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Iron Resources of California
Bulletin No. 129

PART E

Cave Canyon Iron-Ore Deposits
San Bernardino County, California

By CARL A. LAMEY
GEOLOGICAL SURVEY, U. S. DEPARTMENT OF THE INTERIOR

Issued by the
STATE DIVISION OF MINES

CAVE CANYON IRON-ORE DEPOSITS, SAN BERNARDINO COUNTY, CALIFORNIA *

By Carl A. Lamey **
United States Department of the Interior, Geological Survey

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ABSTRACT

The Cave Canyon iron-ore deposits are in the Mojave Desert, about half a mile north of Baxter, San Bernardino County, California. The deposits are owned by the California Portland Cement Company, Los Angeles, and are being mined in open pits by A. S. Vinnell Company, Alhambra.

The reserves may be as much as 3,500,000 to 4,000,000 long tons of ore, with which much waste rock is associated. Probably not more than 2,500,000 tons of ore are recoverable, and possibly half of this amount could be mined at normal peacetime prices.

The orebodies are steeply inclined lenticular masses. Some are associated with gneissic and possibly also quartzitic rocks, and others are associated with pre-Cambrian limestone or dolomite. A dioritic rock and remnants of partly replaced limestone are constantly present with the ore, indicating that it was formed as a contact-metamorphic replacement of limestone.

Faults, shattered and brecciated zones, and folds are the characteristic structural features of the area.

INTRODUCTION

The Cave Canyon iron-ore deposits are in the Mojave Desert, San Bernardino County, California (fig. 23). They are about half a mile north of Baxter, chiefly in sec. 12, T. 11 N., R. 6 E., S.B. The claims covering the deposits are shown by figure 24.

The deposits are reached by a dirt road connecting with U. S. highway 91 about half a mile east of Cronise Valley. This road crosses part of the bed of the Mojave River, which is usually dry. During and shortly after flood periods, however, the road is nearly or entirely impassable.

* Published by permission of the Director, Geological Survey, U. S. Department of the Interior. Manuscript submitted for publication September 28, 1944.

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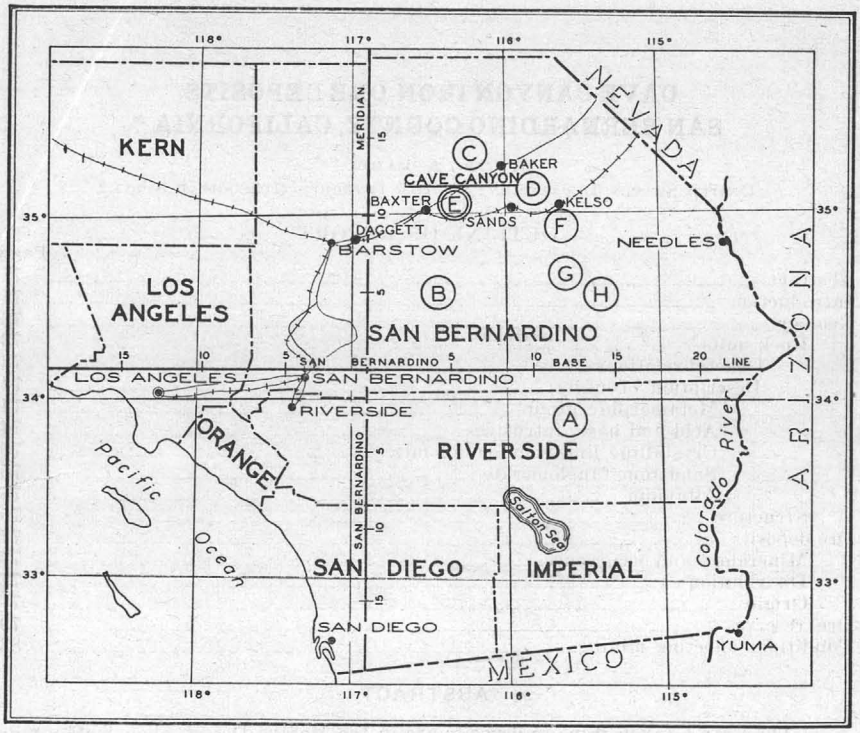


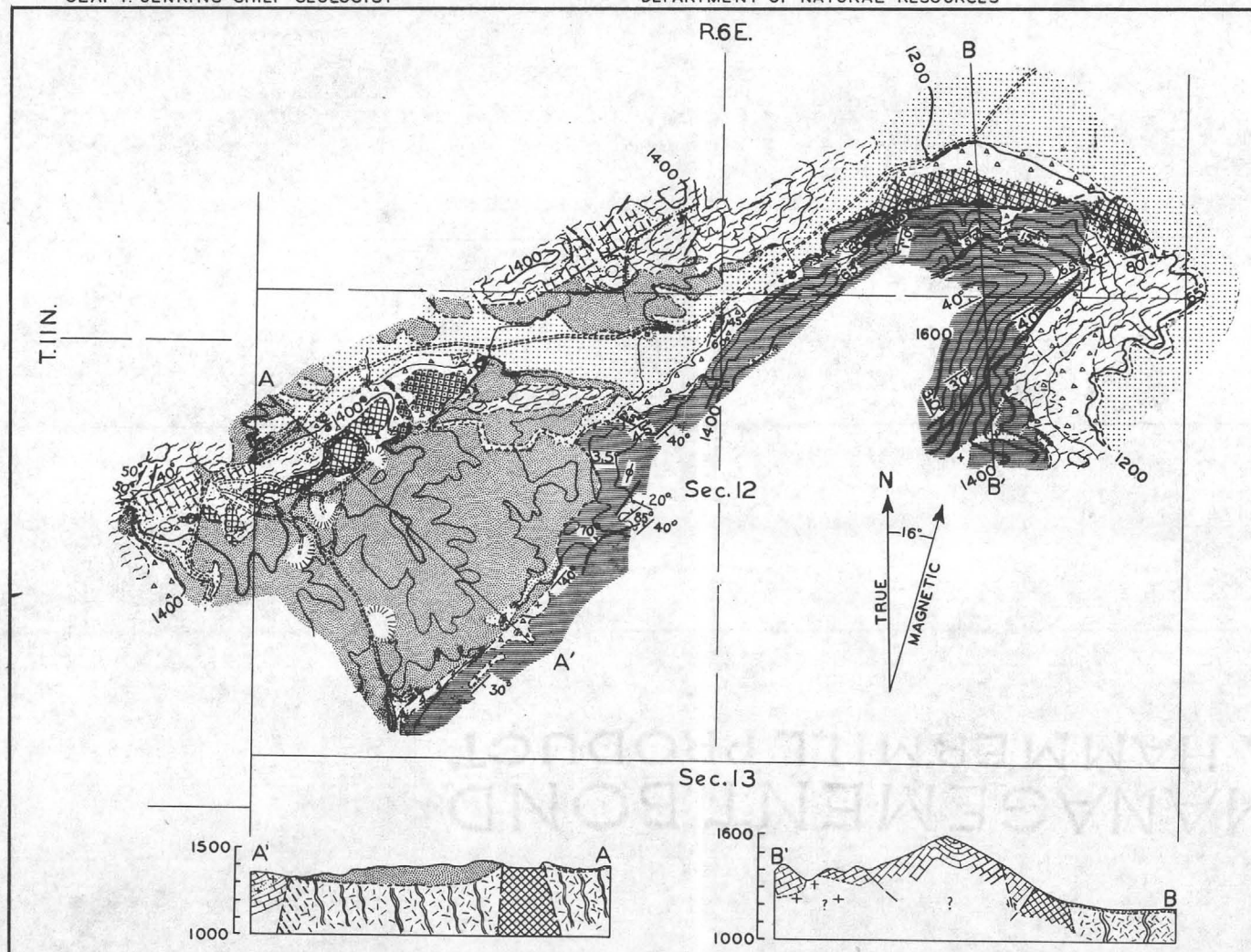
FIG. 23. Index map of southern California iron-ore deposits, showing: (A) Eagle Mountains; (B) Iron Mountain (Lava Bed); (C) Iron Mountain (Silver Lake); (D) Old Dad Mountain; (E) CAVE CANYON, described in this report; (F) Vulcan; (G) Iron Hat; (H) Ship Mountains.

Topographically the area is characterized by ridges trending northeast, with hills interspersed between the ridges. The chief orebodies crop out at altitudes between 1,400 and 1,450 feet, and form a low central ridge that lies between higher ridges to the south and north. Other orebodies are near the foot of the southern ridge, at altitudes between 1,200 and 1,280 feet.

The deposits are owned by the California Portland Cement Company, 601 West Fifth Street, Los Angeles, California, and are being mined in open pits by A. S. Vinnell Company, Alhambra, California. Ore is transported by truck about half a mile to a spur track of the Union Pacific Railroad.

The orebodies have been explored by a number of trenches, adits, and shafts, one of the latter being about 125 feet deep. Most of the adits can be entered, but ladders and timbering in the shafts are not in good condition.

For a number of years the ore has been used in the manufacture of cement.



GEOLOGIC MAP AND SECTIONS
OF THE
CAVE CANYON IRON-ORE DEPOSITS
BAXTER, SAN BERNARDINO COUNTY, CALIFORNIA

TOPOGRAPHY AND GEOLOGY BY

C.A.LAMEY, IN CHARGE, P.E HOTZ AND S.E.GOOD
UNITED STATES DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY

MARCH 1943

SCALE
0 1000 2000 3000 FT.
CONTOUR INTERVAL 20 FEET

EXPLANATION

SEDIMENTARY ROCKS

ALLUVIUM
(Sand and gravel)

TALUS

FANGLOMERATE
(Lithified alluvial fan material composed of lenticular beds of fragmental rock and sandstone)

CRYSTALLINE LIMESTONE
(White and bluish gray moderately well-bedded crystalline limestone

Fault
Strike and dip of beds
Strike of vertical beds
Strike and dip of schistosity
Crushed zone
Adit

IGNEOUS ROCKS

DIORITE PORPHYRY
(Green, slightly altered, medium grained porphyritic rock with prominent plagioclase phenocrysts.)

UNDIFFERENTIATED
(Metamorphosed igneous and sedimentary rocks.)

ECONOMIC PRODUCTS

IRON ORE
(Dot on pattern indicates lean ore.)

Areas of possible ore under cover

Shaft
Dump

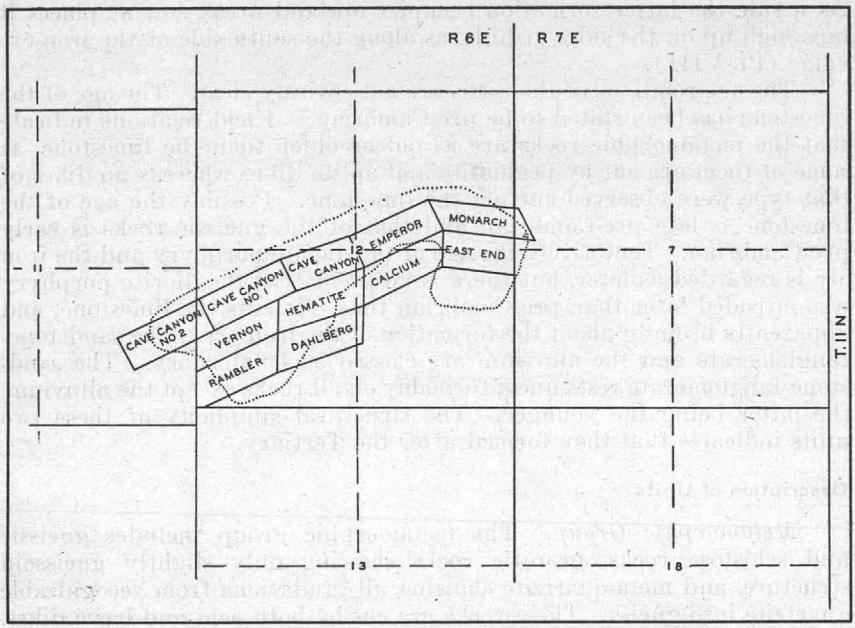


FIG. 24. Claim map, Cave Canyon iron-ore deposits, San Bernardino County. Dotted line indicates position of mapped area.

There is very little published material regarding these deposits.[1]

The deposits were examined and mapped during March 1943, by Carl A. Lamey, Preston E. Hotz, and Stanley E. Good. Mapping was done by means of plane table and telescopic alidade. Elevation was established from U. S. Geological Survey bench mark No. 1421 at Baxter. True north was determined by use of the Baldwin solar chart.

Acknowledgment is due to employees of A. S. Vinnell Company for courtesies extended in the field.

GEOLOGY

Rock Units

General Relations

The major exposed rock units that are associated with the iron-ore deposits include: (1) a metamorphic group consisting of granitic, gneissic, and somewhat schistose rocks, including some meta-quartzite; (2) acid and basic intrusives, dominantly granite, pegmatite, aplite, and diorite porphyry; (3) crystalline limestone or dolomite; (4) a sandstone-fanglomerate formation; and (5) alluvium. Roughly, with the exception of the intrusives and the alluvium, these units occur in zones trending northeast (Pl. VIII). The limestone forms a conspicuous ridge extending westward for about half a mile along the southern part of the area. The principal mass of iron ore makes a low ridge flanked to the north by gneissic rocks and to the south by the sandstone-fanglomerate.

[1] Cave Canyon iron mine: California Div. Mines, Min. Abstracts, Iron, p. 26, 1941. Hewett, D. F., Callaghan, Eugene, Moore, B. N., Nolan, T. B., Rubey, W. W., and Schaller, W. T., Mineral resources of the region around Boulder Dam: U. S. Geol. Survey Bull. 871, p. 78, 1936.

As a rule the latter formation occupies lowland areas, but at places it laps high up on the sides of hills, as along the south side of the iron-ore ridge (Pl. VIII).

The age relations of the rocks are not entirely clear. The age of the limestone has been stated to be pre-Cambrian.[2] Field relations indicate that the metamorphic rocks are as old or older than the limestone, as some of them are cut by pegmatite and aplite dikes whereas no dikes of that type were observed cutting the limestone. Possibly the age of the limestone is late pre-Cambrian and that of the gneissic rocks is early pre-Cambrian. Tentatively the age of the diorite porphyry and the iron ore is regarded as later, but there is no proof that the diorite porphyry was intruded later than pre-Cambrian time. It cuts the limestone, and apparently brought about the formation of the iron ore. The sandstone-fanglomerate and the alluvium are classed as Quaternary. The sandstone-fanglomerate rests unconformably on all rocks except the alluvium, the latter being the younger. The structural simplicity of these two units indicates that they formed after the Tertiary.

Description of Units

Metamorphic Group. The metamorphic group includes gneissic and schistose rocks, granitic rocks showing only slightly gneissoid structure, and meta-quartzite showing all gradations from recognizable quartzite into gneiss. These rocks are cut by both acid and basic dikes. Only the more abundant types will be described.[3]

The chief gneissic types are: (1) a gray, gneissoid to porphyritic rock composed chiefly of white feldspar and black to green hornblende and biotite; and (2) a gneissoid granite, mottled in white, pink, light brown, green, and black, containing orthoclase or microcline crystals about 0.2-inch long and 0.1-inch wide. The first of these rocks is chiefly in the northern metamorphic belt, and makes up part of the southern slope of Cave Mountain, whereas the second is chiefly in the zone south of the limestone (Pl. VIII). In addition to these two gneissic rocks, outcrops of red, coarse-grained granite gneiss are present to the north and west, beyond the mapped area. This granite gneiss forms much of Cave Mountain, and large blocks of it rest on the sandstone-fanglomerate and other units.

The meta-quartzite shows all gradations from well-bedded vitreous and argillaceous quartzite into banded granitic gneiss. Most exposures are conspicuously white. Associated with the meta-quartzite is a very siliceous, white to pink rock that becomes slightly brown on weathering. It has a very fine sugary texture, exhibits a well defined lineation at some places, and contains numerous small feldspar crystals. This rock may be a phase of the meta-quartzite or it may be an aplitic granite.

Schistose rocks include biotite, hornblende, and quartz-mica schists. They occur in minor amounts associated with the gneisses and the meta-quartzite.

Acid and Basic Intrusives. The chief acid intrusives are granite, aplite, and pegmatite. The basic intrusives are chiefly diorite porphyry. The granite is white to tan, of medium granitoid texture, and is composed principally of orthoclase and quartz. The aplite and pegmatite,

[2] Hewett, D. F., and others, op. cit., p. 163.
[3] Rock names and descriptions are based on megascopic examination only.

which occur as dikes, are pink to reddish. The latter is composed chiefly of orthoclase or microcline and quartz. The diorite porphyry is dark green but contains conspicuous phenocrysts of white plagioclase. At some places it grades into a diorite lacking phenocrysts and at others into a dark green to nearly black rock composed chiefly of biotite.

Crystalline Limestone or Dolomite. The limestone or dolomite is chiefly white to bluish gray, but some of it is dark gray, light brown, and reddish brown. Much of it is crystalline and could be classed as marble, but there are also fine-grained varieties. Bedded, massive, and brecciated types are present, but exposures exhibiting well-defined bedding are characteristic. Chert is a conspicuous component of some phases of the limestone. It occurs as nodules and lenses, and as beds from a few inches to 4 feet in thickness. Some of the chert has been recrystallized and has a quartzitic appearance. Thin, elongated tremolite crystals, at places associated with brown mica, occur in some outcrops of the limestone.

Sandstone-Fanglomerate. The sandstone-fanglomerate formation is composed of light-gray to brownish-gray, medium- to coarse-grained, moderately indurated sandstone, and gravels ranging from pebble to boulder size. Many of the sand grains are well-rounded and frosted, but others are subrounded to sub-angular and angular. The gravels are rounded to angular. At least some of them have been transported but a very short distance, as they are composed of the same material as the outcrops on which the fanglomerate rests. Part of the sandstone is massive, part of it is well bedded. At some places sandstone alternates with gravel beds, at others the formation is dominantly sand or dominantly gravel. The total thickness of the formation is not known, but one shaft in the mapped area passed through 90 feet of it and did not penetrate any other rock at the bottom. Several hundred feet are exposed in the adjoining area.

Alluvium. The alluvium is of the usual type, composed of various rock fragments.

Structure

Faults, shattered and brecciated zones, and folds, both simple and complex, are the characteristic structural features of the area. Practically all of the main structures trend northeast. The structure of part of the limestone apparently differs from that of the other rocks.

The structure of the limestone composing the ridge along the south side of the area varies from relatively simple to complex. The west-central part of the ridge, which is not shown on the map, is essentially a simple anticline with steeply dipping limbs striking N. 45° E. This anticlinal structure terminates against a fault striking N. 70° W. and dipping 25° N. The beds on the northern side of the fault dip flatly north 18° to 30°, and strike approximately N. 80° E., although the direction of strike varies considerably in short distances. This fault continues along the southern side of the limestone ridge, but there it strikes about N. 45° E. (Pl. VIII), and dips from 25° to 75°. Apparently it is a thrust fault. Northwest of it the beds are relatively flat, but locally they are crumpled into a series of complex folds that lie in a nearly horizontal position.

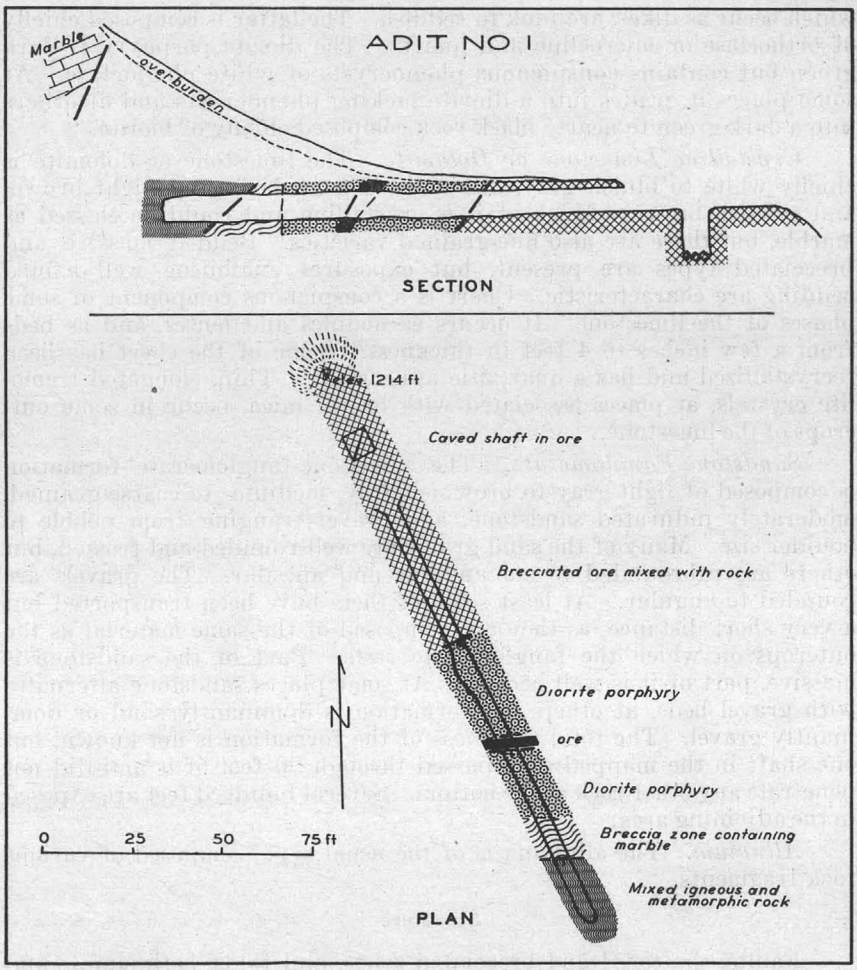


FIG. 25. Plan and section showing geology of No. 1 adit, Cave Canyon iron-ore deposits, Baxter.

Examined in detail, much of the eastern part of the limestone ridge appears to be made up of a series of blocks bounded by faults and brecciated zones. Along the northern side of the ridge there are a number of steeply dipping faults and large quantities of breccia. Much of the breccia appears to have been formed by close folding under relatively light load. The limestone along the northern side of the ridge is separated from the iron ore by faults wherever the contact is exposed. Field evidence is not clear, but apparently these faults are dipping very flatly south, as adits that penetrate some distance beyond the surface exposure of the contact between limestone and iron ore fail to encounter limestone (figs. 25 and 26).

Shearing and shattering are characteristic of some of the gneiss and meta-quartzite, and of much of the iron ore. At some places they are so much shattered that exposures are masses of broken and pulverized rock. Remnants of bedding or foliation indicate steep dips and complex folds.

ORE DEPOSITS

Mineralogy and Occurrence

The ore is black to red, and is composed chiefly of magnetite and hematite, with some limonite. Some brecciated ore masses contain large quantities of gypsum and very minor amounts of malachite and chrysocolla. In surface exposures the ore appears to be relatively firm, but in adits, trenches, and pits most of it is seen to be shattered.

The orebodies are steeply inclined lenticular masses associated with gneissic and quartzitic rock, and limestone. Estimates indicate that the amount of waste rock occurring as scattered masses throughout the ore zone ranges from 25 to 50 percent or more.

Distribution

The deposits consist of two principal ore zones and a few minor orebodies. The most important zone is associated with much shattered gneissic and quartzitic rock in the western part of sec. 12 (Pl. VIII). The other principal zone lies along the northeastern end of the limestone ridge, in the eastern part of sec. 12 (Pl. VIII). A distance of about 2,500 feet separates these two zones. Throughout the intervening area there is alluvium and sandstone-fanglomerate. At one place this intervening area was prospected by a shaft 90 feet deep (Pl. VIII). The only rock encountered in the shaft was the sandstone-fanglomerate.

A few small orebodies occur within the main mass of limestone. One of these is located on the north side of the ridge, near the center of sec. 12 (Pl. VIII). Nearly south of this body, toward the southern side of the limestone, there are a few other small orebodies not shown on the map. The largest of these is about 225 feet long and ranges from 20 feet to 50 feet in width. Ore is exposed throughout a vertical distance of 50 feet. At least half of the orebody consists of waste rock.

Origin

The orebodies are believed to be contact-metamorphic replacement deposits, chiefly in limestone or dolomite but possibly partly in quartzite. The clearest evidence regarding the origin of the ore is shown in the smaller bodies. There are all stages of ore formation, from limestone

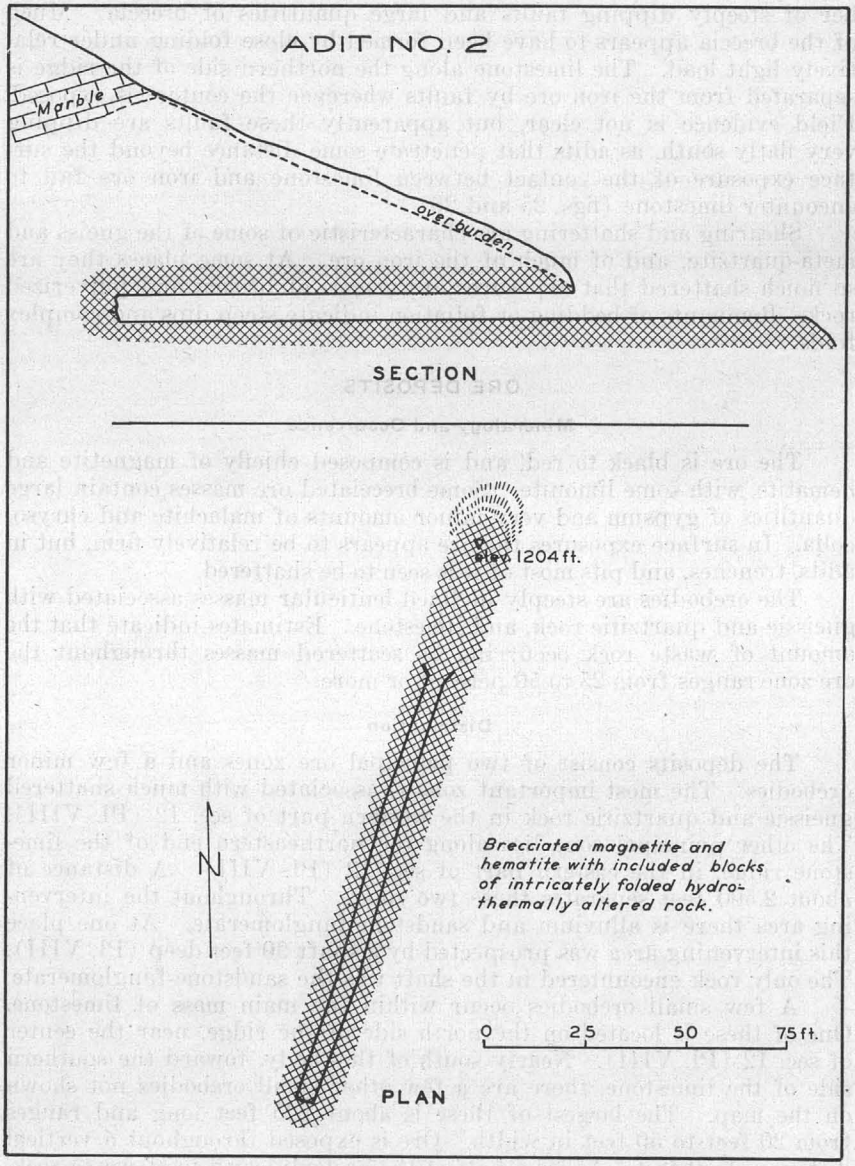


FIG. 26. Plan and section showing geology of No. 2 adit, Cave Canyon iron-ore deposits, Baxter.

containing only minute specks of magnetite through partly replaced limestone into nearly solid ore. At practically every place where ore is exposed, there are also a diorite porphyry and remnants of partially replaced limestone. At one place quartzite occurs next to ore and apparently grades into it. The quartzite has been fractured and the fractures filled with ore. At this place also, the ore may have resulted from replacement of limestone interbedded with quartzite, the limestone having been completely replaced, but there is no direct evidence that this is the case.

ORE RESERVES

The reserves of the area may be as much as 3,500,000 to 4,000,000 long tons of ore, but probably not more than 2,500,000 long tons are recoverable, and not more than half of the recoverable ore could be mined at normal peacetime prices.

The composition of the ore is indicated by the analyses of two samples collected and analyzed by the Kaiser Company, Inc., and one sample collected by the owner, which have been released for publication.

Composition of samples collected and analyzed by the Kaiser Company, Inc., and collected by the owner, Cave Canyon iron-ore deposits, San Bernardino County, California

Sampled by	Percent						
	Fe	*P*	*SiO_2*	*S*	*CaO*	*MgO*	*Al_2O_3*
Kaiser Company	60.00	0.061	5.40	1.01	1.38	0.48	0.31
Kaiser Company	64.60	0.084	2.91	0.043	0.65	0.39	0.58
Owner	67.35	0.122	1.80	--------	--------	--------	--------

The reserves are divided into measured, indicated, and inferred ore. The measured ore was estimated from outcrops, pits, trenches, and adits; the indicated ore, from known depth of ore of 220 feet at one place, as shown by surface outcrops and a shaft; and the inferred ore, from inferred depth based on geologic conditions.

The tonnage factor of 12 cubic feet per long ton probably is the best one to use, because of the broken character of the ore; but estimates are given based on tonnage factors of both 10 and 12, after making volume deductions for waste rock (see page 83).

Not all of the reserve ore is believed to be recoverable, due to conditions affecting mining. Estimates of the amount recoverable at normal peacetime prices and at emergency prices are given on page 83.

The estimate of the amount of ore recoverable at normal peacetime prices may be too high, due to the large amounts of shattered waste rock present with the ore.

It is possible that additional ore not considered in these estimates may be present beneath the limestone along the northeast end of the limestone ridge. At the surface, field evidence indicates that the iron ore is in fault contact with the limestone. However, two adits show that iron ore extends beneath the limestone (figs. 25 and 26). Any ore beneath the limestone would need to be recovered by underground methods, and would be minable at emergency prices only, if at all.

FIG. 27. Cave Canyon iron-ore deposit, near Baxter, California. Prospect tunnels and trenches. *Photo by E. F. Burchard, 1926.*

FIG. 28. Cave Canyon iron-ore deposit near Baxter. Shows open cut where iron ore for manufacture of low-heat portland cement is mined by steam shovel. *Photo by E. F. Burchard, 1941.*

FIG. 29. Cave Canyon iron-ore deposit, near Baxter. Open cut near top of ridge. Shows relations of iron ore (black) and light-colored non-ore-bearing associated rock. *Photo by E. F. Burchard, 1941.*

Estimated iron-ore reserves, Cave Canyon iron-ore deposits, sec. 12, T. 11 N., R. 6 E.

Deposit	Ore, long tons, using tonnage factor	
	10 cu. ft. per long ton	12 cu. ft. per long ton
Western deposit, now being mined:		
Measured ore	450,000	370,000
Indicated ore	805,000	675,000
Inferred ore	1,130,000	955,000
Total ore	2,385,000	2,000,000
Eastern deposit:		
Measured ore	175,000	150,000
Indicated ore	560,000	460,000
Inferred ore	985,000	825,000
Total ore	1,720,000	1,435,000
Grand Total, both areas:		
Measured ore	625,000	520,000
Indicated ore	1,365,000	1,135,000
Inferred ore	2,115,000	1,780,000
Total ore	4,105,000	3,435,000

Estimated iron ore recoverable at normal peacetime prices and at emergency prices, Cave Canyon iron-ore deposits, sec. 12, T. 11 N., R. 6 E.

	Ore, long tons, using tonnage factor	
	10 cu. ft. per long ton	12 cu. ft. per long ton
Probable ore recoverable at peacetime prices	1,350,000	1,000,000
Possible additional ore recoverable at emergency prices	1,400,000	1,300,000
Total possible ore recoverable	2,750,000	2,300,000

CONDITIONS AFFECTING MINING

There are two chief factors detrimental to mining these deposits: (1) the large amount of waste rock present with the ore; and (2) the shattered character of the ore and rock. The waste rock is so badly shattered that it will not remain standing as the ore is mined, but must be removed from the pit. The wall rock at the margins of the main orebody is broken and weak. It is probable that open-pit mining could not be carried much beyond the present depth of 35 or 40 feet without serious caving of the walls. If underground mining were attempted, a great amount of timbering would be necessary.