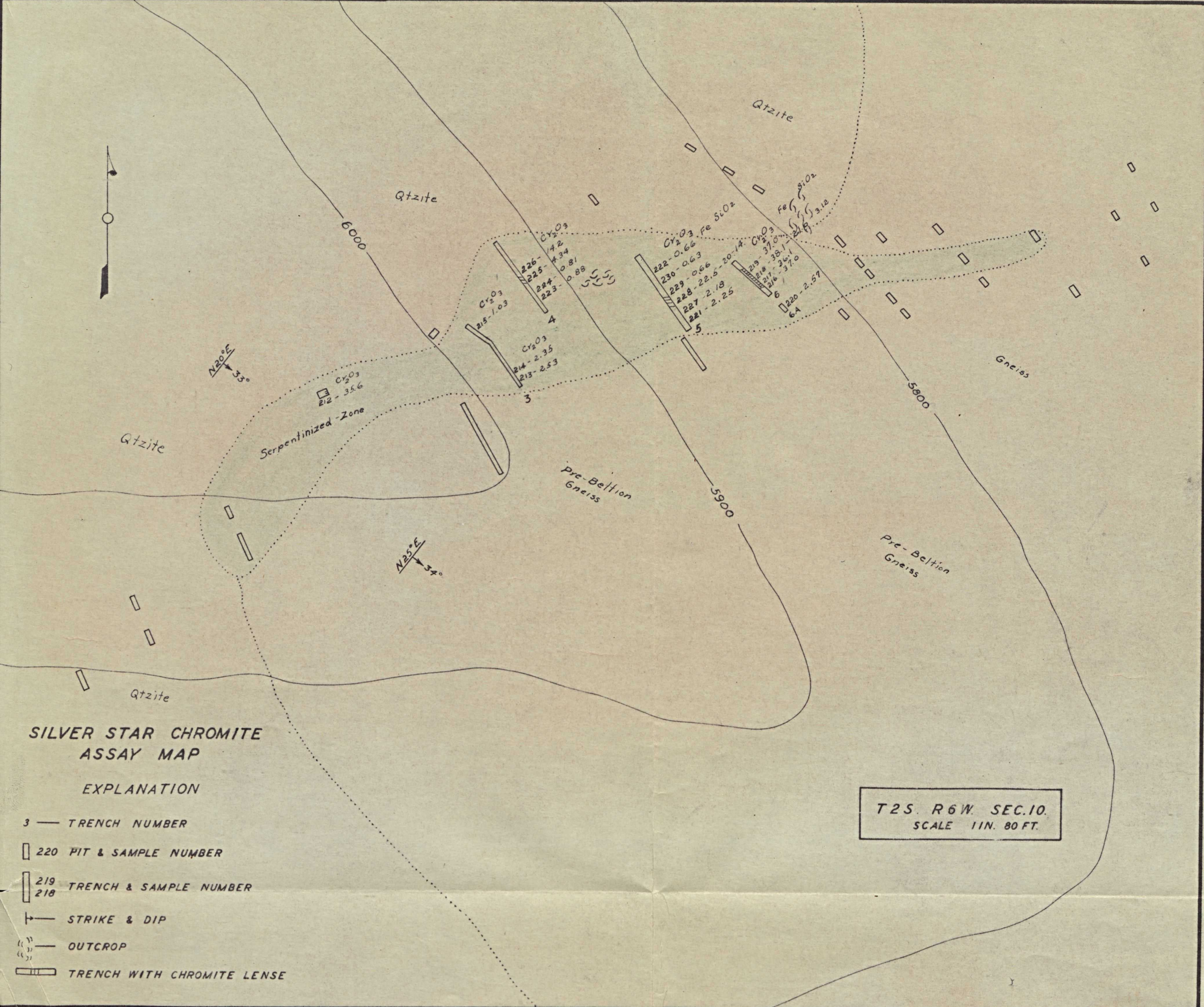
T. 9 S. R. 19 E. SECS. 16, 21

RED LODGE MONTANA

SCALE 1 INCH 80 FEET

EDMOND F. SMIGEL


T2S - R6W
4
3
9
10
Section Cor 5932
Silver Star Chromite
Claimant: James Gordan
Mapped by
Edmond Smigel; Mineral Resources Survey
Scale: 1 in = 300 ft.
June 1941
Purvis Cabin
Nies Cabin
Owsley
Road
Gulch
5 Mi to Silver Star
Gniess
Gneiss
Qtzite
Aurora
Serpentinized Zone
N25°E 34°
N20°E 33°
6100
6050
6000
5900
5800
5700
5600
5500



SILVER STAR CHROMITE
ASSAY MAP
EXPLANATION
3 TRENCH NUMBER
220 PIT & SAMPLE NUMBER
219
218 TRENCH & SAMPLE NUMBER
STRIKE & DIP
OUTCROP
TRENCH WITH CHROMITE LENSE
T2S. R6W. SEC.10.
SCALE 1IN. 80 FT.
Qtzite
Qtzite
Qtzite
Qtzite
Serpentinized-Zone
Pre-Beltion
Gneiss
Pre-Beltion
Gneiss
Gneiss
6000
5900
5800
N20°E
33°
N25°E
34°
Cr2O3
212 - 35.6
Cr2O3
215 - 1.03
Cr2O3
214 - 2.35
213 - 2.53
Cr2O3
226 - 1.42
225 - 4.34
224 - 0.81
223 - 0.88
Cr2O3
222 - 0.66
230 - 0.63
229 - 0.66
228 - 22.5 - 20.14
227 - 2.18
221 - 2.25
Fe
SiO2
Cr2O3
219 - 37.0
218 - 38.1
217 - 36.1
216 - 37.0
220 - 2.57
Fe
SiO2
3.12
3
4
5
6
6A