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# GEOLOGICAL INVESTIGATIONS OF CHROMITE IN CALIFORNIA

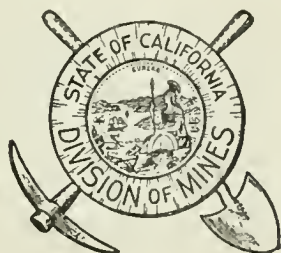
Bulletin 134

PART II — COAST RANGES

CHAPTER 1

## CHROMITE DEPOSITS OF THE NORTHERN COAST RANGES OF CALIFORNIA

By D. H. DOW AND T. P. THAYER  
GEOLOGICAL SURVEY, U. S. DEPARTMENT OF THE INTERIOR





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### ABSTRACT

The chromite deposits in the northern Coast Ranges of California, in Colusa, Glenn, Lake, Mendocino, Napa, and Sonoma Counties, have yielded about 50,000 long tons of chromite since the early eighties. One of the first commercially successful chromite mills in the country, located at the Grey Eagle mine in Glenn County, produced 30,800 long tons of concentrates before the mine was exhausted in 1944. Except for the Grey Eagle mine, production from this region during World War II was very small.

The report consists mainly of descriptions of individual mines and prospects based on published and unpublished information gathered chiefly during the war years 1918-19 and 1941-43. The general geology of the region and of the chromite deposits is outlined, and a complete alphabetical list of chromite mines and prospects is included.

## INTRODUCTION

The chromite deposits of the northern Coast Ranges in California have yielded about 50,000 long tons of chromite, of which about 20,000 tons was lump ore and the remainder concentrates. The southern part of this mountainous area was an important source of chromite in the early eighties, and one of the largest commercial chromite milling operations in the country was successfully completed at the Grey Eagle mine near the eastern edge of the area. This region, therefore, has had an important part in the history of chromite mining in California.

## LOCATION AND ACCESSIBILITY

The deposits described in this report lie within an area of about 7250 square miles which includes Lake and Mendocino Counties, most of Napa and Sonoma Counties, and the western edges of Colusa, Glenn, and Yolo Counties. The area covers the Coast Ranges between the northern boundary of Mendocino County and an east-west line 40 miles north of the Golden Gate (see fig. 1). The region is characterized by narrow, steep mountain ranges that trend northwest and as a group rise toward the northwest. The southern part of the area, where the valleys are wide and the ridges are relatively low, is served by numerous highways and rail lines from San Francisco Bay, and supports about three-quarters of the population of the region as a whole.

The portion north of the latitude of Clear Lake is rugged, and the peaks attain altitudes of 7000 to 8000 feet; some areas are almost inaccessible. The principal transportation routes in Mendocino County are U. S. Highway 101 and the Northwestern Pacific Railroad, which follow the Russian and Eel Rivers. The eastern margin of the region is served by roads along the west side of the Sacramento Valley. Most of the roads in the mountains are narrow and graded but otherwise unimproved, and ore haulage over them is impractical in wet weather.

## HISTORY OF MINING

Chromite deposits in Lake, Napa, and Sonoma Counties are first briefly mentioned in the report of the State Mineralogist for 1884 (Hanks, H. G. 84, p. 137) with the statement that 2000 tons of ore from a deposit of float 4 miles south of Cloverdale, Sonoma County, was sold by Edward Barnes to three buyers at \$7.50 and \$10.00 a ton. The cost of the ore on the dock at Petaluma was said to be \$3.50 a ton. The production from the northern Coast Ranges up to 1900 is estimated at about 7300 tons; the accuracy of this estimate is indicated by the following statement (Hanks, H. G. 84, p. 138):

"In attempts to gain information as to the quantity of [chromite] ore raised in California, the State Mineralogist has met with so much opposition from those who are interested to conceal the amount that no reliable data can be given."

The total production appears to be slightly more than 50,000 long tons (see table 1).

During the period 1916-20 chromite production was stimulated in the region as a whole by wartime demands, and in the southern part by the needs of a tannery at Napa. The operators of the tannery, the Sawyer Tanning Company, purchased high-grade ore either delivered at the plant or at the mine, and leased and operated a few mines in

Table 1. Shipments of chromite ore and concentrates from northern Coast Ranges of California, by counties, from 1915 to 1944 (in long tons)

Year	Glenn	Lake	Mendocino	Napa	Sonoma	Total
1915	893					893
1916	*3,000	385		312	104	3,801
1917	317	980		331	143	1,771
1918	1,309	477	571	1,301	822	4,480
1919						
1920		68	187			255
1921-27						
1928			166			166
1929			39			39
1930-34						
1935				67		67
1936				64		64
1937				64		64
1938				20		20
1939				20		20
1940				30		30
1941				300		300
1942	9,846		25			9,871
1943	17,810	13				17,823
1944	3,150	66		52	71	**3,345
Totals	36,325	1,989	988	2,561	1,140	43,009

\* Estimated.

\*\* Includes 6 tons from Colusa County.

Napa and Sonoma Counties. Shipments officially reported to the Geological Survey during these years amounted to 8200 long tons, in addition to which production in Glenn County during 1916 was estimated at 3000 long tons<sup>1</sup>. The shipments reported in 1920 probably came from stock piles left at the mines at the end of the war.

Shipments between 1935 and 1943 were from two main sources. The 565 tons shipped from Napa County between 1935 and 1941 probably was taken in part from mine stocks estimated at 655 tons at the end of 1918. The Glenn County production in 1942, 1943, and 1944 came entirely from the mill operated at the Grey Eagle mine by the Rustless Mining Corporation.

Most of the chromite shipped, except that from the Grey Eagle mill, was high-grade ore averaging 45 percent or more  $\text{Cr}_2\text{O}_3$ , and was mined from small deposits. The mill at the Grey Eagle mine treated ore from the Grey Eagle and Black Diamond No. 11 claims, and produced concentrates which averaged about 46 percent  $\text{Cr}_2\text{O}_3$  with a chromium-iron ratio of 2.67.<sup>2</sup> Although a few deposits of disseminated ore, in addition to the Grey Eagle deposit, have been mined, shipments have been limited to sorted high-grade ore.

#### SCOPE OF REPORT AND ACKNOWLEDGMENTS

Although substantial amounts of chromite have been shipped from the northern Coast Ranges, the Grey Eagle is the only mine that has been worked on a large scale since 1918. As the high prices during World War II failed to stimulate production in this region, examinations made as part of the chromite investigations of the Federal

<sup>1</sup> Diller, J. S. 19, p. 31, and unpublished data of the U. S. Bureau of Mines.

<sup>2</sup> Rustless Iron and Steel Corporation, written communication, 1945.

Geological Survey were limited to a few of the larger mines, and no systematic attempt was made to visit all reported chromite prospects. Many prospects, however, were examined and accurately located during geologic mapping of serpentine masses in connection with the Survey's quicksilver program. The present report is based on examinations of the larger deposits by Survey geologists between 1941 and 1945, and on unpublished data gathered by engineers of the U. S. Bureau of Mines, the California State Council on Defense,<sup>3</sup> and the State Division of Mines between 1916 and 1918. Although much of the information is sketchy and incomplete, it seems desirable that the available data be compiled and made a matter of public record. The descriptions of deposits, accordingly, include the most complete information available, which in many instances was obtained when the mines were in operation during World War I. Deposits for which descriptions and maps have recently been published are not redescribed in this report, but reference is made to the publication in which the description appears. As in most mining districts, many reports of production are contradictory and cannot be reconciled; the reader therefore may find unexplained discrepancies between officially reported and unofficially estimated production from certain deposits. The tables show only production reported to the Geological Survey or Bureau of Mines for the annual volumes of *Mineral Resources of the United States*.

This summary has been compiled by D. H. Dow and T. P. Thayer from reports, published and unpublished, by F. G. Wells, F. W. Cater, Jr., and Fred Gros, of the Federal Geological Survey; F. B. Caldwell and others of the Federal Bureau of Mines; and E. F. Davis of the Committee on Geology and Mineral Resources of the California State Council on Defense. Most of the information dating from World War I was compiled as a project of the Works Progress Administration, under the auspices of the California Division of Mines and the supervision of Olaf P. Jenkins, Chief Geologist.

#### GENERAL GEOLOGY

Although the northern Coast Ranges have been mapped only in part, they are known to be geologically similar to the central Coast Ranges, which have been well studied in the search for oil, and were described by Taliaferro (41).

The bulk of the ranges is made up of rocks of the Franciscan group and Knoxville formation of Upper Jurassic age. The Franciscan group is composed of many different kinds of rocks, the chief ones being arkosic sandstone, radiolarian chert, pillow lavas, basic and ultramafic intrusives, and metamorphic rocks closely related to glaucophane schist. The Knoxville formation contains rocks similar to the Franciscan, which it overlies, but in most places consists mainly of shale, with sandstone and conglomerate in less amounts. The ultramafic rocks or serpentines which carry the chromite deposits were intruded into the sedimentary series as sill-like sheets, which are most numerous and largest in the upper part of the Franciscan group and the lower part of the Knoxville formation. The serpentines have been intruded by dioritic and more basic rocks which grade into diabase.

<sup>3</sup> For a description of the work of this Council, see Jenkins, O. P. 43, pp. 9-10.

Younger rocks, which range in age from Cretaceous to Recent and show great diversity, are present in many parts of the region.

The structure of the ranges is dominated by folds and faults which break the rocks into narrow blocks that trend north-northwest. The serpentines form lenses up to 15 miles long by 2 miles wide and are distributed in irregular belts parallel to the major folds and faults. Many of the lenses are localized along the contact between the Franciscan group and Knoxville formation; they commonly dip more steeply than the enclosing formations, and therefore are not true sills.<sup>4</sup>

The serpentines were derived from chromite-bearing peridotitic rocks by alteration which may have immediately followed intrusion or may have been much later. The original rocks appear to have been mainly saxonite, composed of olivine and enstatite, accompanied by subordinate masses of dunite and pyroxenite. Although some of the intrusive bodies are massive, most of them are sheared, especially along their contacts. The contacts between serpentine and country rock have been faulted in many places, probably by movements which took place after the rocks had been serpentinized. Some of the serpentine has been converted into a hard silica-carbonate rock in which many quicksilver deposits have been localized. For a fuller discussion of the general geology of the region, and detailed descriptions of areas in which geological relations are well shown, the reader is referred to two recently published reports on quicksilver deposits by Paul Averitt (45) and R. G. Yates and L. S. Hilpert (46) of the Geological Survey.

#### CHARACTERISTICS AND OCCURRENCE OF CHROMITE

The only ore mineral in the chrome deposits is chromite, a dark, submetallic mineral which is characterized by a brown streak and specific gravity ranging from about 4.1 to 4.9. Its composition is indicated by the general formula  $(\text{Mg,Fe})(\text{Cr,Al,Fe})_2\text{O}_4$ ; cleaned chromite from Coast Range deposits averages 50 to 55 percent  $\text{Cr}_2\text{O}_3$ , and has a chromium-iron ratio between 2.5 and 3.2. Chromite occurs as irregular pods and lenses in dunite—a rock composed entirely of olivine—or its altered equivalent. High-grade ore consists of massive chromite mixed with a minimum of gangue; low-grade ores are mixtures of chromite and gangue in various proportions, and commonly grade into barren dunite or serpentine. In districts which, like the Coast Ranges, have been highly deformed, the bodies of high-grade ore usually are bounded by faults and can be readily mined out. Bodies of low-grade or disseminated ore, however, may be intimately mixed with barren serpentine by complex faulting and therefore may be difficult to mine.

The chromite deposits in most peridotites appear to be distributed at random, and no reliable guides to concealed ore bodies have been found. Many ore bodies are alined in shear zones, probably as a result of shearing of large deposits into a number of smaller lenses. In those places, therefore, where shear zones are known to contain ore bodies, prospecting should be concentrated along the strike of the zone. Most shear zones, however, are probably not much more favorable prospecting ground than any other parts of a given peridotite mass.

<sup>4</sup> Yates, Robert, personal communication, 1945.

## RESERVES

The lack of response of mining in the northern Coast Ranges to high prices for chromite is probably the best index to the reserve situation. The accessible parts of the region, particularly in Napa and Sonoma Counties, have been thoroughly prospected, and the high-grade ore bodies have been mined out. The largest locally known low-grade ore body, at the Grey Eagle mine, has also been exhausted. The possibilities for future production therefore would seem to be limited to relatively small low-grade deposits that are accessible, and to undiscovered deposits in unprospected areas. The estimates of reserves given may be changed considerably by future developments, for information on most low-grade deposits is incomplete.

The reserves of milling-grade ore are estimated as equivalent to about 4400 long tons of  $\text{Cr}_2\text{O}_3$  or 8800 long tons of concentrates containing 50 percent  $\text{Cr}_2\text{O}_3$ . The approximate quantities of ore of various grades are as follows: 4000 long tons averaging 20 percent; 29,000 tons averaging 12 to 13 percent; 5000 tons averaging 10 percent; and 12,000 tons averaging 6 percent  $\text{Cr}_2\text{O}_3$ . More than half of these reserves are in 12 deposits in the vicinity of the Grey Eagle mine, and the rest are in the Laton, Sonoma Chrome, Inc., and Holmstedt mines, in Napa and Sonoma Counties. Development of significant reserves, even of milling-grade ore, obviously, depends on new discoveries.

Discovery of large deposits of high-grade ore in Napa, Sonoma, and southern Lake Counties seems improbable. The high prices during World War I apparently led to exhaustion of many deposits, and the Sawyer Tanning Company mined out most of those remaining at the end of the war. The lack of new discoveries of high-grade deposits between 1941 and 1943, in view of government aids such as access roads, does not augur well for future production, even in less-explored areas.

## MINES AND PROSPECTS

In the following descriptions, the deposits are numbered and arranged alphabetically by counties. The names most commonly used appear first, followed in parentheses by others by which the deposit may also be known currently. Deposits which are identified by number on the Economic Mineral Map of California<sup>5</sup> are indicated by the corresponding number in brackets.

The source of unpublished information on deposits is indicated by the name of the person reporting, followed by the initials of the organization and the last two figures of the year in which the mine was examined. The abbreviations used are as follows: G.S., Geological Survey, Department of the Interior; B.M., Bureau of Mines, Department of the Interior. All published and some unpublished reports to which reference is made (i.e. Averill, C. V. 29, etc.), are listed in the *Bibliography* at the end of this report.

## Colusa County

Six chromite prospects in Colusa County, none of which apparently has shipped any ore, are listed in Bulletin 76 of the California State Division of Mines (Bradley, W. W. 18, pp. 123, 124). Three of

<sup>5</sup> Outline geologic map of California showing locations of chromite properties; Economic Mineral Map of California, No. 3—Chromite: California Div. Mines, 1942.

these, the Chrome Wonder (1), Liberty chrome mine (3), and Teathers chrome prospects (5) are in the vicinity of Stony Ford (T. 18 N., R. 6 W.<sup>6</sup>) and may be the ones to which Taliaferro (C.S.C.D. 18) refers as near Fouts Springs (T. 17 N., R. 7 W.). The F. C. Innes prospect (2) was reported to be near Wilbur Springs (T. 14 N., R. 5 W.), and the Princess chrome mine (4) about 1½ miles northwest of Cook Springs, in T. 16 N., R. 6 W. No location was given for the Stella chrome mine, owned by Elmer and George Evans of Sites.

#### Glenn County

*Avery Claims.*—Oscar Avery was said to have three claims 18 miles from Fruto, from which he had mined 80 tons of disseminated ore. R. D. Adams and Company sampled the deposit, but apparently found it to be too low grade to work. The distance from Fruto suggests that this deposit may be near the Black Diamond group, but because of the uncertainty in location it has not been plotted on the index map. (Thompson, H. 18.)

*Black Diamond or Grey Eagle Group (1)* [87, 88]. The Black Diamond or Grey Eagle group of claims covers a number of chromite deposits in secs. 13, 14, 24, and 25, T. 22 N., R. 7 W., and sec. 19, T. 22 N., R. 6 W. For simplicity in description, the following claims are included in this group, although they belong to various owners: Black Diamond, Black Diamond Nos. 2 to 12, Boulder City, Emmeline, Grey Eagle, Grey Eagle Extension, Hooligan, Hospital Ridge, Katherine, Loleta, Manzanita, Manzanita Extension, and Mary Ellen. As all the deposits on these claims were mapped in detail and described as of January 1, 1944, only the developments since then will be reviewed here.

The Rustless Mining Corporation mined 135,800 long tons of ore from the Grey Eagle mine and 640 long tons from the Black Diamond No. 11 claim between February 1942 and March 1944. The ore was mined in open pits, and about 878,000 long tons of overburden was handled, making the ratio of waste to ore about 6.5 to 1. The ore averaged 13 percent  $\text{Cr}_2\text{O}_3$  and the mill produced 30,806 long tons of concentrates averaging 46 percent  $\text{Cr}_2\text{O}_3$ , indicating a recovery of slightly more than 80 percent of the chromite. The tailings averaged 3.33 percent  $\text{Cr}_2\text{O}_3$ . Exhaustion of the Grey Eagle and Black Diamond No. 11 deposits forced the mill to close down, and the inability of the Rustless Mining Corporation to mine the nearby deposits when it had the mill in operation does not seem promising for the future of the district. (Rynearson and Wells 44.)

<sup>6</sup> Meridian is Mount Diablo throughout.

#### *Shipments of chromite from Glenn County mines, 1916-44 (in long tons)*

Mine	1916	1917	1918	1942	1943	1944	Total
Black Diamond group.	*3,000	317	1,309	-----	-----	-----	4,626
Grey Eagle and Black Diamond No. 11	-----	-----	-----	9,846	17,810	3,150	30,806

\* Estimated.

*Conklin and Williams Claims (2).*—Claims were held by Wells Conklin and Ed Williams of Newville on two deposits three quarters of a mile apart in sec. 3, T. 22 N., R. 7 W. A chromite lens 2 feet wide was exposed on one claim, and about 100 tons of high-grade ore had been mined from six lenses on the other claim. None of the ore had been shipped in 1918. (Bradley, W. W. 18, p. 147.)

*High Point Mine (3).*—The High Point mine is described as in the Newville mining district, 32 miles west of Orland. There were three claims on a deposit on top of a rough barren mountain, where open cuts exposed the main deposit over a length of 250 feet. The ore consisted of irregular streaks of disseminated chromite, and the ore body as a whole was said to strike north and dip 60° W. The grade of the ore averaged less than 40 percent  $\text{Cr}_2\text{O}_3$  and reserves were estimated as 200 tons of blocked-out ore, 250 tons of probable ore, and 1000 tons of possible ore. Apparently the deposit contained very little ore of shipping grade. (Thompson, H. 18.)

*Manzanita Mine (6).*—The Manzanita mine is in the NE $\frac{1}{4}$  sec. 31, T. 22 N., R. 6 W., on the Cushman ranch. The workings were caved in 1942, but available evidence indicated possible reserves of milling-grade ore in excess of 1000 tons. The mine yielded 79 long tons of lump ore in 1917. (Ryncarson and Wells 44, p. 22.)

*Swastika Claims (7).*—The Swastika claims in secs. 4 and 5, T. 18 N., R. 6 W., 4 miles north-northwest of Stonyford, were owned by A. E. Brune and leased to A. H. Noyes in 1917. A deposit of exceedingly fine-grained, high-grade ore was opened up by an open cut and a short tunnel. The chromite occurred as small irregular pockets in soft light-green serpentine. About 40 tons of ore had been mined and 10 tons was exposed in the tunnel in August 1917. (Taliaferro, N. L., in Louderback, G. D. 18.)

#### Lake County

Twenty-seven chromite mines or prospects in Lake County have been examined and described by State or Federal engineers or geologists. With the exception of the Cabbage Head claim in the northern part of the county, the deposits fall into two groups, western and eastern. The western group is rather indefinite, but the eastern is well defined and apparently related to a major belt of serpentine which extends southward into northeastern Napa County. The deposits included in the southeastern corner of the western group are, likewise, in the northern end of a serpentine belt which extends into Napa County (see fig. 1). The descriptions of deposits, accordingly, are arranged alphabetically in two groups.

#### Western Group

*Black Bart (Great Western) (1) [90].*—The Black Bart mine is in sec. 16, T. 10 N., R. 7 W., on patented land owned in 1942 by W. B. Shepherd of Monticello and leased to the Anglo-American Mining Company, of Clovis. It is on a steep hillside about 2400 feet above tide and several hundred feet above the Great Western quicksilver mine. Reports of production differ: in Bulletin 76 (Bradley, W. W. 18, p. 149) the mine is credited with 125 tons of ore carrying 45 to 50 percent  $\text{Cr}_2\text{O}_3$ , but Davis (Louderback, G. D. 18) said it shipped 400 tons of ore averaging 48 percent  $\text{Cr}_2\text{O}_3$ . Davis' figure seems rather high,

*Shipments of chromite from Lake County mines, 1916-43 (in long tons)*

Mine or shipper	1916	1917	1918	1920	1943	Total
Black Bart.....			153			153
Lucky Strike.....	385	975				1,360
Sawyer Tanning Co.*.....			168			168
The Deere (T. Smythe)*.....			51			51
Others*.....		5	105	68	13	191

\* Source of ore or location of mine uncertain.

although it is probable that at least 150 tons were shipped to the Sawyer Tanning Company.

The ore ranged from massive high-grade chromite to low-grade disseminated ore, and from 20 to 50 percent  $\text{Cr}_2\text{O}_3$ . The high-grade ore was very irregularly distributed in the various ore bodies, and much of it was broken and friable. Most of the contacts between ore and serpentinite were faulted, and the serpentinite wall-rock was highly sheared.

Mining was started in 1918 on a massive chromite lens 10 to 15 feet long by 5 to 6 feet wide, which trended east and apparently dipped south. The east end of this lens split into three stringers each up to a foot thick; all were followed 40 to 50 feet. A series of drifts were driven on about 20-foot levels, the lowest 50 to 55 feet below the surface, with a number of cross-cuts and raises. The workings appear to have been driven at random, and suggest that several irregular ore bodies were mined, some of them up to the surface.

Operations in 1942 were limited to cleaning out some of the old workings. (Gros, F., G. S. 42; Caldwell, F. B. 18; Davis, E. F., in Louderback, G. D. 18; Bradley, W. W. 18, p. 149; Diller, J. S. 20, p. 664.)

*Brown Prospect (2).*—Chromite float was found in sec. 29, T. 12 N., R. 8 W., on land owned by J. H. Brown of Cobb. Although a large quantity of float was scattered about, none of it had been gathered and no prospecting had been done up to the time of Davis' visit (1917). (Davis, E. F., in Louderback, G. D. 18.)

*Butler Claims (3).*—W. E. and Theresa Butler of Middletown had two claims, probably in sec. 24, T. 10 N., R. 6 W., three-quarters of a mile from the Calistoga road at a point about 12 miles from Calistoga. A total of 16 tons of ore from these claims was sold to the Sawyer Tanning Company in 1918. A chromite lens  $1\frac{1}{2}$  feet wide was exposed over a length of 4 feet in a pit on the southern claim when examined by Davis. This ore was estimated to contain 45 percent  $\text{Cr}_2\text{O}_3$ . On the northern claim, held by Theresa Butler, lenses striking about N.  $30^\circ$  E. and dipping  $65^\circ$  W. were mined by an 8-foot trench and 18-foot inclined shaft. The ore was estimated to range in grade from 38 to 50 percent  $\text{Cr}_2\text{O}_3$ , and the ore mined averaged 48 to 50 percent. (Davis, E. F., in Louderback, G. D. 18.)

*Copsey Claims (4).*—The Copsey group of three claims—the Uncle Josh, Manzanita, and Mint—was located in 1918 by Arthur Copsey of Middletown, who leased shares to W. P. Moore and Joshua Spiers. The claims cover a number of chromite deposits that occur in a belt that extends about N.  $65^\circ$  W. from the northern part of sec. 4, T. 11 N.,

R. 7 W. into the SW $\frac{1}{4}$  sec. 33, T. 12 N., R. 7 W. The workings are a quarter to 1 $\frac{1}{4}$  miles from the main road at a point 7 miles from Middletown and 23 miles from Calistoga.

A good deal of black chromite sand, but relatively little lump ore, was found on the claims. The largest lens of high-grade ore yielded less than 10 tons. Most of the lenses are of disseminated ore and dip about 40° S.

About 20 tons of ore was mined from several lenses on the Manzanita claim in 1917 and sold to the Union Chrome Company. Although chromite sand occurred over an area about 500 by 600 feet on the Uncle Josh claim, several trenches and tunnels indicated that the main stringers and lenses were restricted to an area 20 to 50 feet wide. Little work was done on the Mint claim, although there was some float. (Gros, F., G. S. 42; Davis, E. F., in Louderback, G. D. 18; Caldwell, F. B. 18; Aubury, L. E. 06, p. 362; Bradley, W. W. 18, p. 148.)

*Glad I Found It (5).*—The Glad I Found It claim is near the county line and about half a mile from the Butts Canyon road between Middletown and Lower Lake. It is probably in sec. 24, T. 10 N., R. 6 W. Three tons of ore from this claim was sold to the Sawyer Tanning Company. (Davis, E. F., in Louderback, G. D. 18.)

*Gordon Springs Deposits (6).*—Chromite float was found at two places in sec. 2, T. 11 N., R. 8 W., about a quarter of a mile from the Calistoga-Kelseyville road and 25 miles from Calistoga. In 1918 the land was owned by Mrs. Laura Miles of San Francisco and Mrs. Irene Anderson of Petaluma, who refused to allow prospecting or mining on their land.

A few blocks of chromite occur at one place, and at the other about 200 pounds of ore in chunks up to 10 inches in diameter was scattered over a few square yards. The ore was said to be unusually massive, and to have a glassy luster on freshly broken surfaces; it may be a high-alumina variety, for it assayed only 37.8 percent Cr<sub>2</sub>O<sub>3</sub>. Davis believed that the float must indicate a small ore body in place and recommended surface trenching. (Davis, E. F., in Louderback, G. D. 18.)

*Gunn Claims (7).*—J. A. Gunn of Kelseyville located 5 claims, the Lakeview, Helen Ray, Mummy, Juniper Ridge, and Popgun, in sec. 14 and the SW $\frac{1}{4}$  sec. 11, T. 12 N., R. 9 W., 8 miles south of Kelseyville. The Bruce claims, which were recorded as in secs. 18 and 19, T. 12 N., R. 8 W., and also belonging to Gunn, are believed to be the same.

The chromite was found as float and in small lenses trending northwest. The lenses contained up to a ton of ore, and most of it was massive. A total of 17 tons was mined and shipped to the California Chrome Company, the average grade being 38 percent Cr<sub>2</sub>O<sub>3</sub>. About 7 $\frac{1}{2}$  tons was mined from both the Helen Ray and Juniper Ridge claims, and 2 tons of float from the other three. (Davis, E. F., in Louderback, G. D. 18.)

*Harp and Sons Ranch Deposits (8).*—The Sawyer Tanning Company mined about 50 tons of ore, which was said to have contained 50 to 52 percent Cr<sub>2</sub>O<sub>3</sub>, from open cuts in sec. 20, T. 11 N., R. 7 W., on the Harp and Sons ranch. The chromite occurred in small lenses, which had been mined out by 1918. (Bradley, W. W. 18, p. 149; Averill, C. V. 29, p. 341.)

*Holmstedt Deposits (9).*—The Holmstedt deposits are in sec. 22, T. 10 N., R. 7 W., on land owned by Victor Holmstedt and Van Warner of Middletown, and leased in 1943 to J. H. Scott Company of San Francisco. They are 4 miles south of Middletown, near State Highway No. 29. A small amount of ore is said to have been shipped from here during World War I.

The chromite deposits occur in serpentinized peridotite in a zone which is about 250 feet long, 30 to 35 feet wide, and trends north. As shown in figure 2, the zone has been explored by a number of trenches and drifts. A series of caved trenches to the southeast suggests a continuation of the zone, that lies at an angle of about  $45^\circ$  to the main part. The chromite occurs as small lenses up to a foot in width and as layers of disseminated ore 1 inch to 3 feet wide, separated by essentially barren serpentine. The layers strike parallel to the long axis of the zone, but dip southward at various angles; this structure suggests folding. A sample of average ore analyzed in the Geological Survey laboratory assayed 16.09 percent  $\text{Cr}_2\text{O}_3$ , and had a chromium-iron ratio of 1.63. As cleaned chromite from the same sample contains 52 percent  $\text{Cr}_2\text{O}_3$  and has a chromium-iron ratio of 2.53, a commercial concentrate averaging 45 percent  $\text{Cr}_2\text{O}_3$  with a chromium-iron ratio of 2 or more probably could be produced.

The ore bodies consist of swarms of small lenses and layers, and are estimated to be made up of about 40 percent of chromite-rich layers and 60 percent of barren serpentine. The average grade of the ore is therefore about 6.5 percent  $\text{Cr}_2\text{O}_3$  or 13 percent chromite. The trenches at the north end exposed a body of chromite about 60 feet long by 18 feet wide to a depth of about 8 feet. The layering in this body dips  $70^\circ$  to  $80^\circ$  S. The south ore body has been explored by four trenches that continue into the hill as adits; the southernmost one gives a section 100 feet across, and at the face is 40 feet below the surface. The south ore body is about 120 feet long by 45 feet wide and at least 25 feet deep. About 40 feet of relatively barren serpentine lies between the two ore bodies. (Phoenix and Catheart, G. S. 43.)

*Kangaroo Court Mine (10).*—The Kangaroo Court mine was worked in 1918 by its owners, E. L. Wilkinson of Middletown, and C. L. Russell of Calistoga. It is on a rather steep slope in sec. 25, T. 10 N., R. 7 W., 500 feet from the road and 12 miles from Calistoga.

Small chromite lenses containing up to a ton of ore and connected by narrow stringers were found in a shear zone striking northwest and dipping northeast. About 15 tons of ore averaging 40 percent  $\text{Cr}_2\text{O}_3$  was mined from an open cut and a short tunnel and sold to the Sawyer Tanning Company. No ore was visible when Caldwell visited the mine in July 1918. (Caldwell, F. B. 18; Davis, E. F., in Louderback, G. D. 18.)

*Mastick Ranch Deposits (11).*—Massive chromite float was found in several places on the Mastick ranch, which in 1918 included about 14,000 acres of patented land. The northwesternmost deposit was in sec. 3, T. 10 N., R. 6 W. As the owners refused to lease mining rights, the deposits were not prospected systematically and no shipments have been reported. (Caldwell, F. B. 18.)

*Popp and Nichelini Claim (12).*—Davis reported that in 1918 F. W. Popp and William Nichelini of Calistoga shipped 40 tons of chromite from a deposit in sec. 13, T. 12 N., R. 8 W. Davis did not examine the

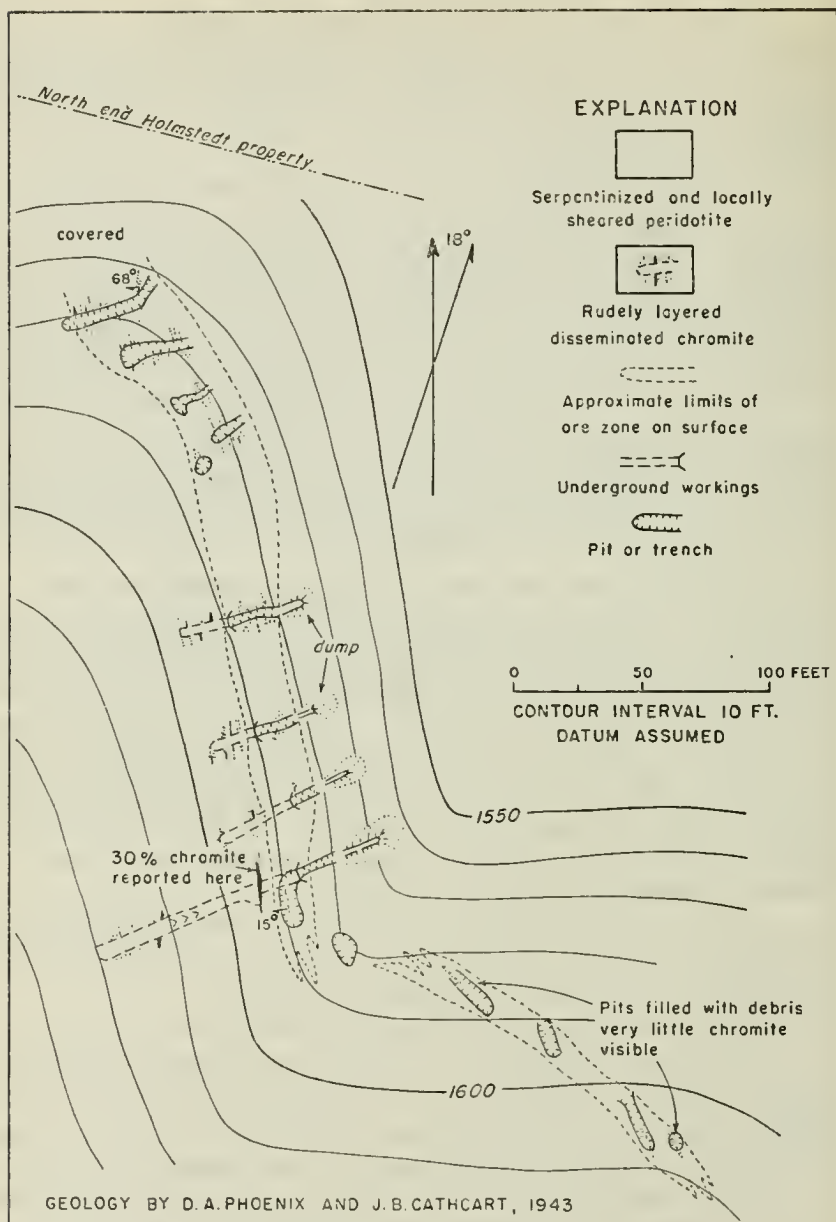


FIG. 2. Geologic map of the Holmstedt chromite deposit.

deposit as he was told it had been mined out. (Davis, E. F., in Louderback, G. D. 18.)

*Schaffer Prospect (13).*—F. Schaffer, of Kelseyville, found small amounts of chromite on his property in sec. 36, T. 13 N., R. 9 W., 4 miles southeast of Kelseyville. Davis indicated that the ore appeared to be of good quality but did not examine the deposits. (Davis, E. F., in Louderback, G. D. 18.)

*Sutro Mine (14).*—The Sutro mine is in the southeast corner of sec. 26, T. 10 N., R. 7 W., half a mile from the road and 11 miles from Calistoga. In 1918 F. W. Popp and William Nichelini of Calistoga had leased the mine from the owner, Charles Sutro of San Francisco.

Numerous lenses of chromite from a few inches to 3 or 4 feet in thickness were found strung out in a shear zone striking N. 35° E. and dipping 45° NW. The ore-bearing zone was 3 to 5 feet wide and was followed 30 feet in an open cut and 12 feet down the dip by an inclined winze. Most of the ore was soft and friable with well-defined contacts against serpentine. About 12 tons of 42 to 45 percent ore was mined.

Two other ore bodies were found about 1000 feet southeast of the main workings. One of these was a small mass of high-grade ore, but the other was low-grade and contained about 20 percent  $\text{Cr}_2\text{O}_3$ . The low-grade body had been only partly explored. (Caldwell, F. B. 18; Davis, E. F., in Louderback, G. D. 18.)

*Whispering Pines Prospect (15).*—David Streckler found chromite on his land in sec. 14, T. 11 N., R. 8 W., 8 miles north of Middletown. Although float was found in several places, the only ore discovered in place was an 800-pound lens exposed by a trench near his house. (Davis, E. F., in Louderback, G. D. 18.)

*Young Adams Prospect (16).*—The Young Adams prospect is near the center of sec. 12, T. 12 N., R. 9 W. Except for the collection of 5 tons of high-grade float ore which was sold to the Sawyer Tanning Company, little work has been done on this prospect. (Davis, E. F., in Louderback, G. D. 18.)

#### Eastern Group

*Betwixt Claim (17).*—The Betwixt claim is one of a group of three claims located in 1918 by G. B. Smith and P. B. Edwards of Lower Lake. The claims are a short distance south of Reiff, in T. 12 N., R. 5 W., and were located by sections as follows: Betwixt, SE $\frac{1}{4}$  sec. 30; E.Z., sec. 29; and Riverside NW $\frac{1}{4}$  sec. 29. About 500 pounds of ore was found in loose and broken serpentine on the Betwixt claim; 200 pounds of high-grade float was found on the E.Z. claim; and the Sawyer Tanning Company mined 4 tons of high-grade ore from the Riverside claim for a royalty of \$3 a ton. The claims were abandoned in 1918. (Davis, E. F., in Louderback, G. D. 18.)

*Lucky Strike Mine (19)* [89].—The Lucky Strike mine is in secs. 13 and 24, T. 12 N., R. 6 W., 7 miles by road from Reiff. It is on a gentle grassy slope at an elevation of 2300 feet, a mile west of, and 400 feet above, the floor of Morgan Valley. In 1942 the mine was owned by W. B. Shepherd of Monticello and leased by the Anglo-American Mining Company.

This mine has been the most productive chromite mine in Lake County, and is credited with shipments of between 1350 and 2000 tons. Although accounts differ on the amount shipped in 1918, all agree that 1350 to 1450 tons was shipped to the Sawyer Tanning Company in 1916 and 1917. No shipments have been reported since 1918.

The workings consist of 25 to 30 pits and open cuts and a few short drifts, concentrated mainly in an area 1000 feet long by 100 feet wide. The largest cut is about 200 feet long, 20 feet wide, and 35 feet in greatest depth; the next largest is about 40 feet long. Very few of the workings show any ore.

The ore is black, massive, coarse- to fine-grained chromite; all of the ore shipped contained 43 percent or more  $\text{Cr}_2\text{O}_3$  and 90 percent of it is said to have exceeded 48 percent  $\text{Cr}_2\text{O}_3$ . The ore formed well-defined lenses with sharp contacts. The main production came from a large kidney-shaped mass which was over 100 feet long, 18 feet in greatest width, and 35 feet deep; it yielded about 1000 tons. The 40-foot cut is said to have yielded 200 tons from a single ore body. The ore bodies were said to trend N.  $45^\circ$  to  $65^\circ$  W. and dip steeply to the north or south.

Exploration in 1942 had uncovered 5 lenses aligned parallel to the main zone and 30 feet to the southwest. The largest ore body was 20 feet long, up to 15 feet wide, and only 5 feet deep where exposed in a 35-foot shaft. The other 4 lenses averaged about 5 feet in length and 2 feet in width. (Gros, F., G. S. 42; Bradley, W. W. 18, p. 149; Averill, C. V. 29, p. 341; Diller, J. S. 19, p. 31; 20, p. 664; Caldwell, F. B. 18; Davis, E. F., in Louderback, G. D. 18.)

*Red Devil Claim (20).*—Davis reported that the Red Devil claim was  $2\frac{1}{2}$  miles northeast of the Lucky Strike mine and south of Lower Lake. He did not visit the deposit, and the location given him seems to be in error, for the Lucky Strike mine is 7 to 8 miles southeast of Lower Lake. The deposit yielded 15 tons of ore in 1917. (Davis, E. F., in Louderback, G. D. 18.)

*Smythe or Herman Prospect (22).*—The Smythe and Black Diamond prospects are about 1000 feet apart in sec. 28, T. 11 N., R. 5 W., a quarter to half a mile from the main road. They are near the southern end of a serpentine mass 4 miles long by a mile wide. Development was retarded by a dispute over ownership in 1918, and no ore is known to have been shipped. August Herman claimed both prospects, Joe and Frank Rhoda claimed the Black Diamond, and Tom Smythe claimed the Smythe.

In 1942 Gros reported that 4 small ore bodies apparently had been mined out on the Smythe or Herman claim, and only one was seen in place. This ore body was about 10 feet long, 5 feet wide, and 10 feet deep at the exposed end.

Chromite boulders were scattered over a distance of 60 feet in an east-west line across the top of the hill on the Black Diamond claim, but no prospecting had been done. (Gros, F., G. S. 42; Caldwell, F. B. 18.)

*Chromite Occurrence (23).*—Davis mentioned chromite float in sec. 35, T. 14 N., R. 7 W., just below the road from Lower Lake to Arabella. Glaucophanite schist was exposed in the road and in a ledge 50 feet below it. The surface debris below the ledge contained pieces of chro-

mite up to 6 inches across. The ore appeared high grade and contained numerous masses of uvarovite, or chrome garnet. (Davis, E. F., in Louderback, G. D. 18.)

*Unnamed Prospects (24, 25).*—During mapping of the Knoxville quicksilver district small chromite showings were noted in the SW $\frac{1}{4}$  sec. 33, T. 12 N., R. 5 W., and in the NW $\frac{1}{4}$  sec. 3, T. 11 N., R. 5 W. The first of these occurrences consists of about 100 pounds of chromite in an exposure of serpentine and the second is of the same order of magnitude. The names and owners of these prospects are not known. (Averitt, P., G. S. 41.)

*Cabbage Head or Fir Root Ridge Claim (26).*—Dave Dondero and W. M. McLeod, of Hullville, both claimed some small deposits of fine-grained chromite in sec. 32, T. 19 N., R. 9 W., in northern Lake County. About a ton of ore had been picked up when Caldwell visited the claim in 1918, but there is no record of any shipment. (Caldwell, F. B. 18.)

#### Mendocino County

The known chromite deposits in Mendocino County appear to be relatively small, and development of the principal prospects is handicapped by lack of roads. Comparison with Del Norte County, however, which is equally undeveloped, indicates that if the deposits in Mendocino County were large, production from 1940 to 1944 would have far exceeded the 25 tons reported.

Two main groups of deposits are known, both of them on "Big Red Mountain." It should be noted, however, that there are two Big Red Mountains, one southeast of Ukiah, in the southeastern part of the county, and the other west of Cummings, in the northwestern part.

*Crawford Prospect.*—Davis and Woodford reported that W. L. Crawford removed 2 tons of chromite from his ranch at Largo, 9 miles south of Ukiah. No other information was given. (Davis and Woodford, in Louderback, G. D. 18.)

*Graham Group (1).*—W. S. Graham of Ukiah located a group of 17 claims on Big Red Mountain, the ridge which forms the boundary between Mendocino and Lake Counties, 11 miles southeast of Ukiah. The mountain is 4,000 to 4,200 feet in altitude, and stands 3,000 feet above the valley to the west. Access to the deposits is by 4 miles of very steep dirt road to Lost Valley from the county graveled road and 2 miles of trail from Lost Valley. The deposits are distributed over a distance of about half a mile along the high part of the ridge, near the center of T. 14 N., R. 11 W.

In 1918 three of the claims were leased by the Noble Electric Steel Company, who mined a few tons of high-grade ore and about 75 tons of low-grade ore. The high-grade ore was later shipped by H. B. Chase

*Shipments of chromite from Mendocino County mines, 1918-42 (in long tons)*

Mine or shipper	1918	1920	1928	1929	1942	Total
Bradley and Eckstrom*					25	25
Graham Group	49					49
Guthrie Group	522	187	166	39		914

\* Source of ore unknown.

of San Francisco. The claims had been allowed to lapse after World War I, and in 1941 were held by Edward George of Ukiah.

The deposits consist principally of thin layers and small lenses of massive and disseminated chromite in dunite that is essentially barren. Many of the layers of ore average 30 to 50 percent  $\text{Cr}_2\text{O}_3$ , but they are so thin and intermixed with barren dunite that the minable rock would exceed 20 percent  $\text{Cr}_2\text{O}_3$  in very few places. The largest of the high-grade ore bodies yielded about 5 tons of ore. Davis and Woodford emphasized the fact that, although high-grade float was abundant in places, the individual pieces were small and obviously were derived from thin layers. The deposits, therefore, would have to be worked by bulk mining and milling methods.

The principal body of low-grade ore, according to Davis and Woodford, is near the north end of the high part of the mountain, just east of the divide. There the streaks and lenses of chromite strike north and are nearly vertical; they were exposed in pits and cuts over a distance of 300 feet. The chromite-bearing zone was described as at least 25 feet wide, and in places outcrops indicated a width of 50 feet, although exposures were not continuous across the entire width. A vertical depth of 50 feet of ore was indicated by exposures in a gulch below some open pits. Davis and Woodford estimated a possible reserve of 10,000 to 30,000 tons of ore containing about 10 percent  $\text{Cr}_2\text{O}_3$ .

About 35 tons of ore averaging 40 percent  $\text{Cr}_2\text{O}_3$  was dug from several trenches near the top of the mountain, on the old Summit claim. Near the south end of this claim, and about 200 feet below the crest of the mountain, a tunnel was driven about 30 feet along the strike of an ore body in which the layers strike N. 20° E. and dip 35° E. Wells stated that this ore body is about 15 feet thick, and estimated the reserve at about 500 tons of ore containing 5 to 10 percent  $\text{Cr}_2\text{O}_3$ .

When Wells visited the claims in 1941 most of the workings were caved and very little ore could be seen. He mentioned a few nodules in layers near the portal of the tunnel, which had caved in. (Wells, F. G., G. S. 41; Bradley W. W. 18, p. 154; Caldwell, F. B. 18; Davis and Woodford, in Louderback, G. D. 18.)

*Guthrie Group (2).*—In 1918 more than 100 claims had been filed on Big Red Mountain, in secs. 18, 19, 20, 29, 30, 31, and 32, T. 24 N., R. 16 W., northwest of Cummings. The claims extended more than a mile along the crest of the ridge, at altitudes of 4500 to 4700 feet. In 1941 the claims were reached by steep county road from U. S. Highway 199 and 4½ miles of road that could be negotiated only with an extra-low gear. The deposits are 37 miles by road from Longvale, a station on the Northwestern Pacific Railroad.

The claims are named for Alex Guthrie, who with Frank Asbill held 47 of the original claims on the mountain. These claims were leased in 1918 to the Moreland Motor Truck Company which packed the ore out to the road on mules. The total cost of transportation to Longvale was about \$30 a ton.

The summit of the mountain appears to be covered with a lateritic soil in which chromite has been concentrated by weathering; in places the soil is said to be 15 feet deep. There were few chromite outcrops, but most of the ore was found by digging or hand-auger holes below

accumulations of float. Much of the surficial ore was very friable, and some of it was very high grade as a result of leaching of the serpentine gangue. The ore that was shipped came from 10 or more lenses which ranged from N. 35° W. to N. 15° E. in strike, and dipped 50° to 65° NE or E. The largest deposit is believed to have yielded about 100 tons.

When Wells examined the deposits in 1941 little ore could be seen. A few streaks of chromite were seen in dunite in a pit, about 100 feet long, on the Mitty claim, but widespread saxonite float indicated that the ore-bearing zone was probably 15 feet or less in width. Some streaks and nodules of chromite were seen on the Marie, Surprise, and Last Chance claims. (Wells, F. G., G. S. 41; Bradley, W. W. 18, p. 152; Davis and Woodford in Louderback, G. D. 18; Caldwell, F. B. 18.)

*Little Red Mountain (Dunn) Deposits (3).*—The Little Red Mountain claims are in sec. 6, T. 23 N., R. 16 W., about 3 miles from U. S. Highway 101. The claims were originally filed by E. A. and W. K. Dunn, C. H. Hawkins, and J. L. Kelley, and in 1941 were held by Eva Dunn. The topographic conditions and the character of the deposits are similar to those on the Guthrie claims. In a trench near the northwest corner of sec. 6, Wells saw a lens of coarse-grained massive chromite about 2 feet wide that strikes N. 30° W. and dips 45° NE., and is said to have assayed 52 percent Cr<sub>2</sub>O<sub>3</sub>. About half a ton of ore was on the dump. High-grade disseminated ore in which some nodules were noted was exposed in another trench, but the exposures were not good enough to justify an estimate of tonnage. (Wells, F. G., G. S. 41; Davis and Woodford in Louderback, G. D. 18; Caldwell, F. B. 18.)

*Lloyd Prospect (4).*—Arthur D. Lloyd of Longvale told Woodford and Davis about chromite float in sec. 35, T. 23 N., R. 15 W., 6 miles by trail from Nashmead, on the Northwestern Pacific Railroad. Apparently the deposit has never been developed. (Woodford and Davis, in Louderback, G. D. 18.)

*Moore Prospect (5).*—O. E. Moore of Ukiah is said to have mined 15 to 20 tons of high-grade ore from a deposit in sec. 24, T. 15 N., R. 13 W., 1½ miles west of Ukiah. The deposit was mined out. (Woodford and Davis, in Louderback, G. D. 18.)

*Shields Prospect (6).*—W. E. Shields of Covelo collected about 30 tons of high-grade float ore in sec. 11, T. 23 N., R. 11 W., 25 miles northeast of Dos Rios. No ore was found in place, and because of the inaccessibility of the deposits none of the ore was shipped. (Bradley, W. W. 18, p. 156.)

*Unnamed Prospect (7).*—Taliaferro described chromite occurring as blocks up to 6 or 8 inches in diameter in a slide made up largely of serpentine fragments, on the west bank of the middle fork of the Eel River opposite the locality known as the Hell Hole. This deposit appears to be in the W½ sec. 1, T. 23 N., R. 11 W., opposite Hell Hole Canyon. A few hundred pounds of ore had been piled in one place, but Taliaferro indicated that the source of the ore probably would be difficult to find because of the extensive slides.

The deposit may be the same one described in 1918 as the Shields prospect, for the locations and descriptions of the two deposits are very similar. (Taliaferro, N. L., in Louderback, G. D. 18.)

## Napa County

Shipments of chromite from Napa County mines, 1916-41 (in long tons)

Mine or shipper	1916	1918	1935-41	Total
Bradley and Eckstrom*-----	-----	-----	1937-39: 64, 20, 20	104
Cicero & Co.*-----	-----	-----	1935-36: 67, 64	131
G. W. Elder*-----	-----	357	-----	357
Moore claims-----	-----	446	-----	446
Morning Star* (Constant)-----	-----	-----	1940: 26	26
H. W. Mullaly*-----	16	68	-----	84
A. Nichelini-----	184	-----	-----	184
Sawyer Tanning Co.*-----	-----	341	-----	341
Sun Slope (T. L. Neil)*-----	93	-----	-----	93
White Angel*-----	-----	-----	-----	-----
Tanzer-----	-----	-----	1940: 4	304
Shepherd-----	-----	-----	1941: 300	-----
White Buck*-----	-----	62	-----	62

\* Source of ore or location of deposit unknown.

Chromite deposits are distributed over the northeastern part of Napa County in a number of serpentine masses. Half of the deposits are concentrated in the northeastern corner of the county between Putah and Eticuera Creeks, in the southern end of a large serpentine mass which extends northward about 15 miles into eastern Lake County. The other deposits are much more widely scattered. For convenience, the deposits between Putah and Eticuera Creeks are described together as the Northern deposits and the others as the Southern deposits.

## Northern Deposits

*Black Hawk Claim (1).*—The Black Hawk claim was apparently located by T. L. Neil in 1916, in sec. 23, T. 11 N., R. 5 W., about 2 miles west of the Moore mine (59). Caldwell did not visit the claim, for he was told that little ore remained after 126 tons had been mined and shipped in 1916 and 1917. (Caldwell, F. B. 18.)

*Cigarette Mine (2) [94].*—The Cigarette mine is in sec. 5, T. 10 N., R. 4 W., 6 miles from Monticello. In 1918 it was covered by a claim located by W. M. Noel of Monticello. Davis reported that the mine had produced over 250 tons of high-grade ore, which was sledded a mile, hauled 4 miles over a bad road by light trucks, then hauled 30 miles in heavy trucks to Winters. Only small patches of chromite were left on the walls of the cuts in July 1918. (Bradley, W. W. 18, p. 157; Davis, E. F., in Louderback G. D. 18.)

*Crystal Creek Claim (3).*—The Crystal Creek claim, which was abandoned in 1918, was on a deposit in the SW $\frac{1}{4}$  sec. 12, T. 10 N., R. 5 W., on a fork of Cement Creek. Forty tons of ore was mined and shipped from an open cut about 50 feet above the creek. The ore body was about 10 feet square by 4 feet thick and dipped about 10° S. in sheared serpentine. A few 2- to 3-inch stringers were left. (Davis, E. F., in Louderback, G. D. 18.)

*Dollerhyde Claim (4).*—High-grade chromite float was found on a claim held in 1918 by R. A. Dollerhyde, in sec. 6, T. 10 N., R. 4 W. Trenching failed to uncover ore in place, and after some ore was shipped the claim was abandoned. (Davis, E. F., in Louderback, G. D. 18.)

*Ferris Claim (5).*—The Ferris claim, in sec. 36, T. 11 N., R. 5 W., was owned by George Graves and leased to the Sawyer Tanning Company in 1918 and 1919. Eight tons of ore was shipped in 1918 from an 8-foot open cut and 10-foot shaft. When Caldwell visited the mine a chromite lens 6 to 18 inches wide was exposed over a length of 10 feet. This body and small nearby lenses were said to strike about north and dip steeply either east or west. (Caldwell, F. B. 18.)

*Graves Mine (6) [93].*—The Graves chrome mine is in the NE $\frac{1}{4}$  sec. 36, T. 11 N., R. 5 W., at an elevation of about 1120 feet, on a gentle grass-covered hillside. In 1942 the deposit was owned by W. B. Shepherd of Monticello and leased to the Anglo-American Mining Company of Clovis. George Graves owned the mine in 1918 and leased it three times, the last time to the Sawyer Tanning Company after the others thought it was mined out. From 1916 to 1918 about 410 tons of ore was shipped, 230 tons of it by the Sawyer Tanning Company.

At one time in 1918 ore was exposed continuously along one side of an open cut 50 feet long, up to 30 feet wide, and 20 feet deep on the uphill side. There were also several smaller cuts. The main ore body evidently was about 50 feet in length, 20 feet in maximum width, and about 8 feet in greatest thickness. The strike of the chromite lenses was about N. 80° W.; they dipped at a low angle into the hill.

The old workings were badly caved in 1942, and only low-grade disseminated ore could be seen in three of the pits. About 50 tons of low-grade ore was stockpiled when Gros visited the mine, and reserves of low-grade ore in place apparently were very small. (Gros, F., G. S. 42; Caldwell, F. B. 18.)

*Grey Claim (7).*—The Grey claim, held in 1942 by W. B. Shepherd of Monticello and leased to the Anglo-American Mining Company of Clovis, was owned and operated in 1918 by John Moore, of Monticello. The claim is 14 miles from Calistoga, in sec. 13, T. 11 N., R. 5 W.

About 100 tons of chromite was shipped from this mine in 1918. The ore was roughly divided into two grades: gray sandy ore mixed with serpentine, and containing 30 to 38 percent Cr<sub>2</sub>O<sub>3</sub>; and friable high-grade chromite that contained 40 to 45 percent Cr<sub>2</sub>O<sub>3</sub>. Truck-load lots sent to the Sawyer Tanning Company ranged from 29.2 to 44.5 percent Cr<sub>2</sub>O<sub>3</sub>.

The ore was mined from an open cut 70 feet long, 6 to 10 feet wide, and 20 feet deep, and a shaft sunk 8 feet below the floor of the cut near the face. The chromite formed a number of closely packed lenses in a space about 25 feet long, 3 to 6 feet wide, and 30 feet deep, in a north-south vertical shear zone. In 1942 the cuts were badly caved, and no ore could be seen in place. About 200 tons of ore of various grades was stacked near the workings. (Gros, F., G. S. 42; Caldwell, F. B. 18.)

*Hightower Claim (8).*—W. C. Hightower was said to have a claim in sec. 12 or 13, T. 10 N., R. 5 W., from which 5 or 6 tons of ore was mined. (Caldwell, F. B. 18.)

*Moore Mine (9) [92].*—John Moore of Monticello owned several chromite deposits in sees. 17, 18, and 19, T. 11 N., R. 4 W., which as a group were known as the Moore mine or Moore claims. The largest deposits were on the Marshall and Vanderbilt claims, and shipments of about 450 tons were about evenly divided between the two claims. Part of the ore was sold to the California Chrome Company and part to the Sawyer Tanning Company.

On the Marshall claim a vertical shear zone striking northeast was explored over a distance of 1500 feet by three groups of open cuts, pits, and trenches. At the main workings several open cuts, the largest of which was 50 feet long and 25 feet deep at the face, were dug on 5 parallel chromite lenses ranging up to 30 feet long and 1 to 3 feet wide. These lenses were scattered over a width of about 50 feet in the shear zone. One of the ore bodies had the form of a very irregular pipe that ranged from 1 to 25 square feet in cross-sectional area and was mined to a depth of 15 feet. A 3- by 4-foot lens was found 1000 feet southwest of the main deposits, and two parallel ore bodies were found 500 feet farther on. Davis said that the ore averaged about 40 percent  $\text{Cr}_2\text{O}_3$ , and Caldwell indicated that it ranged in grade from 35 to 40 percent  $\text{Cr}_2\text{O}_3$ .

The workings on the Vanderbilt claim revealed chromite in a curved zone about 75 feet long, swinging in strike from N.  $45^\circ$  W. to N.  $60^\circ$  E. The lenses of chromite lay parallel, and some of them cut across the trend of the ore-bearing zone. The descriptions by Caldwell and Davis are somewhat obscure, but Caldwell's mention of a shaft 10 feet square and 40 feet deep suggests that one of the ore bodies mined after Davis' visit was pipe-like in form. Caldwell describes the ore as black, speckled, and homogeneous, and ranging from 41 to 46 percent in  $\text{Cr}_2\text{O}_3$  content. (Caldwell, F. B. 18; Davis, E. F., in Louderback, G. D. 18.)

*Mullaly Mine (10).*—About 85 tons of ore assaying 43 to 50 percent  $\text{Cr}_2\text{O}_3$  was shipped to the Sawyer Tanning Company from a deposit in sec. 18, T. 11 N., R. 4 W., by H. W. Mullaly of Monticello. The deposit was near the road to the Moore mine (9) and about 28 miles from Monticello.

The chromite occurred as lenses of various sizes in a shear zone trending northeast and dipping  $45^\circ$  NW. In September 1918, the workings consisted of a cut 70 feet long and 20 feet deep at one end, and smaller cuts at irregular intervals over a distance of 200 feet along the shear zone. The largest ore body appears to have been about 20 feet long and 1 to 3 feet wide. (Caldwell, F. B. 18; Davis, E. F., in Louderback, G. D. 18.)

*Nevada Claim (11).*—The Nevada claim was one of a group of three, the others being the Rockerfeller and St. Gabriel, located in 1918 by George Vanderbilt of Monticello. The Nevada claim was in sec. 32, T. 11 N., R. 4 W.

Trenches at places where high-grade float was found on the Nevada and Rockerfeller claims failed to find ore in place, and a trench on the St. Gabriel claim revealed a half-ton deposit of disseminated ore estimated to contain 38 percent  $\text{Cr}_2\text{O}_3$ . A tunnel, 75 feet down the hill from this ore body, was abandoned after being driven a few feet. There is no record of ore shipped from these claims. (Davis, E. F., in Louderback, G. D. 18.)

*Turner Mine (14).*—The Turner mine is in sec. 1, T. 10 N., R. 5 W., and was worked in 1918 by Clifford Turner. Caldwell said that 40 tons of ore averaging about 40 percent  $\text{Cr}_2\text{O}_3$  was shipped to the Sawyer Tanning Company before the end of August 1918.

The mine consisted of a small open cut and a 5- by 7- foot shaft 30 feet deep sunk on an ore body in a shear zone striking northwest and dipping  $35^\circ$  SW. The ore body appears to have been tabular, for it is described as 6 to 10 feet long by a few inches to 4 feet wide on the surface, and 10 feet long by 1 to 3 feet thick at the bottom of the shaft. Some of

the ore was clean and homogeneous, but most of it was said to consist of nodules in yellowish-green serpentine. (Caldwell, F. B. 18.)

*Unnamed Prospects (15, 16, 17).*—A small prospect (15) was seen in a shear zone striking N. 50° E. and dipping 75° NW. in serpentine in the SW  $\frac{1}{4}$  sec. 12, T. 11 N., R. 5 W.

Other prospects (16, 17), consisting of several small pits and a 20-foot adit that was badly caved were found in the SE  $\frac{1}{4}$  sec. 18, and the SW  $\frac{1}{4}$  sec. 17, T. 11 N., R. 4 W. during mapping of mercury deposits. A lens of chromite about 10 feet long, 7 feet wide, and about 5 feet thick was seen in sec. 18 in a shear zone which strikes N. 55° E. and dips 50° SE. The pits in sec. 17 revealed only a 12-inch lens of low-grade ore. (Averitt, P., G. S. 41.)

#### Southern Deposits

*Astute Mine (18).*—The Astute mine, in sec. 32, T. 10 N., R. 5 W., was held by Young Adams and W. D. Hays of Middletown. The mine is 19 miles from St. Helena, near an old lime kiln in Butts Canyon.

Caldwell described the deposit as a kidney-shaped mass exposed over a length of 30 feet and a few inches to 6 feet or more in width, in soft yellow sandy serpentine. The strike of the ore body was north and it dipped at a low angle. Davis indicated that the ore ranged in grade from about 38 to 50 percent  $\text{Cr}_2\text{O}_3$  and Caldwell said it disintegrated into coarse crystals. The boundaries between high- and low-grade ore were extremely irregular. The mine is said to have shipped a little more than 200 tons to the Sawyer Tanning Company. (Davis, E. F., in Louderback, G. D. 18; Caldwell, F. B. 18.)

*Chrome Center Claim (19).*—A “fairly high grade body of massive gray chromite” was found on the Chrome Center claim in sec. 36, T. 10 N., R. 5 W., by R. W. Wallace of Pope Valley. The ore body was developed by a 20-foot open cut showing 5 feet of ore in places. A small exposure of chromite 75 yards east of the main deposit had not been explored at the time the mine was visited in 1918. There are no records of shipments from this mine, although about 30 tons had been mined. (Bradley, W. W. 18, p. 156.)

*Elder Claim (20).*—About 20 tons of ore averaging 45 percent  $\text{Cr}_2\text{O}_3$  was shipped from a deposit north of the house on the G. W. Tarry homestead, in sec. 31, T. 10 N., R. 4 W. The deposit was completely mined out. (Davis, E. F., in Louderback, G. D. 18.)

*Fourth of July Claim (21).*—Float ore only was found on the Fourth of July claim in the N $\frac{1}{2}$  sec. 18, T. 10 N., R. 5 W., three-quarters of a mile from the Butts Canyon road and about 23 miles from St. Helena. The deposit was worked by Frank Rhoda of Pope Valley.

The chromite was found as boulders in red soil on serpentine. Fifteen tons of ore had been mined from an open cut 10 by 20 feet in area and 3 $\frac{1}{2}$  feet deep, and pieces of ore were visible in the walls. The cut apparently was not dug to bed rock or to the upper limit of float on the hillside. Although the ore appeared to be massive, it was said to assay only 42.2 percent  $\text{Cr}_2\text{O}_3$ . A patch of angular float in which serpentine adhered to the fragments, several hundred feet below the open cut, was regarded by Davis as evidence of another deposit, but apparently it was not explored. (Davis, E. F., in Louderback, G. D. 18.)

*Glad I Found You No. 2 Claim (22).*—The Glad I Found You No. 2 claim was located by W. D. Hays and Young Adams of Middletown. It was in sec. 19, T. 10 N., R. 5 W., within 100 feet of the road from St. Helena via Butts Canyon and Howel Mountain. About 200 pounds of float estimated to contain 45 to 48 percent  $\text{Cr}_2\text{O}_3$  was found at two places. (Davis, E. F., in Louderback, G. D. 18.)

*Graves Ranch Deposit (23) [96].*—Hamilton stated in 1920 that the Graves Ranch mine produced 900 tons of ore which was sold to the Sawyer Tanning Company, and he said the mine was in sec. 11, T. 9 N., R. 4 W. Since no other investigators have reported an important mine in this vicinity it seems likely that Hamilton was referring to the Graves chrome mine (6) [93]. (Boalich, E. S. 21, p. 158; Averill, C. V. 29, p. 216.)

*Nichelini Mine (24).*—The Nichelini mine, in secs. 33 and 34, T. 8 N., R. 4 W., was worked in 1918 by A. Nichelini of Chiles. The chromite was found in a series of lenses aligned in a northeast direction with their long axes pitching  $25^\circ$  to  $30^\circ$  NE. The principal ore body was said to have yielded about 2000 tons in the early days, when it was mined out. Nichelini found several smaller lenses ranging from 5 to 40 tons each near the old cut. In June 1918 a tunnel was being driven under the old workings, and only a few hundred pounds of ore from old dumps was stacked for shipment. Davis indicated that 100 tons of ore averaging 45 percent  $\text{Cr}_2\text{O}_3$  and ranging up to 50 percent  $\text{Cr}_2\text{O}_3$  was shipped in 1918 from this deposit. (Davis, E. F., in Louderback, G. D. 18.)

*Reeve Claims (25).*—The Reeve claims consist of three claims on public land and 40 acres of patented land owned by R. B. Reeve in secs. 10 and 14, T. 8 N., R. 5 W.,  $5\frac{1}{2}$  miles northeast of St. Helena. The deposits are widely scattered over a low hill that has smooth moderately steep slopes.

The ore occurs as scattered lenses and pods of massive and high-grade disseminated, medium-grained chromite. The ore bodies average about a foot thick and 4 to 5 feet long; the largest found was about 3 feet thick and yielded about  $2\frac{1}{2}$  tons of ore. Two pits, 8 by 2 by 2 feet and 25 by 2 by 1 to 4 feet, respectively, had been dug on the patented land and 3 pits, the largest of which was 30 by 2 by 1 to 8 feet, had been dug on claim No. 1. The ore is said to assay about 52 percent  $\text{Cr}_2\text{O}_3$ . (Cater, F. W. Jr., G. S. 43.)

*Claims in Vicinity of Samuel Springs (26-30).*—Fifteen claims were staked during World War I on chromite deposits in a mass of serpentine which forms the divide between Pope Valley and Trout Creek, in the vicinity of Samuel Springs. The serpentine extends southwest from sec. 20 through the southwestern part of T. 9 N., R. 4 W., at least as far as sec. 10, T. 8 N., R. 4 W. The claims were located by 8 residents of Monticello, individually or in partnership: E. V. McGinnis had interests in 8 claims, C. D. Sweitzer and R. S. Little were partners in 7 claims each; A. R. Asbill, Allen Lewis, and W. D. McKenzie were part owners of 2 claims each; and E. A. Boyington and W. C. Cook each had part of one claim. The names of the claims and their locations are shown in the following table.

## Claims in vicinity of Samuel Springs

Claim	Sec.	T.	R.
Blue Jay	10	8 N.	4 W.
Buzzard	SE $\frac{1}{4}$ NW $\frac{1}{4}$ 20	9 N.	4 W.
Buzzard No. 2	SW $\frac{1}{4}$ NW $\frac{1}{4}$ 20	9 N.	4 W.
Cedar Rough	SW $\frac{1}{4}$ 33	9 N.	4 W.
Dottie D.	SE $\frac{1}{4}$ NE $\frac{1}{4}$ 33	9 N.	4 W.
Eagle	NW $\frac{1}{4}$ 29	9 N.	4 W.
Hampton	NW $\frac{1}{4}$ NW $\frac{1}{4}$ 29	9 N.	4 W.
Honolulu Lady	NE $\frac{1}{4}$ SW $\frac{1}{4}$ 28	9 N.	4 W.
Last Chance	10	8 N.	4 W.
Lizzie P.	SE $\frac{1}{4}$ SE $\frac{1}{4}$ 29	9 N.	4 W.
Lost Horse	SW $\frac{1}{4}$ SW $\frac{1}{4}$ 29	9 N.	4 W.
Meadow	NE $\frac{1}{4}$ NW $\frac{1}{4}$ 33	9 N.	4 W.
Mistake	center 33	9 N.	4 W.
Trout Creek	10	8 N.	4 W.
Viola	SW $\frac{1}{4}$ NE $\frac{1}{4}$ 29	9 N.	4 W.

Very little work had been done on the claims when Caldwell and Davis visited them in 1918, and no ore is known to have been shipped. Trenches on the Blue Jay, Buzzard, Buzzard No. 2, and Trout Creek claims revealed small stringers and lenses of massive chromite a few inches thick. Several shallow trenches which did not reach bedrock were dug on the Cedar Rough, Eagle, Hampton, and Lost Horse claims, and a quarter to half a ton of float was collected on each of the Honolulu Lady, Mistake, and Viola claims. Several patches of float on the Dottie D., Lizzie P., and Meadow claims apparently were left untouched. (Davis, E. F., in Louderback, G. D. 18; Caldwell, F. B. 18.)

*Sullinger Claim (31).*—About a quarter of a ton of chromite was mined from the Sullinger claim before it was abandoned in 1918 by W. Kilpatrick of Oakville. The deposit is in sec. 2, T. 7 N., R. 5 W., 5 miles northeast of Rutherford. A lens of high-grade ore 3 feet long and 6 to 8 inches wide was found in one pit, and the extension of this lens or another lens like it was exposed in another pit 6 feet away. (Bradley, W. W. 18, p. 157.)

*Tarry Claim (32).*—G. E. Tarry, of Etna Springs, in 1918 shipped 45 tons of ore to the Sawyer Tanning Company from deposits in the NE $\frac{1}{4}$  sec. 31, T. 10 N., R. 5 E. The main ore body was about 50 feet long and 1 to 5 feet wide, and was mined to a depth of about 20 feet. Chromite was exposed in a small cut 100 feet northwest of the main pit, and float in several places indicated other ore bodies. (Davis, E. F., in Louderback, G. D. 18; Caldwell, F. B. 18.)

*Unnamed Prospects (33, 34).*—Low-grade disseminated ore was found by G. E. Tarry in sec. 5, T. 9 N., R. 5 W., half a mile from the Butts Canyon road. Although a few small lenses of ore were said to contain as much as 40 percent Cr<sub>2</sub>O<sub>3</sub>, most of them were estimated to average 10 to 15 percent. The small size and low grade of the deposits apparently precluded profitable mining.

G. B. Powers of Rutherford told Davis of a chromite deposit in sec. 12, T. 7 N., R. 4 W., but as very little mining had been done, and no ore had been mined, Davis did not visit the deposit. (Davis, E. F., in Louderback, G. D. 18.)

## Sonoma County

Although relatively few chromite deposits have been found in Sonoma County, they have a much larger per capita production than the deposits in Lake and Napa Counties, and contain larger reserves. Very little ore has been shipped from the county since 1918; the main production came before 1890.

*Barnes Mine (1)* [91].—The Barnes mine was first worked by Edward Barnes before 1884, and since then has been known by many names. Barnes' mining apparently was limited to surface work, and underground mining was started in 1896 by unknown persons. From 1916 to 1918 the Wanderer Mining Company, of San Francisco, worked three parcels of land in the vicinity belonging respectively to J. Ferrari, V. and A. Ardoin, and someone named McMahan, all of Cloverdale. These properties include land in secs. 30, 31, and 32, T. 11 N., R. 10 W., but most of the workings are in sec. 32. The main mine is about 4 miles southwest of Cloverdale.

The available information indicates that the ore was collected from surface float or alluvial deposits, and that very little of it was mined from ore in place. A large part of the ore apparently was mined from river deposits in which pieces of chromite from an inch to a foot across were abundant, and boulders ranging up to 12 tons were occasionally found. The ore was said to be especially abundant in the lowermost beds, which rested on serpentine.

In 1918 the Wanderer Mining Company sank an inclined shaft 15 feet below the creek bed and 30 feet below the general ground level, on the Ardoin land, and drove a number of irregular drifts which intersected old workings. The gravel was soft enough to dig by hand, yet firm enough to stand well without timbering; the waste was used to divert the creek. A few small streaks of chromite were found in bedrock in pits sunk along the creek on the Ferrari tract, but they were too small to mine at a profit. Several tons of float were collected and one carload of ore was shipped in 1918. (Bradley, W. W. 18, p. 203; Hanks, H. G. 84, p. 137; Crawford, J. J. 96, p. 50; Davis, E. F., in Louderback, G. D. 18; Caldwell, F. B. 18.)

*Gaver Prospect (2)*.—Chromite float was found in several places, and small lode stringers were exposed in pits on land belonging to A. P. Gaver, in sec. 27, T. 7 N., R. 10 W. Caldwell saw about half a ton of ore in place. (Caldwell, F. B. 18.)

*Laton Mine (3)*.—The Laton mine is owned by A. J. Laton, son of A. H. Laton, who worked the mine in 1918, and in 1942 and 1943 was operated by A. S. and Roy Laton. B. M. Bowman is believed to have

*Shipments of chromite from Sonoma County mines, 1916-18 (in long tons)*

Mine or shipper	1916	1917	1918	Total
B. M. Bowman*.....	96	-----	-----	96
Laton.....	-----	-----	43	43
Meeker.....	-----	-----	644	644
S. M. Thomas*.....	-----	-----	89	89
Others*.....	8	143	46	197

\* Source of ore unknown.

worked the mine in 1916 and 1917. The deposits are covered by 3 claims, the Slats and Rattlesnake, which are in the NE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 13, T. 9 N., R. 12 W., and the Yellow Streak, which is in the SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 18, T. 9 N., R. 11 W. The mine is 10.3 miles by road from Cazadero, divided as follows: 6 miles of Forest Service dirt road, 3.2 miles of one-way road, and 1.3 miles of bulldozer road. All the claims are on steep slopes; the Rattlesnake and Slats are 100 to 300 feet above Austin Creek, and the Yellow Streak is on a small tributary. Austin Creek is a permanent stream which would supply plenty of water for a mill.

Two to 4 carloads of high-grade ore mined principally on the Yellow Streak claim are said to have been shipped in 1918. Assays by the Smith-Emery Laboratories indicate that the last carload contained slightly more than 51 percent Cr<sub>2</sub>O<sub>3</sub>.

A large number of small high-grade lenses were exposed on the Yellow Streak claim, but the largest of them was estimated to contain less than 15 tons, and the main reserves consist of low-grade disseminated ore on the other claims. There are three lenses on the Slats claim, 125 by 10 by 5 feet, 70 by 15 by 2 feet, and 50 by 10 by 5 feet, respectively. They strike north or slightly west of north and appear to dip about 20° E. They have frozen contacts and grade into the surrounding serpentinitized peridotite except where bounded by slickensided joints which strike about north and dip as much as 35° E. The movement on the joints has apparently been small. A body of ore estimated to contain about 10 percent by volume of chromite was exposed over a length of 35 feet and width of 10 feet in the only pit on the Rattlesnake claim. This body strikes N. 22° W. and dips about 65° NE., nearly parallel to the dominant joints.

The probable reserves were estimated as somewhat more than a thousand tons, but if the maximum depth of each lens down the dip is assumed to be equal to half the outcrop length, the reserves would be between 10,000 and 15,000 tons. The ore is believed to average 10 to 15 percent Cr<sub>2</sub>O<sub>3</sub> and Mr. Laton planned to sweeten the ore from the low-grade deposits with higher-grade ore from the Yellow Streak claim. A small mill began operation early in 1944, and during the year produced almost 50 long tons of concentrates containing about 48 percent Cr<sub>2</sub>O<sub>3</sub>, and having a Cr/Fe ratio of 2.6. (Wells, F. G., G. S. 43; Gros, F., G. S. 42; Bradley, W. W. 18, p. 203; 15, p. 319; Boalich, E. S. 21, p. 248; Laizure, C. McK. 26, p. 333.)

*Madeira Claim (4).*—In 1916 George Madeira of Healdsburg mined about 100 tons of chromite from several small lenses on a claim in sec. 31, T. 9 N., R. 10 W., about 8 miles north of Guerneville. The ore was said to contain 34 percent Cr<sub>2</sub>O<sub>3</sub>, and there is no record that it was shipped. (Bradley, W. W. 18, p. 201.)

*Red Hill Claim (5).*—The Red Hill claim, which was owned in 1942 by E. A. Truitt of Healdsburg, is in secs. 15 and 22, T. 11 N., R. 9 W., at an elevation of about 2400 feet on the north end of a ridge. In 1918 the claim was leased by G. W. Elder of St. Helena, who mined 150 to 200 tons of ore.

When Gros visited the deposit in 1942 the workings were badly caved, and there was little evidence of recent work. The workings included a cut about 150 feet long, 10 feet wide and 8 feet deep; a partly caved 15-foot drift at one end of the cut; and two small pits. Chromite could be seen only in the two small pits, in sheared serpentine and white

clay gouge. Scattered veinlets of cinnabar were seen in white silicified serpentine east of the larger cut.

The ore mined in 1918 apparently occurred as nearly horizontal high-grade lenses distributed over an area 100 feet long and 6 feet wide in the large cut. The high-grade ore was said to be more or less surrounded by disseminated ore or a mixture of chromite fragments and sheared serpentine; narrow stringers were common. The high-grade ore was soft and friable, and the low-grade ore was described as sandy. (Gros, F., G. S. 42; Caldwell, F. B. 18; Davis, E. F., in Louderback, G. D. 18; Boalich, E. S. 21, p. 248.)

*Rough Crossing Claim (6).*—The Rough Crossing claim is in sec. 21, T. 9 N., R. 11 W., on patented land which in 1918 belonged to the Eakles Brothers and was leased to K. K. Ash of Healdsburg. It was near the narrow-gage railroad of the Sonoma Magnesite Company. Caldwell indicates that a little shipping-grade ore had been mined from narrow stringers in an extensive deposit near the railroad. The shipping-grade ore was estimated to contain 40 percent  $\text{Cr}_2\text{O}_3$ , but the deposit as a whole was believed to average 6 percent  $\text{Cr}_2\text{O}_3$  or less. A small deposit about a mile to the southeast yielded about 12 tons of ore containing about 40 percent  $\text{Cr}_2\text{O}_3$ , but none of it was shipped. (Caldwell, F. B. 18.)

*Shanks and Copps Claim (7).*—Shanks and Copps, of San Francisco, in 1918 leased claims in sec. 13, T. 10 N., R. 11 W., 9 miles west of Geyserville. Much float was found on the ridge north of Skaggs Springs and about 20 tons of good ore was mined from several small deposits. As the ore was piled at the roadside when the mine was visited in 1918, it probably was hauled away and shipped, although there is no official record of the shipment. (Bradley, W. W. 18, p. 203; Laizure, C. McK. 26, p. 333.)

*Sonoma Chrome, Inc. (8).*—Bentley Neuman of Santa Clara leased 2000 acres of the Meeker Ranch in 1942 under the name of Sonoma Chrome, Inc., and obtained a loan from the Reconstruction Finance Corporation to clean out the old chromite workings and develop low-grade ore. The mine, then known as the Meeker, was leased in 1918 by S. H. Dolbear, who shipped 644 long tons of ore containing 39 to 42 percent  $\text{Cr}_2\text{O}_3$ . The deposits are in secs. 15, 16, and 17, T. 7 N., R. 10 W., on rounded grass-covered hills, and are 17 miles by paved highway from Santa Rosa.

The chromite deposits are alined in three main ore-bearing zones which strike about N. 40° W., parallel to the schistosity in the serpentine country rock. In 1942 low-grade ore was exposed to a depth of 4 feet over two areas about 100 feet by 50 feet each, about three-quarters of a mile apart. The mining in 1918 was limited mainly to a line of high-grade deposits half a mile southwest of the low-grade deposits. The principal working was an open cut 125 feet long by 15 to 20 feet deep, in which a 55-foot shaft was sunk at the lower end. From the shaft a drift is said to have been driven at least 40 feet in ore along the strike back under the cut, and Caldwell indicates that the ore body was a single vertical lens which extended more than 60 feet below the surface. Most of the old pits are less than 10 feet deep, and the other deposits seem to have been small.

The high-grade ore is dense and massive, and is said to range from 42 to 51 percent  $\text{Cr}_2\text{O}_3$ , with a Cr/Fe ratio of about 3:1. The low-grade

deposits are estimated to contain 15 to 20 percent  $\text{Cr}_2\text{O}_3$ , and the reserves appear to be less than 5000 long tons. (Gros, F., G. S. 42; Bradley, W. W. 18, p. 201; Laizure, C. MeK 26, p. 333; Caldwell, F. B. 18.)

*Warner and Clark Claim (9).*—Paul Warner of Pine Flat and Charles Clark of Calistoga located claims in sec. 10, T. 10 N., R. 8 W., near Pine Flat. Blocks of chromite weighing up to 50 or 60 pounds were scattered in the north half of the section, and several small lenses of high-grade ore were found in place. The largest deposit yielded about a ton, and although 5 tons was collected, no ore was shipped. (Davis, E. F., in Louderback, G. D. 18.)

*Welch Prospect (10).*—The Welch prospect is in sec. 22, T. 9 N., R. 11 W., near the Rough Crossing claim, and about a mile from the old Sonoma Magnesite Company railroad. It is on land which in 1918 was owned by Charles Welch, of Guerneville. An open cut revealed an irregular ore body about 50 feet long and 2 feet thick, which trended northwest and appeared to stand vertical. Caldwell estimated the reserves at 20 tons averaging 42 to 45 percent  $\text{Cr}_2\text{O}_3$ , but the deposit was not worked because the price asked by the owner was too high. (Caldwell, F. B. 18.)

#### Alphabetical List of Mines and Prospects

In the accompanying table the mines and prospects are listed alphabetically by counties and numbered as in figure 1. The ownership of the claims is given as of the date of the last report on the deposit and, therefore, in very few instances indicates the owner in 1944. The deposits are divided by production into four classes: A, deposits or properties from which at least 1000 tons of ore has been shipped; B, deposits from which 150 to 1000 tons of ore has been shipped; C, deposits from which small amounts of ore, but not more than 150 tons, have been shipped; and D, deposits from which no ore has been shipped, or whose location is uncertain.

**LIST OF CHROMITE MINES AND PROSPECTS ARRANGED ALPHABETICALLY BY COUNTY AND CLAIM**  
Colusa County

No.	Name of claim	Name of owner	Location			Class by production	Remarks
			Sec.	T. (N)	R. (W)		
1	Chrome Wonder	Sam Sites				D	Near Stonyford
2	Innes	F. C. Innes				D	Near Wilbur Springs
3	Liberty	Wesley Bradley				D	Near Stonyford
4	Princess	J. J. Sweeney	16	6		D	1½ miles NW of Cook Springs
	Stella	Elmer and George Evans				D	Near Stonyford
5	Teathers	Cy Teathers				D	Near Stonyford

## Glenn County

No.	Name of claim	Name of owner	Location		Class by production	Remarks
			Sec.	T. (N) R. (W)		
1	Avery. Black Diamond group.	Oscar Avery. Rustless Mining Corporation	13, 14, 24, 25, 19, 31	22 7	C A	Disseminated Includes Boulder City, Emmeline, Grey Eagle, Grey Eagle Extension, Katherine, Mary Ellen. Known as Whitlock and Oakes in 1893. Mainly disseminated
2	Black Diamond No. 6 (Loleta) Boulder City: see Black Diamond group	K. I. Cooper.	SW24	22 7	C	
1	Conklin and Williams. Emmeline: see Black Diamond group Grey Eagle: see Black Diamond group	Wells Conklin, Ed Williams Rustless Mining Corporation	3 NE25	22 22 7 7	C A	Disseminated; mined out 1944
3	Highpoint	Millsap, Keller.	SE13	22 7	D	32 miles west of Orland
4	Hooligan. Katherine: see Black Diamond group Loleta: see Black Diamond group	F. M. Burrows.			D	Disseminated
5	Manzanita	F. M. Burrows.	NW19	22 6	D	Disseminated
5	Manzanita Extension	Lena Burrows.	NW19	22 6	D	Disseminated
6	Manzanita mine.	Cushman	NE31	22 6	C	Disseminated
7	Mary Ellen: see Black Diamond group Swastika. Whitlock and Oakes: see Black Diamond group	A. E. Brune.	4, 5	18 6	C	

## Lake County

No.	Name of claim	Name of owner	Location		Class by pro-duction	Remarks
			Sec.	T. (N) R. (W)		
17	Betwixt (E. Z.)	P. B. Edwards, G. B. Smith.	SE 30	12	C	Claims abandoned in 1918.
1	Black Bart (Great Western). Black Diamond; see Smythe Bottle Rock; see Young Adams	W. B. Shepherd.	16	10	B	
2	Brown.	J. H. Brown.	29	12	D	Ownership disputed
3	Butler.	W. E. and Theresa Butler.	24	10	C	
26	Cabbage Head (fir Root Ridge).	Dave Dondoro, W. M. McLeod.	32	19	D	Ownership disputed
4	Copsey.	Arthur Copsey.	4	11	C	
18	E. Z.; see Betwixt.	Unknown.	29	12	5	High alumina variety? Owner refused to allow mining
5	Glad I Found It.	Irene Anderson, Laura Miles.	24?	10	C	
6	Gordon Springs.		2	11	D	Included Helen Ray, Juniper Ridge, Lakeview, Mummie, Poppun
7	Great Western; see Black Bart Gunn.	J. A. Gunn.	11, 14	12	C	
8	Harp and Sons Ranch. Herman; see Smythe	Harp and Sons.	20	11	C	Disseminated Mined out in 1918 Produced 1,500 to 2,000 tons Owners refused to allow mining
9	Holmstedt.	Victor Holmstedt, Van Warner.	22	10	C	
10	Kangaroo Cour.	C. L. Russell, E. L. Wilkinson.	25	10	C	Disseminated Mined out in 1918 Produced 1,500 to 2,000 tons Owners refused to allow mining
19	Lucky Strike.	W. B. Shepherd.	13, 24	12	A	
11	Manzanita; see Copsey Mastick ranch. Mint; see Copsey	—Mastick?.	3	10	D	Mined out in 1918 Location uncertain
12	Popp and Nichelini.	William Nichelini, F. W. Popp.	13	12	C	
20	Red Devil.	Sawyer Tanning Co., lessee.	8?	12	C	Ownership disputed Mostly disseminated
21	Riverside; see Betwixt.		NW29	12	5?	
13	Schaffer.	F. Schaffer.	36	13	D	Ownership disputed Mostly disseminated
22	Smythe (Herman).	August Herman, Tom Smythe.	28	11	D	
14	Sutro.	Charles Sutro.	26	10	C	800-lb. lens mined out 5 tons float ore shipped Float reported by Davis Abandoned prospect Abandoned prospect
15	Uncle Josh; see Copsey Whispering Pines.	David Streckler.	14	11	D	
16	Young Adams.	Young Adams.	12	12	C	Abandoned prospect Abandoned prospect
23	Chromite float.	None.	35	14	D	
24	Unnamed prospect.	Unknown.	SW33	12	D	Abandoned prospect Abandoned prospect
25	Unnamed prospect.	Unknown.	NW 3	11	D	

## Mendocino County

No.	Name of claim	Name of owner	Location			Class by production	Remarks
			Sec.	T. (N)	R. (W)		
1	Crawford.....	W. L. Crawford.....		14		D	9 miles south of Ukiah Low-grade layered deposits Mostly float in deep soil. More than 100 claims filed in 1918.  Inaccessible, undeveloped  Mined out Float; inaccessible  Float in landslide
2	Graham group.....	Edward George.....		24	11	C	
	Guthrie group.....	Alex Guthrie, Frank Asbill, et al.			16	B	
3	Little Red Mountain.....	Eva Dunn.....	6	23	16	C?	
4	Lloyd.....	A. D. Lloyd.....	35	23	15	D	
5	Mitty; see Guthrie group						
6	Moore.....	O. E. Moore.....	24	15	13	C	
	Shields.....	W. E. Shields.....	11	23	11	D	
7	Summit; see Graham group						
	Unnamed deposit.....	Unknown.....	W1	23	11	D	

## Napa County

No.	Name of claim	Name of owner	Location			Class by production	Remarks
			Sec.	T. (N)	R. (W)		
17	Adams: see Astute	Young Adams, W. D. Hayes.	32	10	5	B	Disseminated and high grade Mined out in 1917
1	Black Hawk.	T. L. Neil.	23	11	5	C	
25	Blue Jay: see Samuel Springs Buzard group: see Samuel Springs Cedar Rough: see Samuel Springs Chase: see Cigarette		NW20	9	4	D	
18	Chrome Center.	R. W. Wallace.	36	10	5	C?	
2	Cigarette.	W. M. Noel.	5	10	4	B	
3	Crystal Creek.		SW12	10	5	C	Abandoned in 1918
4	Dollerhyde.	R. A. Dollerhyde.	6	10	4	C	Float; claim abandoned in 1918
26	Eagle: see Samuel Springs		NW29	9	4	D	Mined out
19	Elder.	G. W. Tarry.	31	10	4	C	Leased by Sawyer Tanning Co.
5	Ferris.	George Graves.	36	11	5	C	Float; high alumina?
20	Fourth of July.	Frank Rhoda.	N18	10	5	C?	200 pounds of float
21	Glad I Found You.	W. D. Hayes, Young Adams.	19	10	5	D	Low-grade disseminated ore left
6	Graves mine.	W. B. Shepherd.	NE36	11	5	B	Probably same as Graves mine (6)
22	Graves ranch.		11	9	4		No ore visible in place in 1942
7	Grey.	W. B. Shepherd.	13	11	5	C	
8	Hampton: see Samuel Springs Hightower.	W. C. Hightower.	12 or 13	10	5	C	5 or 6 tons of ore mined
	Honolulu Lady: see Samuel Springs Last Chance: see Samuel Springs Last Found: see Grey Little: see Samuel Springs Lizzie P: see Samuel Springs Lost Horse: see Samuel Springs Marshall: see Moore						
27	McGinnis: see Samuel Springs		NW33	9	4	D	
28	Meadow: see Samuel Springs. Mistake: see Samuel Springs.		33	9	4		

9	Moore.....	John Moore.....	17-19	11	4	B	Total production about 2,000 tons
10	Mullaly.....	H. W. Mullaly.....	18	11	4	C	
11	Neil: see Black Hawk	George Vanderbilt.....	32	11	4	D	
23	Nevada.....	A. Nichelini.....	33, 34	8	4	A	
	Nichelini.....						
	Pic: see Cigarette						
	Placer Chrome: see Cigarette						
	Red Bird: see Moore						
24	Reeve.....	R. B. Reeve.....	10, 14	8	5	D	
12	Rocketteller: see Nevada		5	10	4		
25-29	St. Gabriel: see Nevada						
	Samuel Springs claims	S. owners.....					
30	Sullinger.....	W. Kilpatrick.....		8-9	4	D	
31	Tarry.....	G. E. Tarry.....	2	7	5	D	
29	Trout Creek: see Samuel Springs		NE31	10	5	C	
13	Turner.....	Clifford Turner.....	1	10	5	C	
	Vanderbilt: see Moore						
	Viola: see Samuel Springs						
	Wallace: see Chrome Center						
	White Buck: see Turner						
14	Unnamed prospect.....	Unknown.....	SW12	11	5	D	
15	Unnamed prospect.....	Unknown.....	SE18	11	4	D	
16	Unnamed prospect.....	Unknown.....	SW17	11	4	D	
32	Unnamed prospect.....	G. E. Tarry.....	5	9	5	D	
33	Unnamed prospect.....	G. B. Powers.....	12	7	4	D	

Scattered lenses on 15 claims  
Abandoned in 1918

Small scattered lenses

Small lenses; 10 to 15 percent  
Cr<sub>2</sub>O<sub>3</sub>

Mostly nodular ore?

## Sonoma County

No.	Name of claim	Name of owner	Location			Class by production	Remarks	
			Sec.	T.(N)	R.(W)			
1	Ardoin: see Barnes Barnes Burl: see Laton Camp Meeker: see Sonoma Chrome, Inc. Culver Baer: see Red Hill Eakles Bros: see Rough Crossing Ferrara (Ferrari): see Barnes Gaver Juniper Ridge: see Red Hill Key: see Red Hill Laton	V. and A. Ardoin, J. Ferrari, McMahon	32	11	10	A	Float in river gravels	
2	Lock: see Red Hill Lock and Key: see Red Hill Lone Bird: see Laton Madeira McMahon Ranch: see Barnes Meeker: see Sonoma Chrome Inc. Parmeter Ranch: see Laton Patentes: see Barnes Pine Flat: see Warner and Clark Itatlesnake: see Laton Red Hill Red Slide: see Laton Rough Crossing St. Charles: see Welch Serpentine: see Laton Shanks & Copps Slats: see Laton Sonoma Chrome Inc. Vadun: see Barnes Wanderer: see Barnes Warner & Clark Welch Yellow Streak: see Laton	A. P. Gaver	27	7	10	D		
3		A. J. Laton	SE13 SW18	9	12 9	11	C	Mainly milling-grade ore
4		George Madeira	31	9	10	D	100 tons low-grade ore mined	
5		E. A. Truitt	15, 22	11	9	B		
6		Eakles Bros.	21	9	11	C	Low-grade disseminated	
7		Shanks & Copps	13	10	11	C	20 tons probably shipped	
8		Meeker Ranch	15-17	7	10	B	Bentley Neuman, lessee	
9		Paul Warner, Charles Clark	10	10	8	D		
10		Charles Welch	22	9	11	D		

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