Magnesium-Mineral Resources of the Currant Creek District, Nevada

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By CHARLES J. VITALIANO

CONTRIBUTIONS TO ECONOMIC GEOLOGY, 1951

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MAGNESIUM-MINERAL RESOURCES OF THE CURRANT CREEK DISTRICT, NEVADA

By Charles J. Vitaliano

ABSTRACT

The magnesite deposits of the Currant Creek district near Ely, Nev., have produced experimental shipments amounting to not over 1,700 tons. There was no mining activity in the district, so far as magnesite was concerned, when the deposits were studied late in 1942, but the U. S. Bureau of Mines conducted a drilling and trenching project on two of the deposits, the Ala-Mar and the Rex, at that time.

The host rock is the bedded calcareous Currant tuff, considered to be of late Miocene or early Pliocene age, which lies between quartz latite above and basaltic andesite and dacitic rock below in the western part of the area and between quartz latite and dacite in the eastern part. The thickness of the tuff is variable but averages 300 feet. Unaltered tuff may contain as much as 80 percent carbonate. All the beds dip gently eastward from the summit of the Horse Range, but they are broken by a number of major faults that trend northeast and by several minor faults of variable trend.

Magnesite occurs as nodules, as veins or lenses, and as disseminated grains in masses of altered tuff. The associated minerals are dolomite, a magnesium silicate (a member of the serpentine group), calcite, and silica in various forms such as chalcedony, opal, and quartz. The silica minerals are late and transect the others. Magnesite also is earlier than the silica minerals. Its relation to the other carbonates is not always clear, but it is probably later than most of the dolomite. The hard, dense, white nodules are distributed in zones, commonly a hundred feet or more long. The lenses or veins may reach a length of 100 feet and a width of 12 feet but are generally much smaller. Both the magnesite and the associated material are low in alumina and iron content. The alteration is believed to have been due to ascending hot-spring waters, rich in magnesia, that formed the magnesium silicate, dolomite, and nodular magnesite. Later solutions deposited the various forms of silica that cut or replaced the earlier minerals.

The reserves of recoverable magnesite are small, totaling about 8,500 tons. There is a much larger tonnage of altered tuff that contains magnesia but is high in silica and lime. Whether this material can be utilized commercially remains to be seen.

INTRODUCTION

LOCATION AND ACCESSIBILITY

The magnesite deposits of the Currant Creek mining district (fig. 1) are clustered in two groups in an area, roughly 13 miles long in an

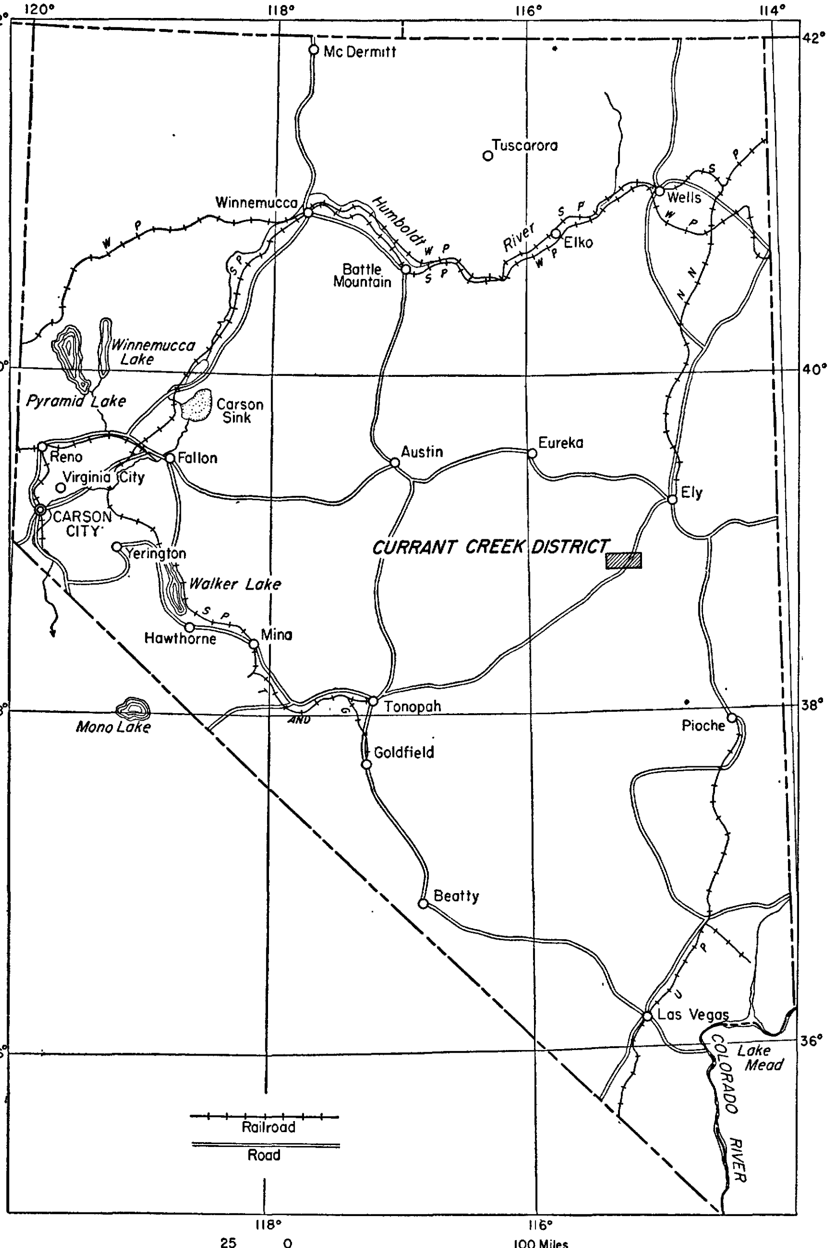

FIGURE 1.—Index map of Nevada, showing the location of the Currant Creek mining district.

east-west direction and 4 miles wide, in White Pine and Nye Counties, Nev. The eastern group of deposits is 29 miles by highway southwest of Ely, the shipping point and principal city in eastern Nevada. The Ala-Mar deposit in the western group is 42 miles by highway and mine road from Ely. The eastern group is in the northwestern part of T. 12 N., R. 61 E., and the adjoining part of T. 12 N., R. 60 E.; the other deposits are in T. 12 N., R. 59 E. (unsurveyed). The Windous, Rigsby, and Chester deposits are close to the Ely-Tonopah highway; the Rex-Pine Lode and White Knolls deposits are reached by branch roads as much as 10 miles long; but the Snowball deposits can be reached only by trail. (See pl. 1.)

The western group of deposits is on the east slope of the Horse Range, which is composed of dissected Tertiary volcanic and sedimentary rocks, at an altitude of 7,000 feet. West of the Horse Range

FIGURE 2.—View looking northeast from U. S. Highway 6 toward the Windous magnesite deposit, Currant Creek district, Nev. The light-colored area on the right is the deposit; the flat-topped butte at the left is capped with porphyritic quartz latite and shows the basal black glassy layer.

is the very prominent White Pine Range, composed of Paleozoic rocks, whereas to the east is a broad basin or plain sloping gently eastward. This plain separates the Horse Range from the low hills and flat-topped buttes in which the eastern group of magnesite deposits occurs (fig. 2). The White River, a small stream that crosses the northern part of the area, doubtless could supply sufficient water for normal drilling requirements. There are four springs on the claims of the Nevada Magnesite Co., and a spring 1¾ miles southeast of the Ala-Mar deposit has been partly developed.

HISTORY AND EXPLORATION

The occurrence of magnesite in the Currant Creek district has been known for many years and was first described by Fulton and Smith (1932, mimeographed supplement to p. 6). Samples sent to the Geological Survey from the area were found to include magnesite and a magnesium silicate, possibly deweylite (Rubey and Callaghan, 1936). The various deposits have been prospected from time to time, but only the Windous and Ala-Mar deposits have yielded even small amounts of magnesite.

The Windous deposit was operated under lease from the owner, Tom Windous, from November 1, 1940, to February 1, 1942, by the Westvaco Chlorine Products Corp. The deposit was explored by numerous surface pits and by two crosscuts and connecting drifts with a total length of 651 feet. A total of about 1,200 tons of magnesite was selectively mined from the several pits and the glory hole and shipped to Newark, Calif., where a special low-iron refractory was prepared for the General Electric Co.

The Ala-Mar, formerly the Manzoni, deposit was explored by a pit and a shaft, the latter now filled in. The pit has a width of 100 feet and a depth of 10 to 20 feet. The present operators, the Ala-Mar Magnesium Co., Inc., installed crushing machinery and mined some of the magnesite, 40 tons of which is said to have been shipped to the General Electric Co. in February 1940. The property operated sporadically from June 1941 to April 1942. Caustic calcine (MgO) is said to have been produced from about 500 tons of the Ala-Mar magnesite in a kiln at Sodaville, Nev.

From September 1 to November 21, 1942, the U. S. Bureau of Mines conducted a program of exploration at the Ala-Mar and Nevada Magnesite properties. Nine holes, with a total length of 1,490 feet, were drilled on the Ala-Mar, and four holes, totaling 374 feet, were drilled on the Nevada Magnesite Co.'s property. Numerous trenches were excavated and sampled, especially on the Ala-Mar property. Four holes were drilled to determine the extent of the magnesite near the Ala-Mar pit, but most of the exploration was devoted to testing the country rock over a considerable area for possible extension of the magnesite.

FIELD WORK AND ACKNOWLEDGMENTS

The Currant Creek district was examined briefly on October 24, 1942, by Eugene Callaghan and the writer, for the U. S. Geological Survey, in company with George Holmes, Jr., Project Engineer, who had been conducting the exploration program, Paul Allsman, Principal Mining Engineer, and Glenn L. Allen, District Engineer, all of the U. S. Bureau of Mines. The period from December 1, 1942, to January 14, 1943, was devoted to the field work and preparation of maps on which this report is largely based. A. J. Bodenlos, D. B.

Vitaliano, and D. K. Hamilton ably assisted in the field work. The writer revisited the area in the fall of 1943 and measured two stratigraphic sections.

The writer is particularly indebted to George Holmes, Jr., for the drill-core records, analyses, and results of sampling on the Ala-Mar and Nevada Magnesite properties. J. B. Perry, Manager of Mines, and R. O. Jones, Mine Superintendent, of the Westvaco Chlorine Products Corp., made available analyses and mining data on the Windous deposit. G. L. Hampton, of the Ala-Mar Magnesium Co., Inc., and F. L. Rigsby supplied information on their respective properties. Professor Jay Carpenter, Director, Nevada State Bureau of Mines, made available analyses of the ore from the Nevada Magnesite Co.'s property from a report by Kenyon Richards, of the Consolidated Copper Mines, Kimberly, Nev. G. T. Faust, of the U. S. Geological Survey, has provided the laboratory and petrographic data in this report. The work was done under the general direction of Eugene Callaghan, of the Geological Survey, and S. G. Lasky, then regional geologist for the Geological Survey for that part of the work done in cooperation with the Bureau of Mines.

GEOLOGY

The magnesite and associated magnesium silicate and dolomite are limited to sedimentary rocks, the Currant tuff, lying between two groups of lava flows, all of Tertiary age. At the west side of the Horse Range the lower flows and the sedimentary rocks pinch out and the upper flows rest upon the Paleozoic limestone of the White Pine Range. The distribution of the various rock units and their structural relationships are shown on the regional geologic map and sections (pl. 1).

In the western part of the area, the lower part of the Currant tuff rests on a flow of basaltic andesite. The upper part of this flow is scoriaceous and resembles true basalt. The main mass is gray, platy, dense, and medium-grained. The basaltic andesite is olivine-free but contains hypersthene, augite, and bytownite. In the eastern part of the area, near the Rigsby and the Windous deposits, the basaltic andesite is absent, and the tuffs are in contact with the hypersthene dacite.

The Currant tuff is composed largely of rhyolitic tuffs with variable amounts of calcium carbonate; most of it is well bedded and commonly thinly laminated. At several places in the western part of the area, fanglomerates are found at the base, with basaltic andesite boulders as much as 9 inches in diameter. No comparable fanglomerates were seen in the eastern part of the area. Some of the beds in this sequence are made up largely of crystal fragments.

The tuffaceous sediments must have been laid down upon an uneven surface of the basaltic andesite flow in the western part of the area, for the thickness ranges from nearly 500 feet to scarcely 100 feet between two points 1,000 feet apart. However, the thickness appears to be more uniform in the eastern part of the area, where it is about 300 feet. The sediments must have been deposited in a shallow lake basin in which volcanic ash was the main material added, but in which variable amounts of calcium carbonate were also being deposited.

Overlying the tuffaceous sedimentary rocks are porphyritic quartz latite flows. These flows are quite thick in the western part of the area and make up the sharp peaks of the Horse Range. In the eastern part of the area, near the Windous deposit, the buttes and mesas of tuffaceous sedimentary rocks are capped by a single flow of porphyritic quartz latite that has a conspicuous layer of black glass at the base.

PETROLOGY

The petrographic descriptions of the igneous rocks and tuffs in the district were made by G. T. Faust, of the U. S. Geological Survey. A complete treatment of the petrography, as well as a discussion of the magnesian mineralization in the Currant Creek district, has been published (Faust and Callaghan, 1948, pp. 11–74). For the purposes of this report, however, a brief field description of the various rock types will suffice.

The rocks of the Currant Creek district are essentially a layer or lens of tuff (the Currant tuff), which was deposited on the eroded surface of volcanic flows, composed of hypersthene dacite and basaltic andesite, referred to as the lower volcanics. On top of the Currant tuff were deposited the upper volcanics, composed of porphyritic quartz latite and an overlying massive latite crystal tuff.

LOWER VOLCANICS

Hypersthene dacite.—The hypersthene dacite occurs throughout the Currant Creek district and is common in the eastern part. The dacite is mottled and ranges in color from reddish or purplish brown through tan to gray. According to Faust and Callaghan (1948, p. 26), the color in the reddish- and purplish-brown varieties is due to the oxidation of ferrous iron to hematite around cavities and vesicles. The gray variety of dacite clearly shows its glassy nature in hand specimens; it contains magnetite instead of hematite. The dacite is commonly characterized by phenocrysts of hypersthene and feldspar as much as 2 millimeters in length. Locally, black chert, opalescent chalcedony, brown jasper, and green opal fill little pockets or veinlets in the dacite.

Basaltic andesite.—The basaltic andesite is commoner in the western part of the area, where a considerable thickness of it occurs in the vicinity of the Ala-Mar magnesite deposit. It is in general black to grayish black and dense. The top of the flow is vesicular and grayish black to red, depending upon the degree of oxidation. Some of the vesicles are filled with calcite and other minerals. The weathered surface of the dense black variety of basaltic andesite has a platy structure, a weathering surface that has developed on many basaltic andesites of the western United States (Callaghan and Buddington, 1938, p. 13). Iron oxide and hyalite are weathering products on the platy surfaces.

CURRANT TUFF

The Currant tuff (Faust and Callaghan, 1948) is made up of beds that are light gray, white, or sometimes greenish in color. Much of the material is pumiceous, porous, and of low specific gravity. Samples taken by both the Geological Survey and the Bureau of Mines show great variation of carbonate content in the unaltered tuffs. This variation takes place both horizontally and vertically. There is as much as 80 percent carbonate in rocks containing fresh glass. Where completely altered to carbonate and silicate, the rock commonly becomes quite dense and heavy, even though the bedding is preserved.

The volcanic ejecta in the members of Currant tuff were derived from a common source. The same minerals—pyroxene, amphibole, biotite, plagioclase, sanidine, quartz, apatite, magnetite, and calcite—are found throughout the formation. The calcite was added later than the rest of the minerals. Lithic fragments of basaltic andesite and hypersthene dacite in the tuffs indicate a close relationship between the Currant tuff and the lower volcanics. A brief description of the members of the Currant tuff follows. (For petrographic details see Faust and Callaghan, 1948.)

Stratigraphic column of Currant tuff at the Ala-Mar deposit (west), Currant Creek district, Nev. (sec. 34, T. 12 N., R. 59 E.)

Upper volcanics: Porphyritic quartz latite. Limestone.	
Currant tuff:	*Feet*
Reworked calcareous tuff; some lithic fragments; mottled gray	Up to 46
Vitric tuff containing biotite and lithic fragments; gray	16
Thin-bedded vitric tuff with a few biotite fragments; very pale gray. Diatom and ostracod bearing	10
Vitric tuff; contains calcite	3.7

Stratigraphic column of Currant tuff at the Ala-Mar deposit (west), Currant Creek district, Nev. (sec. 34, T. 12 N., 59 E.)—Continued

	Feet
Thin-bedded, calcite-bearing vitric tuff. Fossiliferous seam about 1 inch thick at top; white	18
Vitric tuff indurated with calcite; gray	.17
Thin-bedded vitric tuff; calcite bearing; light gray	30
Thin-bedded dark-gray tuff; fossiliferous layer. Fractured in places with gray tuff filling fractures	.17
Tuffaceous limestone; gastropod bearing; white to light buff	5.6
Replaced tuff. Sample from top 5 feet. Siliceous for topmost foot; white to light buff. Replaced tuff near bottom contains small nodules of magnesite. Section somewhat obscured by cover; light buff	40.6
Replaced tuff; massive- to irregular-bedded; highly altered. Taken 70 feet above base. Vugs present; light buff	70
Tuff (lithic fragments?). Altered to honey yellow. Replaced tuff near bottom. Contains vugs with soft filling. Rock thoroughly weathered	1
Replaced tuff; massive-bedded; altered by carbonate and silicate replacement; light buff. Replaced tuff near bottom; white and powdery	90
Gray vitric tuff; very fine grained; thin-bedded 1-foot seam of reworked material about 2 feet above base; gray tuff	11.3
Green vitric tuff. Biotite flakes, partly iron-stained. Two feet of fanglomerate at top	9.5
Vitric tuff; coarse-grained at base with lithic fragments and biotite tuff; cross-bedded at top; gray	9.3
Fanglomerate; pebbles of basalt up to 6 or 7 inches in diameter in a tuff matrix. Pebbles constitute 60 to 80 percent of mass. Partings 29 feet from base, 0.5 foot; 25.5 feet from base, 0.6 foot; 16 feet from base, 0.3 foot; 15 feet from base, 0.4 foot; and 5 feet from base, 1 foot	31
Green crystalvitric tuff with biotite and feldspar grains up to 1 millimeter in diameter	7.4
Vitric tuff with some carbonate and biotite flakes up to 2 millimeters in diameter; contains lithic fragments that appear to be highly altered	7.5
Water-laid crystalvitric tuff. Pebbles up to one-fourth inch in diameter. One-inch tuff parting at base	8.5
Vitric tuff; lithic fragments slightly more pronounced; white and gray	5
White to gray vitric tuff and lithic fragments composed of basalt and gray tuff, up to 1½ inches in diameter, embedded in tuff	12.8
	433.5

Lower volcanics: Fault contact; fault breccia. Basaltic andesite.

The rocks of the Currant tuff have been invaded and altered by hydrothermal solutions. The resulting rocks include hydrothermally replaced tuffs, silicate-carbonate rocks, and silica-carbonate rocks. The replacing solutions contained large quantities of Mg and bicarbonate ions. In the replacement process, magnesite and silicate, carbonate, and silica minerals were deposited. (For details of the mineralogy of the altered rocks and the magnesite deposits, see Faust and Callaghan, 1948.)

UPPER VOLCANICS

The upper volcanics are composed of porphyritic quartz latite, with a dark glassy phase at its base, and massive latite crystal tuffs that lie on top of the porphyritic quartz latite. The upper volcanics are thick in the western part of the area, where they form the peaks of the Horse Range. In the eastern part of the area they thin out considerably and are represented in many places by a thin layer on top of the Currant tuff. The black glassy phase is present everywhere, whereas the latite crystal tuff is absent in the eastern part of the area.

Porphyritic quartz latite.—The porphyritic quartz latite is brownish, with sanidine, plagioclase, quartz, and biotite phenocrysts, commonly 2 millimeters across, embedded in a dense brown groundmass. In the black glassy phase the groundmass contains a higher proportion of glass. The brown porphyritic quartz latite has a platy structure, and as a consequence, the talus piles at the foot of the cliffs formed by this rock are made up of thin, flat, brownish slabs. The black glassy phase has very well developed flow lines and weathers to a friable blackish-gray mass in which the phenocrysts occur.

Latite crystal tuff.—Latite crystal tuff occurs in the southwestern part of the Currant Creek district, in the vicinity of sec. 1, T. 11 N., R. 57 E. The tuffs are exposed along the road leading to the Ala-Mar magnesite deposit and are white to tannish white. Fragments of glass and quartz up to a quarter of an inch in diameter are set in a very fine grained groundmass. Cliffs of the latite crystal tuff are pockmarked with small caves, the result of weathering.

STRUCTURE

A major and a minor system of faults cut the rocks in the Currant Creek district and yield two types of structural patterns. In the western part of the area the entire sequence of volcanic rocks dips gently eastward from the higher areas in the Horse Range. Along the extreme eastern edge of the mapped area, also, the volcanic rocks dip gently eastward. In the northeastern part of the Currant Creek district, on the other hand, a horst-and-graben structure has resulted.

There is evidence of a major northeast-trending fault in the vicinity of the Snowball and the Rex-Pine Lode deposits in the western part of the area. The steep scarp, the springs that are alined parallel to the scarp, and the reduction in the thickness of the Currant tuff are supporting evidence of this fault, which is paralleled to the east by three other major faults (pl. 1). In the eastern part of the area, the volcanic rocks dip gently eastward from another northeast-trending fault, which is about three-quarters of a mile east of both the Windous and Rigsby deposits. In the northeastern part of the area, in the vicinity of the Chester, Windous, and Rigsby deposits, several smaller faults branch from the major northeast-trending fault. A few smaller faults, trending at almost right angles to the major faults, break the rocks into a series of horsts and grabens. One major fault with an easterly trend occurs north of the Chester deposit.

All the deposits that contain considerable magnesite are located on or near faults. In this category are the Ala-Mar, Snowball, Rex-Pine Lode, and Windous deposits. The Chester deposit area is heavily covered by gravel, and fault relations there are obscured; however, the major east-trending fault to the north and a smaller fault, both shown on plate 7, are strong evidence that this deposit is on or near a major fault. The evidence for the existence of a fault at both the Rigsby and the White Knolls deposits is less clear. At the Rigsby deposit the size and dome shape of the altered zone, as well as the composition of the sinter that makes up the dome, suggest an ancient hot-spring channel as the source of the magnesium-bearing solutions.

The only evidence for the relative age of the faults is shown where the east-trending faults intersect and displace the northeast-trending faults, indicating that the latter are the older. All the faults are post-late Miocene in age but are generally covered by Recent alluvium. At no place was direct evidence of major faults observed in the form of displaced alluvium. All the faults examined are steep normal faults.

OCCURRENCE OF MAGNESITE

Magnesite, especially valuable in this district because of its high magnesium content and low content of iron and alumina, is the only mineral in the deposits that has been mined commercially, even in a small way. A hydrous magnesium silicate of the serpentine group occurs with the magnesite and is particularly noticeable as a pinkish to white gel-like material in the tunnels and pits in the Windous deposit. Exceedingly fine- to fine-grained white carbonate, chiefly dolomite and magnesite, occurs with the serpentine. Calcite is found as fine-grained material in crusts in cavities or in veinlets. Silica occurs in chalcedonic veins and masses, as opal, as a crusty, sinterlike material, as granular quartz replacing the carbonate and silicate, or as quartz veinlets, even in the dense magnesite such as that found in the Rex and Pine Lode deposits. It has been the hope of the Ala-Mar Magnesium Co., Inc., that the entire mineral assemblage could be treated for the recovery of magnesium.

The magnesite, especially in the Windous and Ala-Mar deposits, forms dense white nodules that range in length from a fraction of an inch to several feet within the mass of altered material. The magnesite is also found in lenticular veins (fig. 3) as much as 12 feet wide and 100 feet long. The nodules and veins (fig. 3) have a cauliflower-like surface against the surrounding material. Fragments of the associated minerals and host rock caught in the irregular-shaped areas

FIGURE 3.—Lenticular vein of magnesite showing the fibrous-appearing cross structure. Note the necklace arrangement of nodules of magnesite within the vein.

formed by adjacent nodules make it difficult at times for the operator to produce a pure product, even by hand-cobbing methods. Much of the nodular magnesite is hard and flinty, but small nodules of soft chalky magnesite were observed in the Windous tunnels. Some of the magnesite is veined by quartz, which commonly shows drusy surfaces. Part of the vein magnesite has a fibrous appearance on the weathered surface, as shown in figure 3. Fine-grained magnesite also occurs intimately mixed with the dolomite and silicate matrix that surrounds the nodules or in places where no nodules exist.

The grade of the magnesite, even if the associated materials are disregarded, is highly variable. Selected samples of nodules from the Windous deposit contained impurities amounting to less than 1.5

percent, as determined by the Westvaco Chlorine Products Corp. Selected hard, white material, taken from the Ala-Mar deposit by Westvaco engineers, yielded—after ignition loss—1.47 percent CaO, 4.38 percent SiO_2, 0.01 percent Fe_2O_3, and 0.06 percent Al_2O_3. Other samples show a much higher content of impurities, particularly lime and silica. The content of iron and alumina is generally low, even in the associated silicate and dolomite. In fact, the iron content is so low that there is no appreciable color change on firing the material, even if it is highly siliceous.

The silicate material is being studied in the laboratories of the U. S. Geological Survey. Chemical analyses and X-ray diffraction studies indicate a hydrous magnesium silicate of the deweylite-serpentine series. Under the microscope the material is revealed as an aggregate of minute grains. The purest material is pinkish and gel-like but commonly intimately mixed with extremely fine grained dolomite and minute amounts of magnesite. This aggregate is snowy white and generally light and porous, particularly in the two deposits most completely exposed, the Windous and the Ala-Mar.

The dolomite is mainly snowy white, extremely fine grained, and intimately mixed with silicate and some magnesite. A few grains are sufficiently large to be identified under the microscope.

The calcite is commonly granular and is especially noticeable at the Windous deposit as veinlets and crusts or in open boxwork structures, in large part later than the magnesite.

Montmorillonite, a clay mineral, is found replacing volcanic glass in some of the tuffs. It also occurs, as revealed by the drill cores, in the basaltic breccia underlying the tuff. A little montmorillonite was found in the quartz latite and basalt.

Silica is present as opal, chalcedony, or crystalline quartz. Opal commonly is found as fragments on weathered outcrops of the magnesite deposits. Chalcedony forms a large rib at the east side of the Windous deposit. Granular or crystalline quartz is found in veinlets cutting all the other minerals and in aggregates and networks that indicate penetration and replacement of the carbonate materials. Porous, crusty sinter is found in some of the deposits. In general, the silica minerals are late, invading and replacing the carbonates and the silicate. Residual minerals of the tuff, such as quartz, hypersthene, biotite, sanidine, augite, and plagioclase, are recognized in parts of the areas of altered rock.

The areas containing abundant nodules of magnesite are all small, mainly less than 100 feet across the outcrop. In the Windous deposit, the area of nodules is 500 feet long and nearly 200 feet wide. The depth, as determined by diamond drilling, is 67 feet at the Ala-Mar deposit. The magnesite veins tend to have a wider distribution than the nodules within the areas of altered rock. The areas of altered rock are rarely completely exposed, and it is difficult in the field to distinguish between highly calcareous sedimentary rock and the altered material. At the Windous deposit, the altered zone is 1,300 feet long, not including a possible extension to the south. The other altered areas seem to be smaller, and some are probably 200 or 300 feet in their greatest dimension. As the altered areas are confined to the tuff, their thickness is necessarily limited by that of the tuff, but it rarely exceeds 100 feet.

As far as the writer is aware, this association of dense nodular magnesite with volcanic tuff is unique. The nodules of magnesite replaced the tuff and are associated with a matrix of other carbonate and serpentinelike magnesium silicate. Opal and chalcedony commonly are associated with the magnesite, as Hess (1908), Bradley (1925), and Bodenlos (1950) have stated they occur in the California serpentine deposits, but they are later in age than the carbonate and silicate minerals. In general, it is believed that hydrothermal or hot-spring solutions charged with magnesium and carbon dioxide moved upward and attacked the calcareous tuff at favorable horizons. The resulting material is an aggregate of magnesium silicate, dolomite, and magnesite. Some montmorillonite may have formed at that time. Magnesite grew in the previously mentioned gelatinous medium and developed into the cauliflowerlike nodules now present. Cracks or other openings filled with magnesite, forming the veins or lenses. The magnesite must have had the consistency of a gel, for it shows dehydration cracks. Later solutions were saturated with silica that filled openings and replaced some of the earlier carbonate minerals. Most of the deposits are near faults that were probably the channelways for the solutions.

DESCRIPTION OF DEPOSITS

The eastern group of magnesite deposits contains the Windous, Rigsby, and Chester deposits. The western group contains the Ala-Mar, Rex-Pine Lode, Snowball, and White Knolls deposits. Regardless of location, however, the deposits are here described in the order of decreasing importance.

WINDOUS DEPOSIT

The Windous deposit (eastern group), the most completely exposed of all the occurrences of magnesite in the Currant Creek district, has the largest measurable reserve and has yielded the most high-grade magnesite to date. It is near the line between secs. 5 and 6, T. 12 N., R. 61 E., about a mile by dirt road east of the paved highway leading to Ely, 29 miles distant. The deposit is on homesteaded land belonging to C. E. Munson, a rancher.

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The magnesite of the Windous deposit, found as lenticular veins and nodules, is distributed through a length of 1,000 feet and a width of generally less than 200 feet. The deposit crosses the face of a hill 1,700 feet long that rises 180 feet above the valley floor (pl. 2 and fig. 4). This hill is composed of the sedimentary calcareous tuff, largely altered, that lies upon the lower volcanics exposed on the slope to the east. The later volcanics (quartz latite) cap the nearby hills to the north (fig. 2), and the older dacite makes up the ridge to the east. The tuff dips gently eastward and fills irregularities in the surface of the lower volcanics. Bedding is largely obscured by alteration.

FIGURE 4.—Windous magnesite deposit, Currant Creek district, Nev., from the west. The hill is capped by chalcedony. Older dacite in the hills in the distance.

Many pits and two tunnels, all excavated by the Westvaco Chlorine Products Corp. between November 1940 and February 1942, expose the belt of nodular magnesite, which is less than 500 feet long and less than 100 feet wide. Veins of magnesite, mainly 1 foot or less in width and as much as 100 feet long, occur both to the north and the south, so that the magnesite zone has a total length on the outcrops of 1,000 feet and a maximum width of 200 feet. The pits on the surface, the north tunnel (fig. 5), and especially the glory hole above the north tunnel show two zones of magnesite nodules. The west zone does not appear in the tunnel, but the east zone is 150 feet wide in the tunnel and 30 feet wide on the surface, as shown in section *A–A′* (pl. 2). The east zone dips irregularly to the east beneath an overlying body of sinterlike silicate-carbonate rock. As the south tunnel exposes only a few nodules of magnesite, the magnesite zone essentially bottoms a few feet below the surface. The associated magnesium silicate

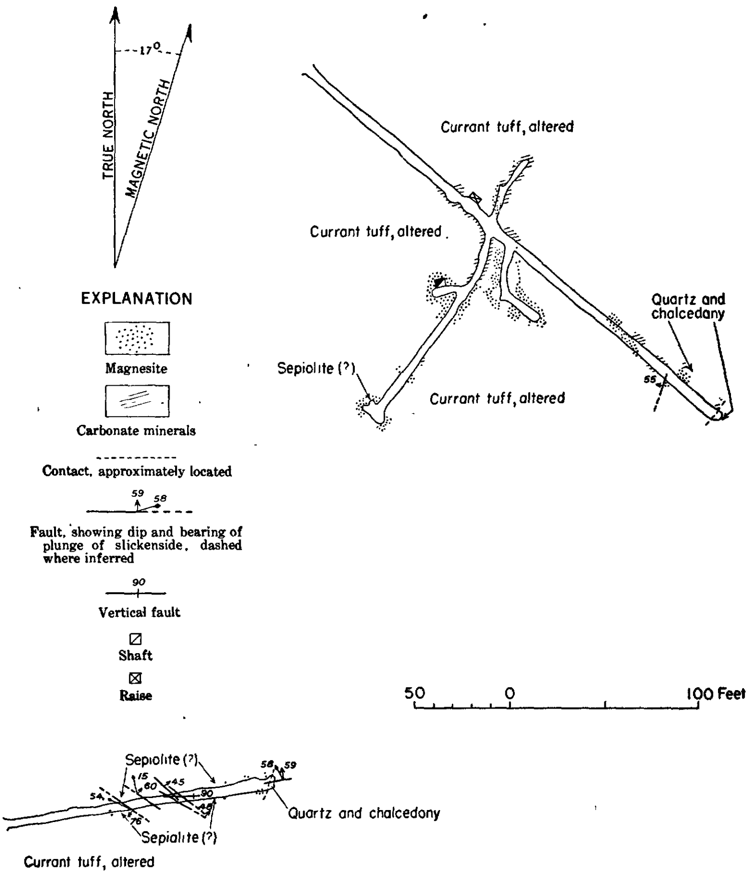

FIGURE 5.—Geologic plan of the underground workings of the Windous magnesite deposit, Currant Creek district, Nev.

(U. S. Geological Survey, 1943) and dolomite have a much wider distribution and are exposed in all the workings, especially in the south tunnel. All this material is cut off sharply at the east by the large rib of chalcedony previously mentioned.

The grade of the magnesite is highly variable, as shown by the partial analyses of samples taken by the Westvaco Chlorine Products Corp. (table 1). In general, selected hard, white magnesite from the centers of the nodules is likely to be extremely pure, with total impurities amounting to as little as 1.5 percent on the ignited basis. The content of iron and alumina is almost negligible. Any inclusions of magnesium silicate, dolomite, calcite, or silica in samples lower the grade in proportion to the amount of each constituent that is present. As the magnesium silicate is intimately mixed with varying proportions of the carbonates, scarcely a spoonful of material free of carbonate could be obtained in any one place. Quite possibly this mixture could be beneficiated and at least a part of the carbonate removed.

TABLE 1.—*Partial chemical analyses of material from the Windous magnesite deposit, Currant Creek district, Nev.*

[Analyst: Westvaco Chlorine Products Corp. Ignited basis]

Sample No.	Description	CaO (percent)	SiO_2 (percent)
6832	Central shaft; soft, white material	16.70	
6835	Outcrop north of shaft; hard, white material	36.80	
6838	Cut 2 dump; select hard, white, vitreous material	.95	0.28
6839	Outcrop north of cut 2; hard, white material	1.20	.65
6840	Shaft 2A, bottom; moderately hard, white material	13.20	
6841	Outcrop above shaft 3; hard, white magnesite	.95	.27
6843	Shaft 7 dump; select hard, white magnesite	1.53	.98
6844	Shaft 9 dump; moderately hard, white material	40.00	
6852	Surface-ore stockpile, north area; unsorted material	5.60	3.09
6853	Surface-ore stockpile, south area; unsorted material	5.04	2.17
6856	Car 1; sample of material	3.46	1.65
6868	Pit N-5 reject; granular type	2.94	4.28
6884	North tunnel, south drift; sorted magnesite	5.58	.79
6887	North tunnel, south crosscut face; selected magnesite	1.28	.60
6890	North tunnel, south drift; sorted magnesite	3.12	.88

The Westvaco Chlorine Products Corp. shipped about 1,200 tons of selectively mined magnesite from the pits, glory hole, and north tunnel. This material averaged about 2 percent SiO_2, 2.75 percent CaO, 0.15 percent Fe_2O_3, and 0.4 percent Al_2O_3 on the ignited basis—that is, after the removal of CO_2 and water. Undoubtedly, considerable nodular and vein material remains, though probably the best exposed material has been removed. On the basis of an outcrop length of 550 feet, a width of 50 feet, and an ore-to-waste ratio of 1 : 8, it is estimated that there is roughly 1,000 tons of magnesite above the level of the north tunnel. The veins and lenses are estimated to contain 500 tons to a depth of 20 feet below each outcrop. In addition, given a conversion factor of 20 cubic feet per ton, 120,000 tons of magnesian material roughly averaging 34 percent MgO, 8 percent CaO, 0.1 percent R_2O_3, and 32 percent SiO_2—with an ignition loss of 26 percent—would exist in a block 600 feet long, 200 feet wide, and an average of 20 feet deep (including the north and south tunnels).

ALA-MAR DEPOSIT

The Ala-Mar magnesite deposit (western group), formerly known as the Manzoni, is the second-largest deposit in the district from the standpoint of both production and reserves; it is the one toward which most of the exploratory effort of the U. S. Bureau of Mines was directed in 1942. The property comprises nine claims held by the Ala-Mar Magnesium Co., Inc., a Nevada corporation in which R. H. Fish, G. C. Oxtaby, and G. L. Hampton are the principal stockholders. Though some exploration preceded the acquisition of the property by the present owners, the principal operations were started in 1940, and 40 tons of crude magnesite was shipped to the General Electric Co. in February 1941. The crushed magnesite was hauled in light trucks to a bin on the mine road, whence it was taken by larger trucks to the shipping point or calcining plant. Sporadic operations since June 1941 have yielded some 500 tons of material, which, according to the owners, was converted to caustic calcine in a plant at Sodaville, Nev. It has been the hope of the operators that all the magnesium-bearing material, including silicate and dolomite, could be treated to yield magnesia or the metal magnesium.

Actual magnesite in lenses and nodules has been found only in the vicinity of the pit shown on the map (pl. 3) and, in detail, on plate 4. The magnesite is in the bottom of the valley. The Currant tuff on the slopes both to the east and to the west was trenched and drilled by the Bureau of Mines; although altered material with considerable magnesia was found, no magnesite in veins or nodules was noticed.

As shown on plate 1, the magnesite and the areas of intense alteration are in the sedimentary calcareous tuff, which ranges in thickness from scarcely more than 100 feet to 400 and possibly 600 feet. The tuff is conglomeratic at the base and lies upon basaltic andesite and dacitic breccias of the lower volcanics, which were penetrated in the bore holes, and is overlain by quartz latite flows in the ridges to the south and east.

At the pit magnesite occurs as small lenses and nodules in a matrix of magnesium silicate, dolomite, and calcite, formed by alteration of the sedimentary calcareous tuff. The underlying basaltic andesite was reached at a depth of 120 feet below the surface of the quarry. The nodules are not distributed evenly in the quarry but occur in three northwest-trending zones that are as much as 12 feet wide and 125 feet long. In addition to the zones of nodules there are two prominent lenses of magnesite that trend north and crop out northeast of the quarry (pl. 4). The longest lens is 65 feet in length, and the maximum width is 9 feet. The four holes drilled by the Bureau of Mines and shown on plate 4 penetrated the altered tuff and some magnesite. Detailed records of hole 1 were not kept, but there may have been magnesite nodules in the first 65 feet. The recovered core, assayed by the Bureau of Mines, averaged 42.6 percent MgO, 1.8 percent CaO, 13.6 percent SiO_2, and 1.0 percent R_2O_3. The first 40 feet of hole 1A averaged 37.3 percent MgO, 5.4 percent CaO, 20.5 percent SiO_2, and 0.7 percent R_2O_3. One part of this core contained a 3-foot section of solid magnesite and a 5-foot section with recognizable magnesitic nodules. The upper 56 feet of the core from hole 1B averaged 41.6 percent MgO, 2.0 percent CaO, 13.3 percent SiO_2, and 1.6 percent R_2O_3. The upper 101 feet of core from hole 1C averaged 39.3 percent MgO, 3.8 percent

CaO, 17.5 percent SiO_2, and 1.2 percent R_2O_3. Only 6 feet of the core was found to contain recognizable magnesite nodules. The remainder of the material was magnesium silicate, dolomite, calcite, a minor quantity of quartz, and possibly some finely intermixed magnesite.

In considerable parts of some of the other cores, drilled to the east and to the west of the deposit, the rock is altered and has a magnesia content of 20 to 30 percent and an R_2O_3 content of less than 5.0 percent, but only those parts of the hole 3 core between 112 feet and 172 feet below the collar and the hole 7 core between 211 and 266 feet below the collar averaged more than 30 percent MgO. The former averaged 38.2 percent MgO, 5.2 percent CaO, 15.7 percent SiO_2, and 1.8 percent R_2O_3; the latter averaged 35.8 percent MgO, 7.8 percent CaO, 17.9 percent SiO_2, and 1.0 percent R_2O_3. Cores from holes 2 and 7 were largely in tuff, with less than 10 percent magnesia and 4 to 10 percent R_2O_3, but the analyzed parts of the cores from holes 2, 3, 4, and 5 showed considerable magnesia, mainly between 20 and 30 percent, according to the Bureau of Mines. It was noted that even in the vicinity of the quarry the drill passed from material with a high magnesia content to that with a low magnesia content. Other cores passed from tuff with a low magnesia content to that with a much higher content. All the bore holes were vertical.

Estimating the amount of magnesite in a deposit of this nature is somewhat like estimating the number of raisins in a pudding that has not been evenly mixed. Assumptions must necessarily be broad and are based most securely on actual mining experience. The detailed results of mining in the Ala-Mar quarry are not available, but the factor of 1 ton of magnesite ore to 8 tons of waste obtained at the Windous deposit may be used. This ratio coincides with the estimate that 500 tons of magnesite ore and 4,000 tons of waste material have been taken out of the excavation. However, if the figure of 238 tons shipped, as reported by the railroad, is more exact, then the ratio is about 1 to 17. The Bureau of Mines estimates that the block bounded by drill holes 1A, 1B, and 1C, extended to a depth of 64 feet, contains 72,000 tons of material, which, at a ratio of 1 : 8, would contain some 9,000 tons of magnesite. However, if only the blocks or strips of nodular magnesite revealed in the pit were extended to a depth of 60 feet, the total would be only about 3,000 tons of magnesite. If the two large veins and several smaller ones continue to a depth of 60 feet, which is unlikely, there would be available an additional 1,000 tons of magnesite. The total amount of silicate and dolomite would be much larger and would approach the 72,000 tons mentioned above. Moreover, as shown by the other drill cores, there are masses of silicate and dolomite within the tuff outside the quarry area.

REX AND PINE LODE DEPOSITS

The Rex and Pine Lode deposits (western group) are on adjoining claims in T. 12 N., R. 59 E. (unsurveyed), held by the Nevada Magnesite Co. There has been no magnesite production of consequence, and workings are limited to several pits and a tunnel 72 feet long on the Pine Lode claim, the westernmost of the two. Both deposits are reached by a poor road branching from the Forest Service road that follows the White River (pl. 1.). Late in 1942 the U. S. Bureau of Mines drilled four holes, totaling 374 feet, on the Rex deposit.

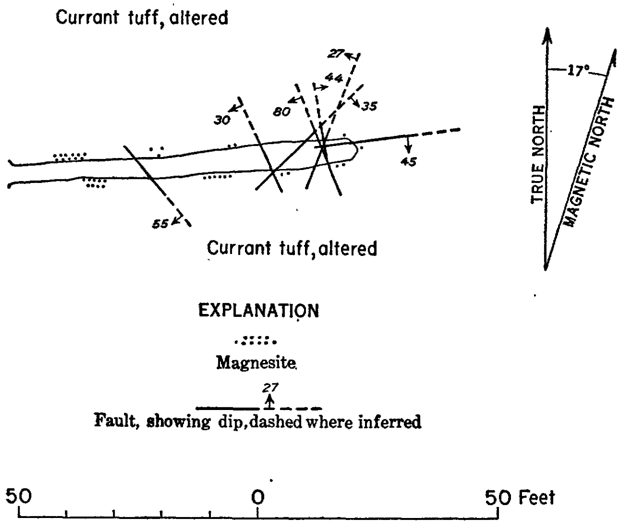

FIGURE 6.—Map of the tunnel in the Pine Lode magnesite deposit, Currant Creek district, Nev.

The Rex deposit (pl. 5) is in altered tuff, 300 feet thick, between outcrops of the underlying lower volcanics to the north and the outcrop of upper volcanics (quartz latite) to the south. In the ravine east of the deposit the quartz latite is faulted down toward the east. Impure magnesitic material, showing neither the characteristics of the nodular magnesite nor those of true magnesite veins, is exposed in several pits on a gently sloping spur ridge. Of the four holes drilled by the Bureau of Mines on the Rex deposit, two are less than 60 feet deep, one is 157 feet deep, and the other is 110 feet deep. The core from hole NM4 was largely highly calcareous tuff with very little magnesia and considerable silica, but except for the lower part of the long hole NM3 and the upper part of hole NM1, the magnesia content is mainly between 20 and 30 percent. In the upper 35 feet of hole NM1 the recovered core averaged, according to the analyses made by the Bureau of Mines, 35.1 percent MgO, 8.2 percent CaO, 21.0 percent SiO_2, and 0.4 percent R_2O_3. Much of this material is soft, white, and claylike and contains no recognizable magnesite, though there may be some magnesite and dolomite disseminated through the silicate, as indicated by the analysis.

The outcrop of the Pine Lode deposit, 1,900 feet west of the Rex, shows an area about 100 feet long and 60 feet wide that contains nodules of magnesite veined by quartz and calcite. The nodules are sporadically scattered through the matrix, both in the tunnel (fig. 6) and on the surface. The grade of the material is indicated by the samples taken and by Bureau of Mines analyses (table 2).

There are essentially no reserves of pure magnesite in the Rex and Pine Lode deposits. At the Rex deposit a block 320 feet long and 85 feet wide, including drill holes NM1, NM2, and NM3 and extended to a depth of 85 feet, would contain—given a factor of 25 cubic feet to the ton—about 90,000 tons of material averaging 34.8 percent MgO, 12.2 percent CaO, and 17.2 percent SiO_2. At the Pine Lodge deposit a block 180 feet long, 100 feet wide, and 20 feet deep would contain roughly 15,000 tons of material averaging about 35 percent MgO, 8.0 percent CaO, and 19.0 percent SiO_2.

TABLE 2.—*Analyses, by U. S. Bureau of Mines, of samples from the Pine Lode magnesite deposit, Currant Creek district, Nev.*

Sample No.	SiO_2	R_2O_3	CaO	MgO	Ignition loss
1	19.6	0.4	7.8	36.2	33.8
2	20.2	.5	4.4	38.8	33.5
3	19.6	.4	3.8	39.8	34.8
4	14.8	.4	2.0	42.2	37.8
5	18.0	.4	2.4	41.3	35.9
6	11.4	.7	2.4	42.1	41.2
7	19.0	.3	2.5	41.1	35.6

1. North side of adit, 17 feet from portal.
2. South side of adit, 27 feet from portal.
3. North side of adit, 46 feet from portal.
4. South side of adit, 55 feet from portal.
5. Across face of adit.
6. Grab sample, north side of dump.
7. Grab sample, south side of dump.

SNOWBALL DEPOSITS

The Snowball deposits (western group) are 1.8 miles west of the Rex and Pine Lode deposits, in T. 12 N., R. 59 E. (unsurveyed), and are held by the Nevada Magnesite Co. The terrain is rugged, and the deposits can be reached only by trail. (See pl. 1.)

The magnesite occurs as lenses in altered tuff that is highly variable in thickness. The tuff was evidently deposited on a very irregular surface of the lower volcanics, and, in addition, the contact with the overlying upper volcanics (quartz latite) is very irregular. As shown in the cross section (pl. 6), the formations dip rather sharply to the south, but the structure is further complicated by normal faults. One fault downthrown to the south is within the quartz latite parallel to the strike of the quartz latite and is followed for a considerable distance by a longitudinal depression. At least one fault (pl. 6) is normal to the strike fault, with its downthrown side to the east. Conglomerate at the base of the tuff shows evidence of crushing, and several springs emerge from the strike faults.

The eastern deposit shown on the map and in the section (pl. 6) trends roughly east and consists of a single lens of magnesite 50 feet long and at most 10 feet wide. The western deposit, 2,100 feet distant, consists of several lenses that trend roughly east and that are distributed through a northwest-trending zone 400 feet long and 100 feet wide. The matrix material is the usual mixture of magnesium silicate, dolomite, calcite, late quartz, and residual material.

The exposed lenses, estimated to a depth of 30 feet, would contain roughly 4,000 tons of material. At the western deposit, a block of the altered tuff 280 feet long and 80 feet wide, estimated to a depth of 40 feet, would contain roughly 35,000 tons of magnesia material, probably averaging 23.6 percent SiO_2, 9.91 percent CaO, and 32.9 percent MgO. Assays of samples taken by K. Richards, of Kimberly, Nev., and by the U. S. Bureau of Mines are given in table 3.

TABLE 3.—*Assays of samples from the Snowball magnesite deposits, Currant Creek district, Nev.*

[Assays 1 and 2 by Consolidated Copper Mines, Kimberly, Nev., courtesy of J. Carpenter and Kenyon Richards; assays NM19 to NM26, inclusive, by the U. S. Bureau of Mines]

Assay No.	SiO_2	R_2O_3	CaO	MgO	Ignition loss
1	14.20		11.30	28.02	
2	39.40		3.50	23.42	
NM19	4.0	2.2	3.3	43.8	47.1
NM20	1.9	1.3	1.5	46.4	49.4
NM21	24.6	.9	14.3	37.6	32.5
NM22	17.4	.3	5.1	39.1	38.1
NM23	32.4	.6	6.4	33.8	27.3
NM24	22.6	.3	10.0	33.9	33.4
NM25	27.9	.3	11.9	28.7	30.0
NM26	13.2	.3	18.3	28.3	38.6

CHESTER AREA

Three claims and a fraction in secs. 1 and 2, T. 12 N., R. 60 E., held by C. A. Chester of Ely, Nev., and one claim held by L. T. White, also of Ely, cover the Chester area of magnesite deposits (eastern group). The property is 1½ miles west of the Ely-Tonopah highway and is crossed by a well-graded, graveled road that follows the White River. Development is limited to a few pits. About 11 diamond-drill holes are said to have been put down by an Eastern chemical concern, but no data on the results were available to the writer.

Magnesite as nodules and as a single lens is limited to one outcrop of altered tuff (pl. 7), exposed on the slope of a dissected terrace west of the White River. Probably much of the western part of the area shown on the map is underlain by tuff, but it is largely covered by terrace gravels. The underlying lower volcanics, probably brought up by faulting, are exposed in one place (pl. 7). The overlying quartz latite is exposed south of the magnesite area. Outcrops of altered tuff are limited to a northwest-trending area about 200 feet wide and 600 feet long. Prominent outcrops of chalcedony flank this exposure on either side.

Recognizable magnesite as dense, hard, white material is limited to the lens, which is 80 feet long and 6 to 12 inches wide, and to an area of disseminated nodules about 800 feet square. The nodules are so scattered in the matrix as to indicate that only about 10 percent of the material is magnesite. Most of the matrix material at the surface is sinterlike, made up chiefly of a mixture of dolomite and calcite with or without minor amounts of magnesium silicate.

The total amount of magnesite in the area exposed, estimated to a depth of 30 feet, is not over 500 tons. Nothing is known of the grade of the material.

RIGSBY DEPOSIT

The Rigsby deposit (eastern group), covered by one claim held by Frank Rigsby, of Ely, Nev., is in sec. 7, T. 12 N., R. 61 E., about 32.5 miles from Ely and 1.2 miles east of the Ely-Tonopah highway (U. S. 6). There has been no production and only a very minor amount of trenching. No drilling has been done.

The lower volcanics in this area consist of dacitic rocks rather than the basaltic andesite of the western part of the area. The capping quartz latite is a considerable distance away, so that only the tuff and the underlying dacitic rocks are exposed. The magnesite is limited to 11 narrow lenses or veins in altered tuff in the center and on the east slope of an isolated hill. (See pl. 8.) Most of the hill is either capped by a frothy siliceous sinter of hot-spring origin or covered by float of the same material.

All but one of the lenses of magnesite are in altered tuff within an area of 200 square feet. One lens, somewhat to the southeast of the main group of magnesite lenses, projects through the float of sinter-like material. Two of the lenses have a length of 60 feet and a maximum width of 3 feet, but the others are much smaller. The material seems to be the usual type of dense magnesite, but nothing is known of its grade.

On the basis of the exposed length and thickness of the lenses and an estimated depth of 20 feet, the total amount of magnesite in the

Rigsby deposit is 1,000 tons. The altered tuff, which consists chiefly of a mixture of magnesium silicate, dolomite, and calcite, has an outcrop area roughly 200 feet wide and 400 feet long. There is undoubtedly a considerable tonnage of this mixed material in the deposit, but whether it can be utilized is not yet known.

WHITE KNOLLS DEPOSIT

The White Knolls magnesite deposit (western group), covered by one claim held by Glen and Dorothy Stark, of Ely, Nev., is in T. 12 N., R. 59 E. (unsurveyed), and is reached from the highway by 7 miles of unimproved road. Prior to 1939, P. J. Johnson, of Kimberly, Nev., sank a shaft 65 feet deep and trenched some of the outcrops. Little if any work has been done on the property since 1939.

A mass of altered magnesite-bearing tuff about 150 feet square occurs on the north side of a ridge capped by quartz latite. The deposit is limited on the east by a fault contact with a downdropped capping of quartz latite. Neither lenses nor nodules of magnesite were observed, though analyses of samples taken from the shaft are reported to indicate magnesitic material. It is said that the analyses showed a progressive increase of silica with depth.

No estimate of actual magnesite is given, though there is doubtless a considerable tonnage of mixed material.

ORE RESERVES

The calculation of ore reserves in the Currant Creek district presents almost as many problems as there are deposits. Each deposit requires special consideration of the distribution of commercial magnesite in the matrix, which is a mixture of volcanic rock, dolomite, magnesium silicate, and silica. The conversion factor used in estimating the tonnage of pure magnesite in the Ala-Mar deposit and other deposits is 11.0 cubic feet per ton.

The matrix material in many deposits contains the magnesium silicate material, which at some future date may be of commercial value. Accordingly, where a sizable block of the material exists, the tonnage is estimated. The specific gravity of the matrix material is highly variable, and an arbitrary conversion factor of 20 cubic feet per ton was assigned to it. In the Rex deposit, however, it was necessary because of increased impurities to use a conversion factor of 25 cubic feet per ton.

On this basis it is estimated that in the entire Currant Creek district there are about 10,000 tons of commercial-grade magnesite and about 350,000 tons of magnesium silicate-bearing material.

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