barren-looking milky-white quartz that is only slightly stained with iron oxide on the joints and in places shows a few widely scattered crystals of pyrite. The pyrite at the upper tunnel level is largely altered to a dark-brown oxide. The ore at the lower tunnel level is less oxidized and shows a few specks of galena in its more heavily mineralized parts. This ore is said to carry some gold and silver, but from all that could be learned is rather low grade. The matrix of the quartzite near the vein is somewhat sericitized and shows some minute crystals of pyrite between the quartz grains which form most of the rock.

HUNTER DISTRICT.

LOCATION AND ACCESSIBILITY.

The Hunter district (No. 26, fig. 1, p. 18) is on the west side of the Egan Range about 25 miles south-southwest of Cherry Creek, which is its shipping and supply point. The Hunter mine is about 10 miles northwest of Steptoe post office, which is on the west side of Steptoe Valley, 23 miles north of Ely. (See Pl. I.)

GEOLOGY.

SEDIMENTARY ROCKS.

In the vicinity of the Hunter mines the mountains are formed of dark massive-bedded dolomitic limestones which dip 25°–30° W. and overlie the Cambrian quartzites exposed farther north in the range. Among some fossils collected by the writer at the Hunter mine Edwin Kirk determined Bryozoa and *Cyathophyllum* sp., which he states occur in the Nevada limestone, of Devonian age, of the Eureka district.

IGNEOUS ROCKS.

The limestones at the mines are intruded by at least three large dikes of granite porphyry. The igneous rocks are altered and exact determination of their constituents is not possible. They contain conspicuous rounded, somewhat smoky quartz phenocrysts one-eighth inch in maximum diameter; other phenocrysts that appear to have been feldspars but that are now altered to a soft white substance, and, generally, a few flakes of dark greenish-brown biotite. Examined in thin sections the phenocrysts that were thought to be feldspars are seen to consist of a mixture of quartz, an isotropic substance with index higher than balsam, and some calcite. The groundmass of the rock is microgranular, consisting of quartz, altered feldspar, and some biotite. It exhibits less alteration than would be expected from the complete breaking down of the feldspar phenocrysts.

ORE DEPOSITS.

HISTORY AND PRODUCTION.

The lead-silver ores of the Hunter mines were discovered in 1871, according to Whitehill,[1] and were most extensively worked between 1877 and 1881. At that time the ores smelted on the ground were said to carry about 48 ounces silver and 48 per cent lead a ton. Some very rich silver chloride ore is said to have been mined at that time in a pipelike deposit on the Crown Point lode. The 18 patented claims in this district were bought by the Vulcan Mining, Smelting & Refining Co. in 1907. In 1913 this company, under the direction of Mr. H. Ornauer, was reopening the main workings on the Vulcan and Copperhead Split ore bodies.

According to data collected by the United States Geological Survey, the total production of the Hunter properties from 1905 to 1908, inclusive, was 28,072 ounces silver, 118,584 pounds of copper, and 412,305 pounds of lead, having a total value of $60,316.

DEVELOPMENT.

The main development at the Hunter district is through a crosscut tunnel about 1,700 feet long, which trends southeast into the mountains. This tunnel intersects the Copperhead Split and the Vulcan ore bodies, the latter at a depth of 400 feet on the dip. The Vulcan is also opened higher up by a 300-foot drift tunnel, and the ore shoot, which had a drift length of 75 feet, is said to be stoped to the lower tunnel level. The ore bins and power house are at the mouth of the main tunnel. A steam-driven compressor supplies air for the hoist at the winze on the Copperhead Split ore body and for two hammer drills.

Water from a spring 3 miles north of the mine is piped to both the power house and camp. Sufficient piñon for mine timbers can be found on the mountain east of the mine.

GEOLOGY OF THE TUNNEL.

The first 400 feet of the tunnel are through somewhat crystalline, rather dark gray fetid-smelling dolomitic limestone in beds 1 to 3 feet thick, which strike about north and dip 30° W. At 400 feet the tunnel cuts the western side of a 75-foot dike of granite porphyry which dips steeply west. The contacts are sharp and show no contact metamorphism along either side. Postintrusion faulting with horizontal movement is shown. The Copperhead Split ore bodies lie along this dike.

A second dike, 80 feet wide, is cut at 800 feet from the portal, and a third, 60 feet wide, at 970 feet. From a point 1,320 feet from the

[1] Whitehill, H. R., Nevada State Mineralogist Fourth Biennial Rept., for 1871–72, p. 145 [1873].

portal to the face the tunnel is in granite porphyry. The Vulcan ore body lies west of this mass of porphyry, but the fault along which the ores occur has cut into the dike at places.

The limestones along these dikes appear to be unmetamorphosed even at the contacts, and the dikes themselves do not show any change in texture or size of grain. Postintrusion faulting is seen along all the dikes. Movement along practically all these faults seems to have been horizontal, as evidenced by deeply cut grooves on the walls. Much breccia has been formed along most of the faults and it is in these brecciated masses that the ore bodies occur.

OCCURRENCE AND CHARACTER OF THE ORE BODIES.

The Copperhead Split ore body is cut by the tunnel 575 feet from the mouth, where it strikes N. 30° E. and dips 75° E. It is a limestone fault breccia about 5 feet in width below a dike of altered granite porphyry. The lead carbonate ores occur as irregular masses in the breccia and are usually associated with coarsely crystalline white calcite. In a winze, 130 feet below the tunnel level, the breccia strikes north and dips 45° E. A stope at this level is 150 feet long, 15 feet high, and 6 feet wide. The ore, an ocherous lead carbonate containing some residual masses of galena coated with thin films of anglesite, seems to have been formed by partial replacement of the limestone breccia, as it includes many fragments of limestone. In some places in this stope malachite is rather abundant, and most of the limonitic ore carries copper, even where it shows little copper carbonate. The assay returns of some of the shipments of ore mined in 1913 show the lead ore to carry on the average 0.01 ounce gold, 15 ounces silver, 13 to 16 per cent lead, 4.5 per cent copper, and 5 per cent zinc. Sorted copper carbonate ore shipped in 1913 carried 27 to 34 ounces of silver and 10 to 11 per cent copper.

The Vulcan ore body is cut 1,500 feet from the mouth of the tunnel. It strikes about S. 30° E. and dips irregularly, varying from vertical to 40° NE. or 70° SW. At the tunnel level the ore is in altered granite porphyry, but in the upper workings and in a drift 200 feet north of the tunnel it occurs in a breccia at the contact of the limestones and the dike. As shown in the drift the fault breccia along the contact is 30 feet wide. The ore is all oxidized and is similar to that being stoped from the Copperhead Split body, though it is said to have carried less copper.

GRANITE (STEPTOE) DISTRICT.

LOCATION AND ACCESSIBILITY.

The Steptoe or, as it was formerly called, the Granite district (No. 25, fig. 1, p. 18), includes a portion of the east side of the Egan Range about 12 miles long and 4 miles wide. Steptoe post office, at W. D. Campbell's ranch in the southeast corner of the district, is 5½ miles southwest of Granite siding and 23 miles north-northwest of Ely, on the Nevada Northern Railway. (See Pl. I.) Most of the mines are easily accessible, and roads from the mouths of the various canyons lead toward Granite siding. In recent years the roads have been used to some extent by woodchoppers and are in fair shape. The Cuba mine, about 2 miles west of Steptoe post office, is difficult of access, as many of the workings are on a ridge with precipitous slopes.

GEOLOGY.

This part of the Egan Range is composed of yellow and red weathering quartzites, exposed at the east base of the mountains, overlain by green and red shales, above which lie massive light-gray compact limestones which form all the higher mountains. In the northern part of the district, at Water Canyon, the sedimentary rocks are intruded by a large stock of granite that varies from equigranular to porphyritic in texture. In other places in the district there are small dikes and masses of granite porphyry.

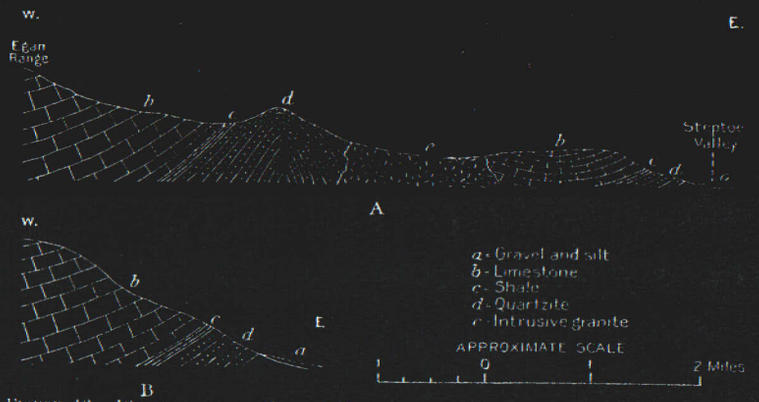

FIGURE 16.—Diagrammatic sections of the east front of the Egan Range, Steptoe district, White Pine County, Nev. A, At Water Canyon, 10 miles north of Steptoe post office; B, 4 miles northwest of Steptoe post office.

SEDIMENTARY ROCKS.

The oldest sedimentary rocks are most extensively exposed in the vicinity of Water Canyon, about 10 miles north of Steptoe post office. They are quartzites of a rather light color on fresh fractures, but weather yellow or red on the surface. About 2 miles above the mouth of Water Canyon they are folded into a tight anticline, across whose axis the stream has cut. At the east they are cut off by a large stock of granite. Northeast of the mouth of Water Canyon

limestones overlie the igneous rock. (See fig. 16, A.) In the western limb of this anticline the quartzites are lighter colored and thinner bedded near the top of the series than in the lower part. The quartzites are overlain by about 150 feet of greenish, drab, and red shales, which grade into the overlying limestone. At the base the limestone is dark gray and dense and lies in beds 6 inches to 1 foot thick. The higher beds of the series are more massive, and alternating light and dark gray bands are conspicuous.

About 4 miles northwest of Steptoe post office the limestones form practically all of the mountains, though the underlying shales and thin-bedded light-colored quartzites appear in the foothills. (See fig. 16, B.)

Though no fossils were found in any of these sedimentary rocks during the reconnaissance, the writer has little hesitancy in referring them to the Cambrian. They probably are the equivalents of the Prospect Mountain quartzite and the Eldorado limestone of the Eureka section.

IGNEOUS ROCKS.

About 2 miles above the mouth of Water Canyon, in the northern part of the district, a body of granite intrudes both the quartzite and the limestones. (See fig. 16, A.) This is the south end of what seems to be a large body of granitic rock that extends for some miles along the east front of the range toward Cherry Creek. The typical rock of the middle portion of this stock is a coarse, inequigranular to porphyritic granite, which weathers in rounded forms and produces an immense amount of coarse arkosic sand. At the west side of the stock the rock becomes much finer grained and appears to contain less of the iron-bearing minerals than the typical rock. In the coarse-grained rock large crystals of quartz, pink orthoclase, and biotite are conspicuous and in many places are the phenocrystic minerals that are set in an inequigranular groundmass composed of the same minerals and of what seems to be a plagioclase feldspar. In the fine-grained phase of the rock oligoclase is less abundant than quartz or orthoclase, and a little muscovite and what appears to be bleached biotite are present.

Four and a half miles northwest of Steptoe post office, near the Nubagah claim, there is a dike of granite porphyry which has a purplish-red color. Rounded quartz phenocrysts are thickly studded through a fine-grained matrix of quartz, orthoclase, and glass. Some phenocrysts, having the form of feldspars, are altered to quartz, calcite, and iron oxide.

A few hundred feet west of the Cuba ore body some inconspicuous, weathered croppings of a much-altered yellowish-green granite porphyry have small rounded grains of quartz, sericitized feldspars, and some biotite as their phenocrystic constituents. The groundmass is fine grained and seems to be made up of quartz, feldspar, and chlorite.

STRUCTURE.

In general the rocks of the southern two-thirds of the Granite district dip west at low to medium angles. About a mile south of Water Canyon there seems to be an eastward-trending break in the mountains. South of this fault the quartzites are shifted so that they are seen only in the foothills (see fig. 16, B), but due north of it they dip eastward on the east limb of a tight anticlinal fold. (See fig. 16, B.)

ORE DEPOSITS.

HISTORY AND PRODUCTION.

According to Mr. W. D. Campbell, the Ben Hur vein was located by himself in 1891 and was the earliest location in the Granite district. The Cuba and Stinson ore bodies were discovered in 1902 and the Campbell and Blaine groups in 1907. The latest discovery of ore was made in 1913, on the Nubagah claim, by Baird and Campbell. The gold deposits were worked earliest, and Mr. Campbell states that he has recovered about $15,000 worth of bullion from ores mined from the Ben Hur, Stinson, and Campbell groups. This ore was milled in a 5-stamp water-driven amalgamation mill at Mr. Campbell's ranch. Some lead ores from the Cuba and Bunker Hill and Sullivan mines have been shipped to the Utah smelters. In October, 1913, the Cuba was being worked, under lease, by E. E. Vanderhoff, of Ely, Nev. None of the older properties were being worked, but the Nubagah was being prospected.

According to figures collected by the United States Geological Survey, the total production of the Granite or Steptoe district from 1902 to 1912 inclusive was 454.28 ounces gold, 615 ounces silver, and 114,772 pounds of lead, having a total value of $14,633.

TYPES AND OCCURRENCE OF THE ORE DEPOSITS.

Two distinct types of ores are shown in the Granite district. One type carries gold and a little silver in quartz veins in quartzite. The Blaine, Campbell, Stinson, and Ben Hur, all deposits of this type, have a gangue of white quartz or brecciated quartzite. Metallic minerals are very scarce, and so far as developed all of the gold is free milling. The second type carries lead and a very little silver in fissure replacements in limestone. Carload shipments of sorted galena from the Cuba are said to run 74 to 78 per cent lead and 2.75

ounces silver a ton. The most important metallic mineral is galena, which is found at the surface, with a minor amount of cerusite and anglesite. Coarsely crystalline white calcite is the characteristic gangue mineral, though some siderite has been found in the Cuba ore body.

THE PROPERTIES.

GOLD VEINS.

Alvin mine.—The Alvin vein on the W. D. Campbell group is opened by a 150-foot shaft, a drift tunnel 200 feet long that intersects the shaft at a depth of 75 feet, and a 75-foot drift on the 150-foot level of the shaft. This work is in low foothills about 6 miles northwest of Steptoe post office. The vein cuts thin-bedded light-yellow siliceous limestones and calcareous sandstones that lie at the top of the quartzite series. It strikes N. 50° E., stands nearly vertical, and ranges in width from 8 inches to 4 feet (average about 18 inches). The filling is a yellow clay carrying crushed fragments of limestone and some calcite and quartz. No metallic minerals are visible. Ore from the tunnel level is said to have averaged $8 a ton in gold, and that from the bottom level about $3 a ton. A sample of ore from the tunnel level, panned by the writer, gave a very small concentrate of pyrite and magnetite.

Ben Hur mine.—The Ben Hur vein is opened by a series of open cuts and a drift tunnel 300 feet long, about 3 miles northwest of Steptoe post office. In this vicinity the thin-bedded, light-colored quartzites strike north and dip 60° W. The vein strikes N. 44° E. and dips 53° SE. It is filled with barren-looking white quartz, not much stained with iron, that averages 10 inches in width but in places widens to a maximum of 14 inches. Faulting along the footwall of the vein has crushed the quartz and wall rock so that in places there are 2 feet of yellowish clay with fragments of quartz and quartzite. The hanging wall is very irregular, and the quartz is frozen to it in most places. The ore near the surface is said to have carried about $10 in gold a ton, but at the tunnel level it is said to be too low grade to pay mining and milling charges.

Blaine prospect.—The Blaine property, near the head of Water Canyon, is about 12 miles north-northwest of Steptoe post office. The main development on this property is a tunnel driven southwestward from Water Canyon for 1,200 feet. The first 150 feet of the tunnel trends S. 50° W. along a 2 to 4 inch vein of white quartz that dips 60° SE. This vein cuts quartzite, but postmineral movement along both walls has produced a narrow selvage between the quartzite and vein. A fault that trends north and dips 75° W. cuts off the vein 150 feet from the portal. Beyond this vein the tunnel continues as an irregular crosscut in quartzites, in some places following the bedding and in other places following fractures with north or northeast strike. The last 210 feet of the tunnel follows a 2 to 8 inch lode of gouge, crushed quartzite, and vein quartz that strikes N. 60° E. and dips 50° N. The lode is slightly iron stained and contains a few minute crystals of pyrite and a little magnetite. It is said to carry gold, but no free gold was obtained in panningsmade by the writer. Grooves on the walls of this vein are horizontal. A 600-foot incline raise on the Blaine vein connects with the surface work, where the vein is seen to be on the west limb of an anticline, in quartzite, about 50 feet east of the lowest shale bed of the overlying series. (See fig. 16, A.)

Stinson mine.—The Stinson veins, the property of W. D. Campbell, about 4½ miles northwest of Steptoe post office, are developed by several short tunnels, open cuts, and a lower tunnel 300 feet long. One 10-inch lode striking N. 40° E. and dipping 35° NW. consists of three subparallel slips, with intervening fractured quartzite. The other lode strikes N. 40° E., dips 35° SE., and averages 10 inches wide. Both fissures are filled with yellowish clay and quartz. Panningsof the ore from these veins give more concentrates than ore from any of the other veins in the district. The concentrates consist of magnetite and a few specks of pyrite. Sorted ore from the surface of these veins is said to have carried from $30 to $80 a ton in gold.

LEAD DEPOSITS.

Bunker Hill and Sullivan mine.—The Bunker Hill and Sullivan ore body, the property of people from Moscow, Idaho, is 8 miles north-northwest of Steptoe post office in light buff-gray, thin-bedded, somewhat siliceous limestones that strike north and dip 40° W. Slightly oxidized galena occurs in irregular masses in a fault breccia 2 to 10 feet wide that strikes N. 30° E. and dips 60° W., and also in small tabular bodies parallel to the bedding of the limestone. The property is developed by a 75-foot crosscut tunnel that intersects a whim shaft about 30 feet below the collar. The shaft is 160 feet deep, but shows little ore below the tunnel level. The galena is clearly a replacement of the limestone. Postmineral movement has crushed both the limestone and ore, producing what is known as steel galena.

Cuba mine.—The Cuba fissure, about 2 miles west of Steptoe post office, strikes N. 40°–43° E. and dips 40°–65° SE., cutting across the bedding of light and dark colored dense limestones in beds 2 to 4 feet thick that strike N. 20° E. and dip 30° W. The fissure has been opened by a number of short tunnels and open cuts for about 3½ miles through a vertical distance of 500 feet. In most places the fissure is filled with large crystals of white calcite or brownish iron-bearing calcite and in places shows drusy openings. In this gangue

there are scattered, irregular bodies of galena. The largest body of ore was mined from a tunnel at a barometric elevation of 8,100 feet, on the north side of the hill across which the fissure runs. This body, averaging about 2 feet wide, was 75 feet long on the drift and about 25 feet high on the dip of the vein and pitched northeast in the fissure. At both ends of the ore shoot the barren calcite filling of the fissure continues. About one-half mile south of this body, in the bottom of a gulch, at a barometric elevation of 7,600 feet, tunnels on the fissure open some smaller bodies of ore. There is very little oxidation on this vein. Nearly pure galena outcrops all along its strike, but occasionally small amounts of anglesite and cerusite are seen as thin crusts coating the galena directly at the surface. The sorted galena is said to carry about 2.75 ounces of silver a ton.

Nubagah prospect.—The Nubagah prospect is 4½ miles northwest of Steptoe post office, in the middle part of the east slope of the Egan Range, where the massive limestones are the country rock. A 10-foot shaft is sunk on a tight fissure with north strike and steep east dip. A little galena and cerusite replace the limestone for a short distance on both sides of the fissure. The largest body of ore was found directly at the surface and east of the fissure.

WARD DISTRICT.

LOCATION AND GENERAL FEATURES.

The Ward district (No. 29, fig. 1, p. 18) includes a few square miles of the east front of Egan Range, about 16 miles south of Ely, its shipping and supply point. A good road in Steptoe Valley leads to the camp (barometric elevation, 8,025 feet) at the base of the range, which rises abruptly from the valley floor at least 1,500 feet in about 2 miles. The principal mines are in secs. 14 and 15, though some claims are in secs. 9, 10, and 16, of T. 14 N., R. 63 E. (See fig. 17.) Small springs occur in the vicinity of the mines, and a good stream of water flows in Willow Canyon about 4 miles south of the camp.

GEOLOGY.

This part of the Egan Range seems to consist entirely of a series of thin-bedded, light and dark blue-gray Carboniferous limestones that have been intruded by an intricate system of quartz monzonite dikes. In the surface exposures the igneous rocks are not conspicuous, but in the various mine workings large amounts of them may be seen

SEDIMENTARY ROCKS.

The limestones, which form the greater part of the surface exposures in the Ward district, are in beds 10 inches to 2 feet thick.

They are usually of a light blue-gray color, though some beds are dark gray and some contain a large amount of brown chert. Between the Paymaster and the Mammoth tunnels (Nos. 6 and 8, fig. 17), lime shales are interstratified with the true limestones. Among a few fossils collected by the writer on the trail halfway between the Paymaster and Martin White tunnels (Nos. 6 and 9, fig. 17), G. H. Girty identified the Pennsylvanian forms *Rhombopora* sp., *Productus* sp., and *Spirifer* aff. *S. cameratus*. Spurr[1] reports that a large collection of Permian fossils was obtained from limestones on the southeastern slope of Hamels Peak, whose summit is about 6 miles northwest of Ward. (See Pl. I.)

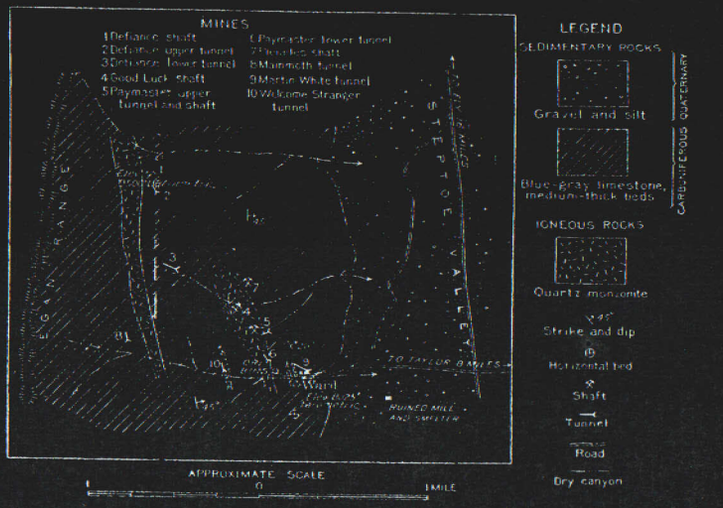

FIGURE 17.—Sketch map of the Ward district, White Pine County, Nev.

In the vicinity of Ward the sedimentary rocks have a north or north-northwest strike and a low east dip. South of the mouth of Ward Canyon the limestones are horizontal. A rather strong fault seems to strike north-northwest across Ward Canyon a mile west of the Ore Bins and east of the upper Defiance workings (Nos. 1 and 2, fig. 17). This fault appears to dip east and is thought to have dropped the beds on the east relatively to those on the west.

IGNEOUS ROCKS.

All of the dike rocks of this district are much altered and most of them have been mineralized to some extent. A specimen of fairly

[1] Spurr, J. E., Descriptive geology of Nevada south of the fortieth parallel and adjacent portions of California: U. S. Geol. Survey Bull. 208, p. 52, 1903.