STATUS OF MINERAL RESOURCE INFORMATION FOR THE DUCK VALLEY INDIAN RESERVATION, OWYHEE COUNTY, IDAHO, AND ELKO COUNTY, NEVADA

Administrative Report BIA-61

1980

Prepared by

U.S. Geological Survey and U.S. Bureau of Mines

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By

Roscoe M. Smith
U.S. Geological Survey

Samuel W. McNary
U.S. Bureau of Mines

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SUMMARY AND CONCLUSIONS

The mineral resource potential of the Duck Valley Indian Reservation seems low. However, significant amounts of copper, silver, and gold, as well as minor amounts of lead, zinc, antimony, tungsten, and uranium, have been produced from the Mountain City mining district adjacent to the reservation's southeast corner. From 1932 to 1948, the Mountain City (Rio Tinto) copper mine, about 1.5 miles southeast of the reservation, was the third-largest copper producer in Nevada. Most silver, gold, and lead production in the district was during the periods 1869-1900 and 1932-48. Small shipments of uranium and tungsten ore were made in the late 1950's and early 1960's.

During the 1870's, several gold placer mines were operated on the Owyhee River and its tributaries, from the town of Owyhee southeast to Mountain City. A few placers made profits, but none had significant production. Placer mining was attempted in this area during the 1920's and 1930's but was not economically successful.

A small, low-grade manganese occurrence (the Indian manganese prospect), in the southeastern part of the reservation, was explored during the 1940's. The deposit was considered to be uneconomic; except for two small pits, no development work was done.

The metallic deposits of the Mountain City district occur both as veins and as irregularly-shaped discontinuous bodies. The massive sulfide deposit at the Mountain City copper mine is localized in a quartzite unit of the Ordovician Valmy Formation; this formation does not crop out on the reservation. The silver and gold deposits are in fissure veins near quartz monzonite-sedimentary rock contacts, or within quartz monzonite.

Uranium minerals are associated with contact zones. They are between ash-flow tuffs or rhyolite, and quartz monzonite or sedimentary rocks in the Mountain City district. Tertiary volcanic rocks on the reservation could possibly be hosts for uranium minerals.

Several gravel pits are on the reservation, especially near State Highway 51. These have been sources of crushed rock and gravel for road material and local construction. The remote location of the reservation would probably preclude development of sand, gravel, and stone deposits except for local use.

No hot springs are reported on the reservation. However, the regional geographic and geologic settings appear favorable for geothermal resources. The presence of Tertiary volcanic rocks, abnormally high heat flow in the Snake River Plain to the north and in the Battle Mountain area to the south, Basin and Range type faulting, and the presence of warm springs to the southeast are factors to be considered in evaluating the geothermal potential of the reservation.

Extensive prospecting during the past 100 years in the Mountain City mining district, including those areas which are now part of the Duck Valley Indian Reservation, has probably led to the discovery of all major near-surface deposits. Many mineralized veins and zones reported in the literature are too small or too low-grade to be economic. The use of new and refined geochemical and geophysical exploration techniques could possibly reveal deep-seated, or low-grade, disseminated deposits that have thus far escaped detection. The recent discovery of a "Carlin-Cortez" type disseminated gold deposit about 40 miles southeast of Mountain City could stimulate additional exploration.

The lack of published information on mineral resources of the Duck Valley Reservation indicates that no detailed evaluation has been made. Although the mineral potential seems low, additional studies may be warranted. A field study might include stream sediment sampling of major streams and their tributaries; detailed geologic mapping and examination of the Tertiary volcanics; examination and evaluation of the gold placer areas and the Indian manganese prospect; sampling of spring and well waters; scintillometer surveys and other appropriate geophysical studies; and rock and soil sampling.

INTRODUCTION

This report has been prepared for the U.S. Bureau of Indian Affairs (BIA) by personnel of the U.S. Bureau of Mines (USBM) and the U.S. Geological Survey (USGS) under an agreement to compile and summarize available information on the geology, minerals, energy resources, and potential for economic mineral resource development of Indian lands. Primary sources of information were published and unpublished reports, the Mineral Industry Location System (MILS) files of the Western Field Operations Center of the USBM, and personal communications. No fieldwork was done.

Acknowledgments

Mr. Norris M. Cole, Superintendent, Eastern Nevada Agency, BIA, Elko, Nevada, provided maps, data, and general information on the Duck Valley Reservation. His whole-hearted cooperation is greatly appreciated.

Mr. Larry J. Garside, Energy-Resources Geologist, Nevada Bureau of Mines and Geology, furnished valuable unpublished data on hot springs in the Mountain City area.

Geography

The Duck Valley (Shoshone-Paiute) Indian Reservation is a rectangular area approximately 22 miles long and 20 miles wide that straddles the Idaho-Nevada border. It includes 145,545 acres in southern Owyhee County, Idaho, and 144,274 acres in northwestern Elko County, Nevada (figures 1 and 2) (U.S. Bureau of Indian Affairs, Eastern Nevada Agency, 1978, files). All land is tribally owned, but can be assigned to individual tribal members. Tribal headquarters is in the town of Owyhee in the southeastern part of the reservation. In 1976, about 960 Indians resided on or adjacent to the reservation (U.S. Bureau of Indian Affairs, 1976, p. 164).

State Route 51, a paved north-south highway, passes through the eastern part of the reservation from Elko, Nevada (about 80 miles to the south) to Mountain Home, Idaho (80 miles to the north). Several dirt and gravel roads, including State Route 11, which leads to Tuscarora (50 miles to the south) provide access to most parts of the reservation (figure 2). The nearest commercial air, train, and bus facilities are in Elko.

Summers tend to be hot and dry, and the winters cold and wet. Temperatures range from sub-zero to more than 100° F (38° C), with the average annual temperature at Mountain City being 41° F (5° C). Precipitation, which averages 16 inches annually at Mountain City, occurs mainly during the fall and winter. Heavy snowfall is common at the higher elevations (National Oceanic and Atmospheric Administration, 1975).

The Owyhee River and its tributaries form the principal drainage system. Most streams flow north or south to the Owyhee River, which itself flows northwest

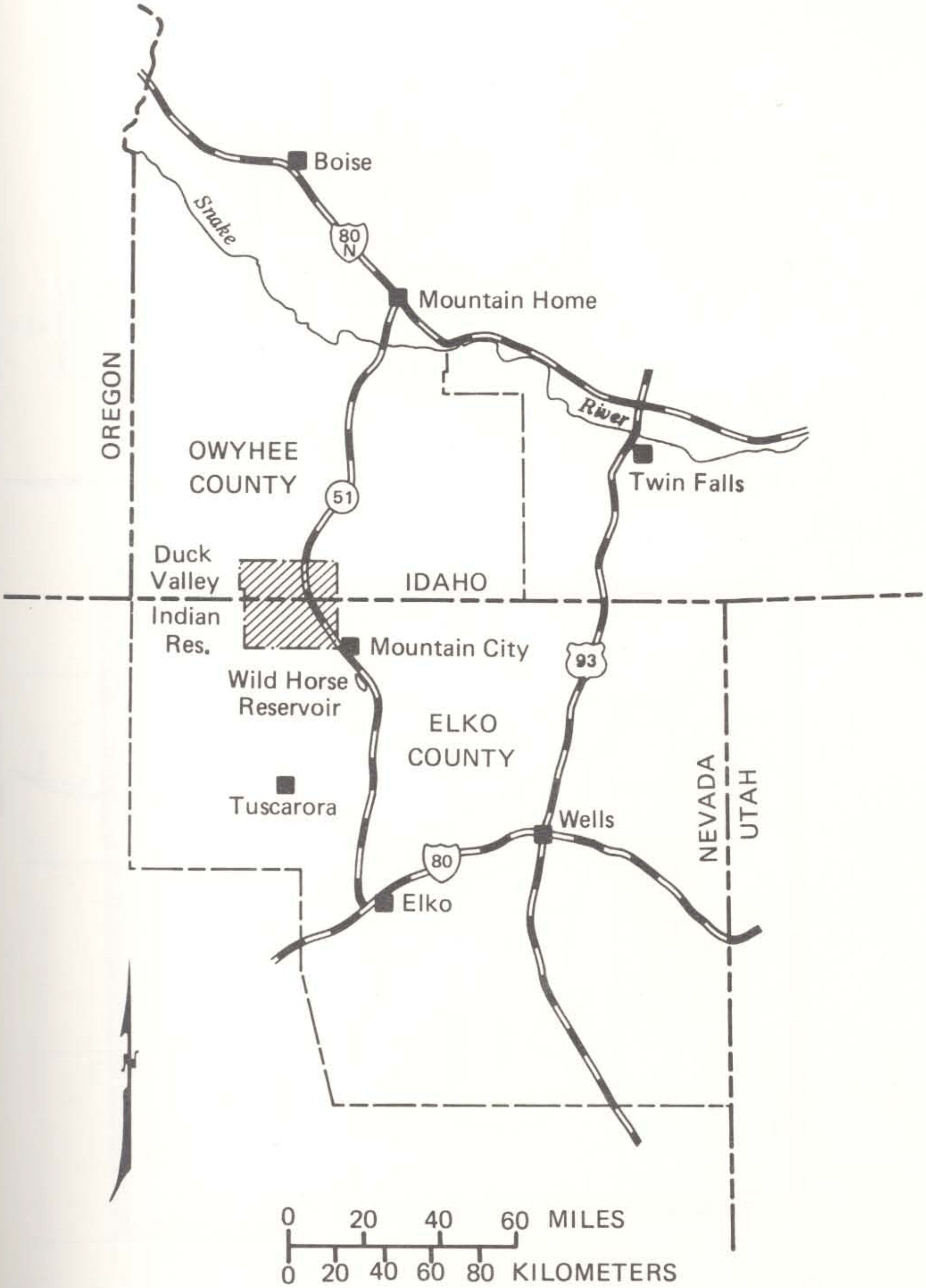

Figure 1--Index map of the Duck Valley Indian Reservation, Idaho and Nevada.

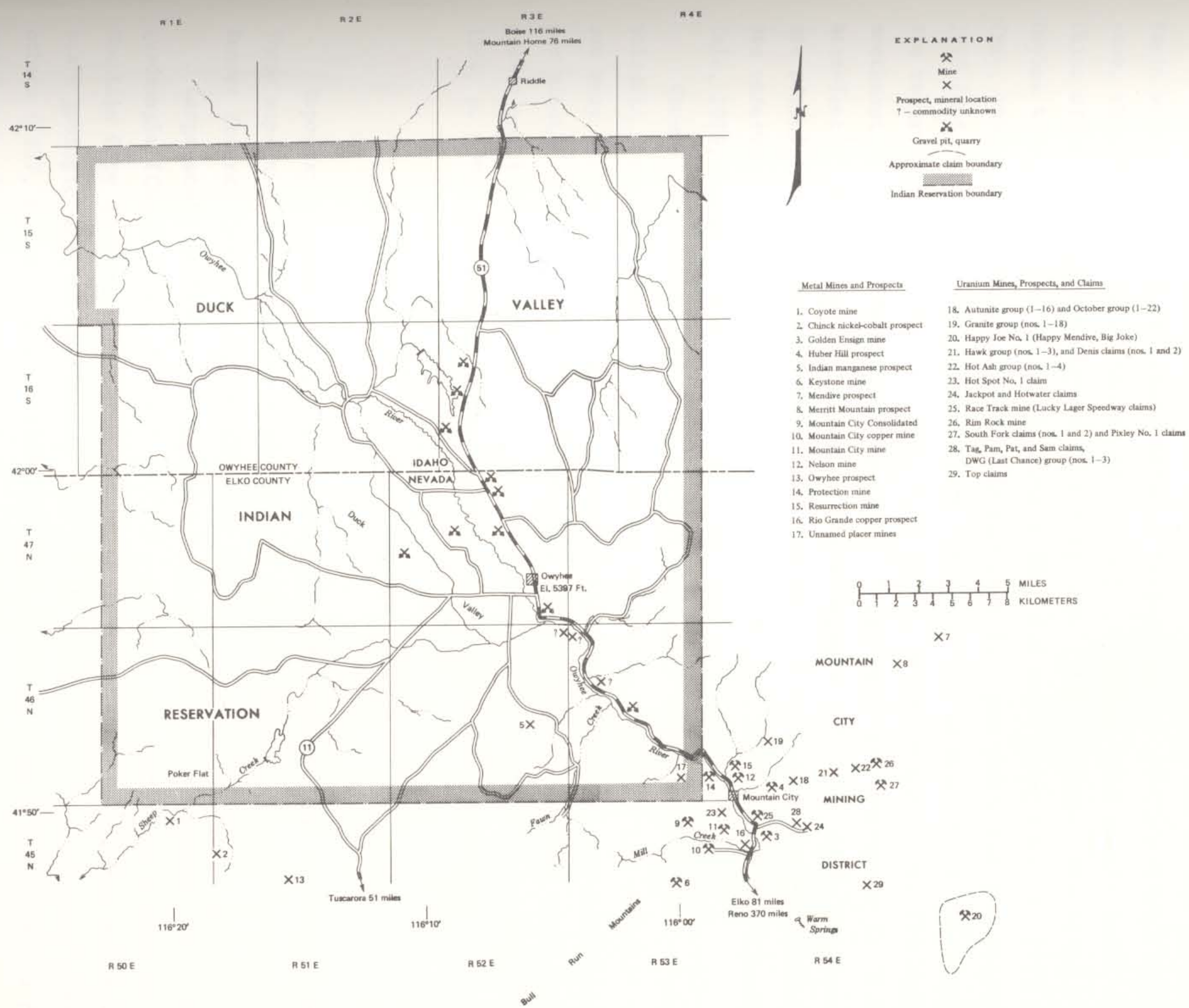

Figure 2--Mineral occurrences of the Duck Valley Indian Reservation area, Idaho and Nevada.

(figure 2); however, streams in the southwestern part of the reservation flow southwest to the South Fork of the Owyhee River. Many streams are active only during spring runoff or periods of heavy rain.

Surface water supplies depend entirely on precipitation in the Owyhee River Basin which surrounds the reservation. Average annual precipitation, mostly as snow, ranges from 8 to 20 inches (20-51 cm). Drainage area of the basin above China diversion dam near Owyhee is 458 sq. mi. (1186 sq. km). Discharge of the Owyhee River above the China dam ranges from 1.8 cfs[2] (Nov. 1961) to 2710 cfs (May, 1952) and averaged 135 cfs (97,810 acre-feet per year) for the years 1939-1970 (U.S. Geological Survey, 1974, p. 384). Water is stored for the benefit of the reservation in Wild Horse Reservoir on the Owyhee River 15 mi. (24 km) southeast of the reservation (figure 1). Capacity of the reservoir is 32,690 acre-feet[1]. Three thousand acres of the reservoir and 1,000 acres of shoreline are administered by BIA and have been leased to the Shoshone-Paiute Tribe. Efforts are underway to make this area a part of the Duck Valley Reservation (Norris M. Cole, 1979, personal comm.).

Ground water is supplied to springs and wells from the older and younger volcanic rocks and from older and younger alluvium. Some of the volcanic strata are very permeable, and some wells in the basin yield several thousand gallons per minute[3] and are as much as 2,000 feet (610 m) deep. Alluvium along streams yields small to moderate amounts of water at shallow depths (Travis and others, 1964, p. 299), but routine measurements, if any, are not published.

Map coverage

Topographic maps covering the Duck Valley Reservation are shown on figure 3. These maps may be ordered from the Branch of Distribution, U.S. Geological Survey, Denver Federal Center, Denver, Colorado 80225.

Large-scale geologic map coverage is available for the Owyhee 7 1/2 minute quadrangle (Coats, 1971, scale 1:48,000), and for the southwestern part of the Mountain City quadrangle (Coats, 1968b, scale 1:20,000). Less detailed, smaller-scale geologic maps of the Nevada part of the reservation are those by Granger and others (1957, plate 1, scale 1:250,000), Hope (1970, scale 1:200,000) and Stewart and Carlson (1976 and 1977, scale 1:1,000,000).

A recent USGS open-file map by Ekren and others (1978, scale 1:125,000) covers that part of the Duck Valley Reservation within Owyhee County, Idaho. No other detailed geologic maps are available for the Idaho portion of the reservation.

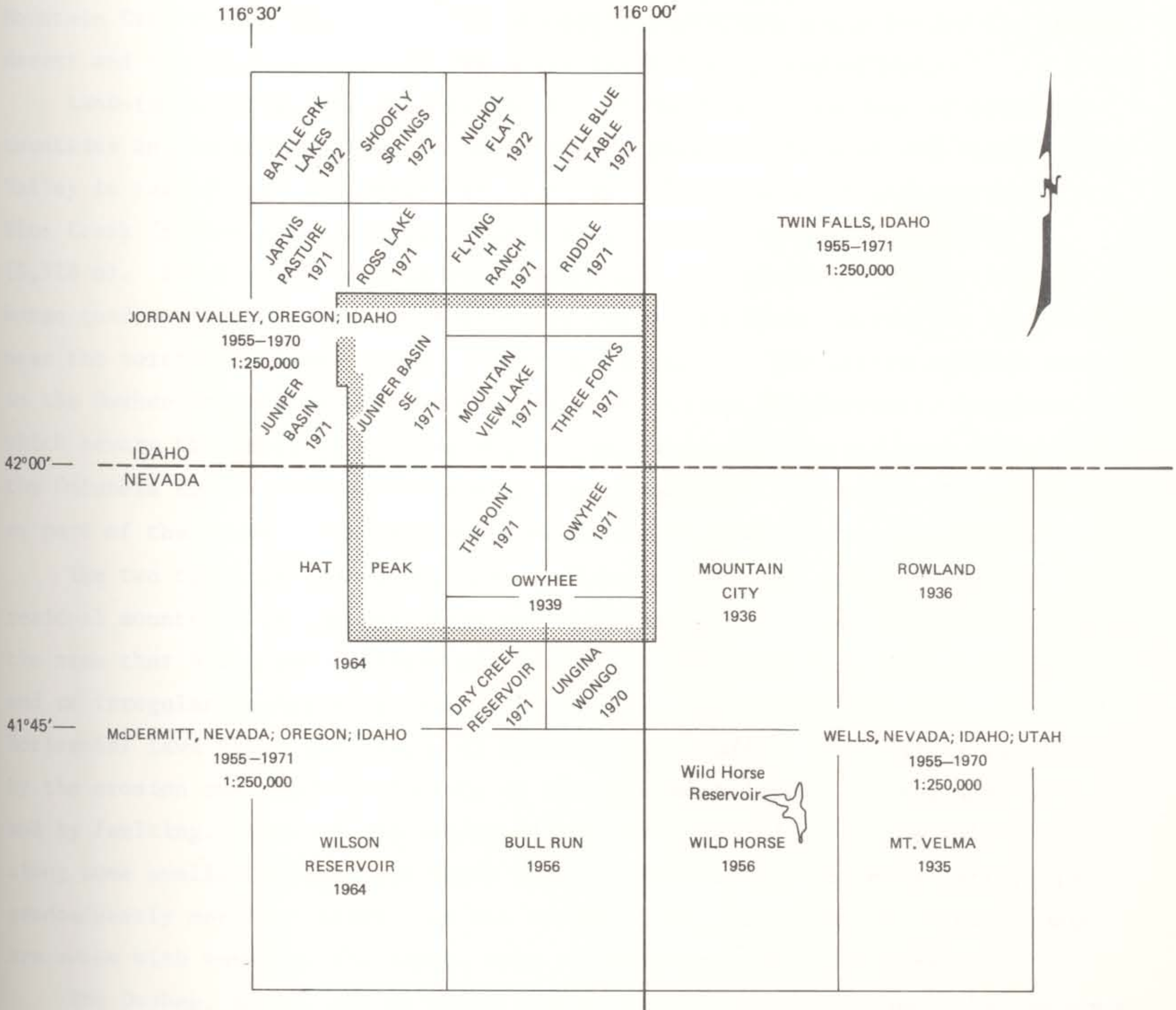

Figure 3--Index to topographic maps available for the Duck Valley Indian Reservation, Idaho and Nevada.

Detailed maps of the geology of the Mountain City district, especially the Mountain City copper mine and the surrounding area, are by Emmons (1910), Matson (1947), Granger and others (1957), Coats (1969), and Coats and Stephens (1968).

Physiography

The southeastern part of the reservation lies on the northwest flank of the Bull Run (Centennial) Mountains, and borders the Humboldt National Forest and Mountain City mining district. The western and northern parts border the Owyhee desert and the southern edge of the Snake River Plain, respectively.

Land-forms within the reservation are of two types, residual or erosion mountains in the southeast and a lower lava plateau in the west and north. Duck Valley is carved into the uppermost lavas by the Owyhee River and its tributary Blue Creek (figure 4). Altitudes range from 7,536 ft (2,297 m) to 4,980 ft (1,518 m). The highest peak is Wonga Douya near the southeast corner (Ungina Wongo quadrangle). Lowest point is where the Owyhee River leaves the reservation near the northwest corner (Juniper Basin quadrangle). The entire area is included in the Owyhee Uplands Section of the Columbia Plateau Physiographic Province, which covers the parts of Washington, Oregon, Idaho, and Nevada that drain into the Columbia River. The area has also been classified for water and waterpower as part of the Snake River Hydrologic Basin and the Owyhee Drainage Basin.

The two types of land-forms each reflect a different geologic history. The residual mountains in the southeast are remnants of the oldest rock formations in the area that have been uplifted and eroded, resulting in many dome-like hills and an irregular drainage pattern. The plateau part of the area contains nearly horizontal lava flows and layers of volcanic ash (tuff). Duck Valley was formed by the erosion and removal of parts of the uppermost layers of lava and tuff, and by faulting. Some of the basalt cliffs along the edges of the valley and along some smaller streams are fault scarps. The Plateau drainage pattern is predominantly north or south into the Owyhee River. Between the streams there are mesas with numerous dry lakes, some of which are now reservoirs.

The Owyhee, Snake, and Columbia Rivers are antecedent streams; that is they maintained nearly their former courses in spite of gradual uplift of the mountains. The result is many deep narrow canyons, such as the Owyhee River Canyon on the reservation.

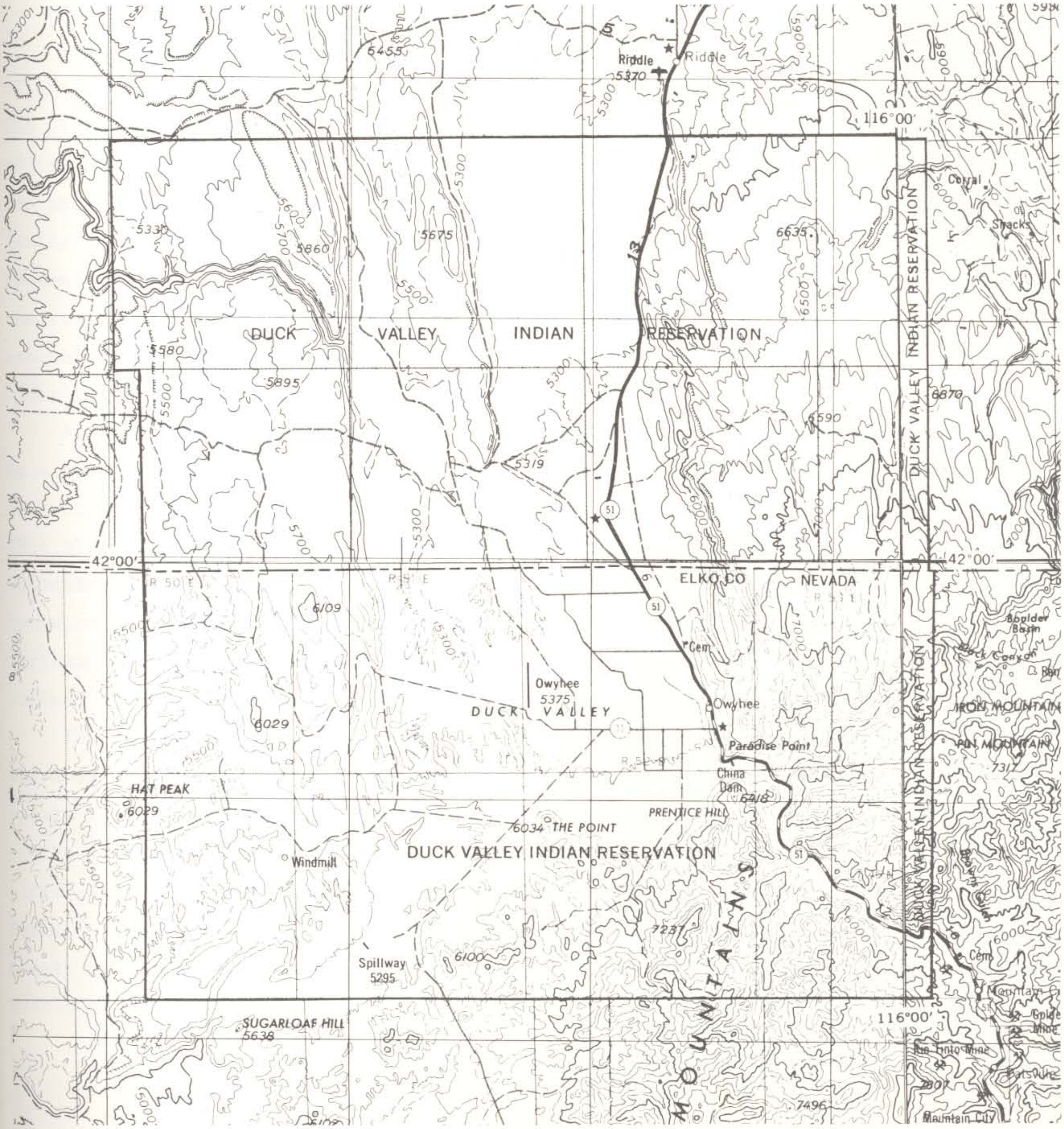

Figure 4--Topographic map of the Duck Valley Indian Reservation, Idaho and Nevada; Scale 1:250,000.

GENERAL GEOLOGY

Abstracted from Coats, 1971

Rock formations in the reservation were formed during four different periods of geologic history that cover a time span of about 330 million years (figure 5). The oldest are sedimentary and metamorphic rocks of Paleozoic age--(sandstone, siltstone, phyllite, quartz mica schist, and slate)--which are exposed only in the southeast corner of the reservation. These oldest formations were folded, faulted, and intruded at depth by stocks of granitic rock (granodiorite and quartz monzonite) of Cretaceous age. The stocks were fractured, and mineralized along the fractures with gold-quartz veins, also of Cretaceous age. The entire assemblage was then uplifted and the upper part eroded, exposing the granitic and older rocks at the surface.

After a lapse of perhaps 50 million years the erosion surface was covered by a third group of rocks (volcanic tuffs, lava flows, and interbedded sediments) of Tertiary age. Total thickness of these volcanic rocks exceeds 3,000 feet (914 m). This third group of formations is herein divided into older and younger volcanics because a second interval of mineralization of middle Tertiary age hydrothermally altered the older volcanic rocks in many parts of a zone trending northeastward in T. 46 N., R. 52 E. (figure 5). The altered rocks are bleached, stained with iron oxide, and opalized. Younger volcanic rocks are not altered.

The latest volcanic rock to be deposited is basalt of the Banbury Formation which is about 7 m.y. old. In Idaho this formation has been mapped as Snake River basalt (Ross and Forrester, 1947). In the southern part of the reservation much of the volcanic rock has been eroded, again exposing parts of the granitic and older formations. In the northern part, Banbury basalt is nearly flat-lying and forms most of the surface at higher altitudes, but in Duck Valley part of the basalt is eroded to form the fourth group of formations (older and younger alluvium) mostly of Quaternary age.

ECONOMIC GEOLOGY

The only mineral commodities reported to have been produced from the reservation are alluvial gravel, basalt, welded tuff, and placer gold. Water resources are replenished by rain, snow, and by inflow from Wild Horse Reservoir southeast of the reservation.

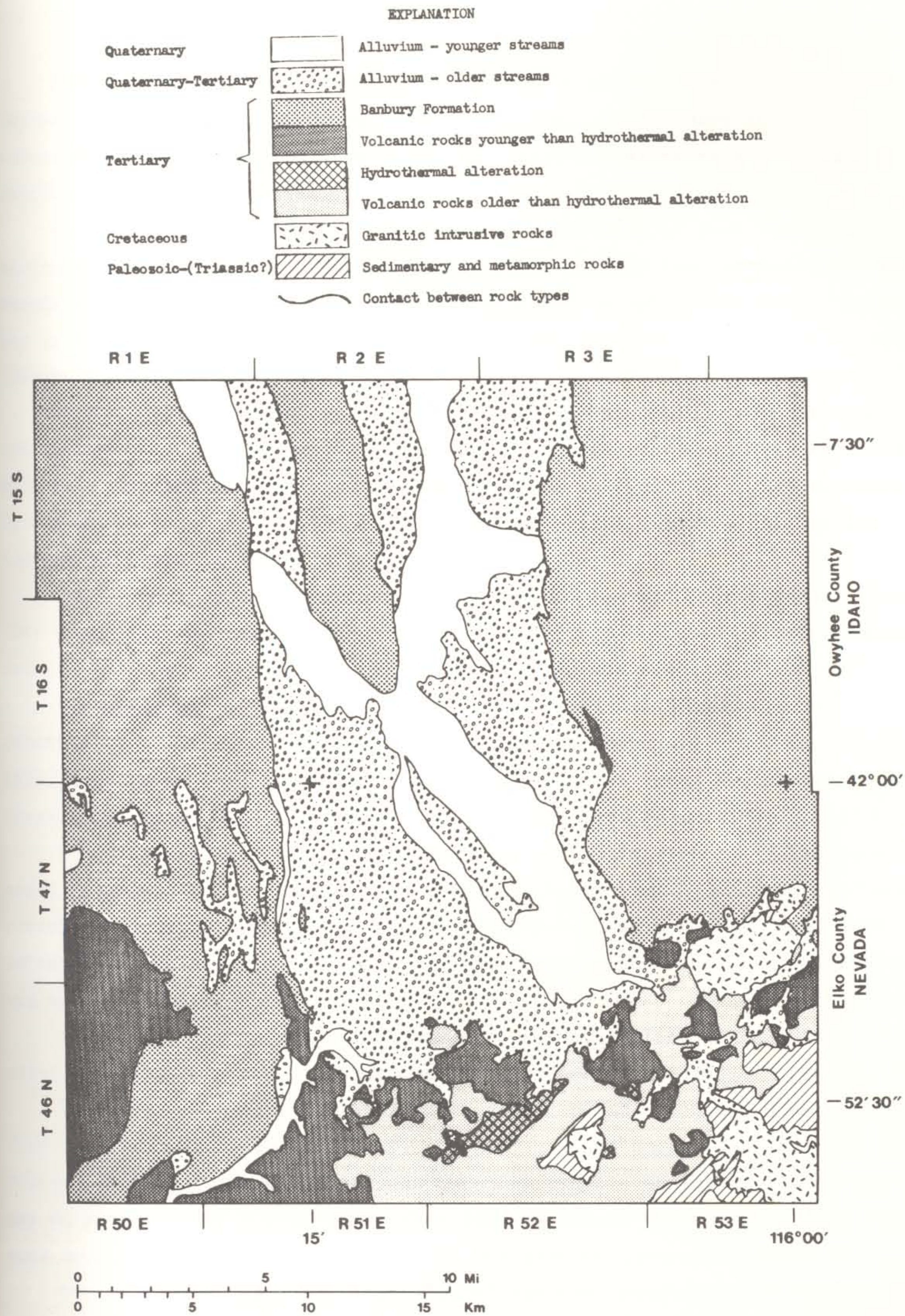

Figure 5--Geologic map of the Duck Valley Indian Reservation. Adapted from Coats, 1971, and Ekren and others, 1978.

Sand and gravel deposits occur along nearly all streams and along the Owyhee River in both younger and older alluvium. Gravel used in highway construction was mined from three pits in Idaho and eight pits in Nevada (see section on Mineral Deposits).

Basalt flows cover much of the area east and west of Duck Valley at altitudes above 5,400 to 5,600 feet. They are part of the extensive Banbury basalt that covers much of the Snake River Plain in southern Idaho. Basalt for use in highway construction was quarried in the northern part of the reservation (Charboneau, 1964, p. 172).

Welded tuff of the older volcanics is found only in the southern part of the reservation. It occurs as domes and erosion remnants commonly less than a mile (1.6 km) across and is as much as 400 feet (122 m) thick. In many places it forms the tops of small hills, and on Cain Spring (Quarry) Hill it was quarried for use as building stone in Owyhee.

Two types of precious metal deposits are recognized in the nearby Mountain City area, one consisting of gold-quartz veins, the other of silver-gold-quartz veins. Both types occur along fractures in granitic stocks.

The gold-quartz veins are considered to be of Cretaceous age, and to be genetically related to the granitic intrusives. They have not been mined but have contributed gold to placer deposits of Holocene age. The placer gold in Grasshopper Gulch, on the reservation, probably came from veins of this type.

The potential for placer gold deposits in modern streams is low because areas of granitic rock, which are their source, are small. Tertiary stream gravels presumably underlie the older volcanics in some places, but their potential for placer gold is not very high because the area of exposed granite was not very large.

There may be some potential, however, for concealed quartz veins containing silver-gold below and near the zones of hydrothermal alteration shown on figure 5.

Tertiary silver-gold veins furnished most of the production in the Mountain City district before the discovery of the Rio Tinto copper deposit, and concealed Tertiary ore deposits ~~and~~ of grade may possibly exist. The older lavas, however, may in places be more than 1,400 feet (427 m) thick. Even if ore deposits are in rock underlying the lavas, they may be too deep to discover profitably.

The potential for copper deposits within the reservation is small. The Rio Tinto deposit is confined to rocks of the Valmy Formation which was transported to its present location in the upper plate of a thrust fault and does not crop out on the reservation.

MINERAL RESOURCES

Metallic mineral resources

The area's significant mineral production has come from the Mountain City mining district, that includes the extreme southeast corner of the Duck Valley Indian Reservation (figure 2). Therefore, the production history and ore deposits of this district are discussed at length.

The only other nearby mining districts that have had any significant production are the Aura, Edgemont, and Van Duzer districts, 6 to 10 miles south of the reservation. These districts are discussed briefly. Their locations are not shown on figure 2.

No mineral deposits are reported from the Wild Horse Reservoir area. Tertiary volcanic rocks constitute the predominant country rock and might possibly be hosts for uranium minerals. Alluvial deposits occur near the southern part of the reservoir (Stewart and Carlson, 1976, Sheets 3 and 4). The Island Mountain mining district (not shown on figure 2) is about 8 miles to the northeast in Tps. 44 and 45 N., Rs. 55 and 56 E.

Mountain City mining district

History and production.--The Mountain City mining district, also known as the Cope, Van Duzer, and Rio Tinto, is in the northeastern Bull Run (Centennial) Mountains near the Owyhee River. Mining has centered chiefly around Mountain City, one mile east of the southeast corner of the Reservation (figure 2).

Considerable prospecting took place in the district during the 1870's and early 1880's. Reports indicate that before 1881, the district yielded more than $1 million in silver. Most silver production was from rich, but shallow, oxidized ore bodies that were exhausted by the early 1880's. Very little silver was produced after 1881 (Granger and others, 1957, p. 112).

The four mines in the Mountain City district yielding the bulk of the silver were the Nelson, Protection, Resurrection, and Mountain City. Brief descriptions of these and other mines in the district are given in table 1; their locations are plotted on figure 2.

Although gold was discovered in the gravels of the Owyhee River in the early 1870's, very little placer mining was done for several years. In the mid-1870's, gold was discovered in Grasshopper Gulch (figure 2) in secs. 26 and 35, T. 46 N., R. 53 E., in the southeast corner of the Duck Valley Reservation (Vanderburg, 1936, p. 74). This discovery must have been made before the reservation was established. According to Vanderburg (1936, p. 74) a half-mile stretch of the gulch was profitably worked by placer mining methods.

Emmons (1910, p. 80) reports three inactive gold mills in the Mountain City district during the early 1900's. These mills probably processed gold ore from lode mines active during the late 1800's.

Very little prospecting was done in the district from 1908 to 1918. A renewed flurry of prospecting activity occurred in 1919, when the Duck Valley Reservation was opened for mineral location. However, no significant discoveries were reported (Coats and Stephens, 1968, p. 1077).

In the early 1930's, small-scale placer operations were intermittently active in Hansen Gulch (not shown on figure 2), just east of Grasshopper Gulch, and along the Owyhee River, several miles north of Mountain City. None of these operations had a significant production (Vanderburg, 1936, p. 75). Placer gold production from the Mountain City district, most of which was before 1900, has an estimated total value of $150,000 (Granger and others, 1957, p. 112).

From 1919 to 1931, S. F. Hunt, a geologist-prospector, explored a gossan which overlay the Rio Tinto ore body near the old Mountain City mine. Hunt and his partners sank an inclined shaft, which, in 1932, at a depth of 242 feet, penetrated a 72-foot-wide supergene ore body that assayed 50 percent copper. In 1932, International Smelting and Refining Company, purchased a controlling interest in the property, which became known as the Mountain City copper mine (Coats and Stephens, 1968, p. 1079).

The mine was the third largest copper producer in Nevada until exhaustion of the deposit in 1947. From 1932 until the operation ceased in 1947, about 1,109,878 short tons of ore averaging 9.7 percent copper, 0.27 ounce of silver per ton, and 0.0057 ounce of gold per ton were produced. Of the total production,

Table 1--Descriptions of metal mines and prospects in the Mountain City district, Nevada

[Numbers correlate with locations on figure 2]

Name	Location	Commodity	Description and remarks
1 Coyote mine	Sec. 2, T. 45 N., R. 50 E.	Copper, molybdenum	Molybdenite-bearing quartz veins are associated with black carbonaceous shale and thin-bedded limestone which have been fractured and intruded by rhyolite and andesite dikes. Molybdenite, pyrite, and chalcopyrite occur as tiny seams in quartz veins. In 1947, development consisted of a shallow shaft and surface trenches. No production (USBM files).
2 Chinck Nickel - Cobalt prospect	Unsurveyed sec. 7, T. 45 N., R. 51 E., or unsurveyed sec. 12, T. 45 N., R. 50 E. (location uncertain)	Nickel, cobalt, copper, molybdenum	Country rocks consist of shale and shaly limestone which have been broken by faults, and intruded by andesite and rhyolite dikes. Two quartz veins containing thin molybdenite seams and scattered pyrite and chalcopyrite crystals are exposed in old cuts. Highly altered and leached zones contain small amounts of pyrite, cobalt, and nickel. In 1960, development consisted of surface trenches and a discovery shaft which was 4 feet square and about 10 feet deep (USBM files).
3 Golden Ensign mine	SW1/4, W1/2, W1/2 sec. 6, T. 45 N., R. 54 E., about 1.5 miles southeast of Mountain City.	Molybdenum, gold, silver	Molybdenite is associated with gold and silver. Small production in 1952 (Schilling, 1962b, p. 13).
4 Huber Hill	Sec. 31, T. 46 N., R. 54 E., 2 miles east of Mountain City.	Molybdenum	Molybdenite occurs with pyrite in quartz veins, and as disseminations in quartz monzonite. Development consists of an adit, dozer trenches, and several drill holes. No production (Schilling, 1962b), p. 13).

Table 1--Descriptions of metal mines and prospects in the Mountain City district, Nevada (Continued)

Name	Location	Commodity	Description and remarks
5 Indian manganese prospect	Sec. 23, T. 46 N., R. 52 E., about 5 miles south of Owyhee (location uncertain)	Manganese	See main text for description.
6 Keystone mine	Sec. 15, T. 45 N., R. 53 E.	Copper	None.
7 Mendive prospect	Sec. 6, T. 46 N., R. 55 E., 17 miles northeast of Mountain City.	Antimony	A small amount of yellow antimony oxide has been reported. No production (Lawrence, 1963, p. 63).
8 Merritt Mountain prospect	Secs. 11 and 12, T. 46 N., R. 54 E.	Antimony, lead	Grab samples from dump contain galena, pyrite, and small amount of yellow antimony oxide (Lawrence, 1963, p. 63).
9 Mountain City Consolidated	Sec. 3, T. 45 N., R. 53 E.	Copper, gold, silver	None.
10 Mountain City copper mine	S1/2, NW1/4 sec. 11, T. 45 N., R. 53 E., 2 miles southwest of Mountain City.	Copper	See main text for description.
11 Mountain City mine	SE1/4 sec. 2, T. 45 N., R. 53 E.	Silver	A fissure vein, carrying silver chloride and native silver, and striking N. 50° W., cuts a metamorphosed, black shaly limestone. In the 1870's, the mine reportedly yielded several hundred thousand dollars worth of silver ore (Granger and others, 1957, p. 120).

Table 1--Descriptions of metal mines and prospects in the Mountain City district, Nevada (Continued)

Name	Location	Commodity	Description and remarks
12 Nelson mine	N1/2, N1/2 sec. 36, T. 36 N., R. 53 E., 3/4 mile north of Mountain City.	Silver, gold	Ore deposits occur as 1- to 3-foot wide fissure fillings in quartz monzonite, limestone, and aplite. Sulfide minerals present are pyrite, galena, sphalerite, tetrahedrite, chalcopyrite, arsenopyrite, and small amounts of ruby silver and argentite. Native silver and cerargyrite occur near surface. Free gold, some of it crystalline, is associated with quartz and brown iron oxide. Development consists of about 4,000 feet of workings (Granger and others, 1957, p. 119).
13 Owyhee prospect	Sec. 16, T. 45 N., R. 51 E.	Molybdenum	Molybdenite-bearing quartz veins cut slade, which in places, is unconformably overlain by Tertiary basalt. Development consists of several trenches and three churn-drill holes. No production (Schilling, 1962b, p. 13).
14 Protection mine	NE1/4, NE1/4 sec. 35, T. 46 N., R. 53 E., 1 mile northwest of Mountain City.	Silver, gold, lead, zinc	A quartz vein, with a maximum width of 4 feet, occurs as a fissure filling in quartz monzonite, and contains pyrite, galena, sphalerite, tetrahedrite, stephanite, and ruby silver. The deposit, one of the first discoveries in the district, was worked in the 1870's (Granger and others, 1957, p. 118).
15 Resurrection mine	Unsurveyed NE1/4 sec. 36, T. 46 N., R. 53 E., 1/2 mile north of Mountain City.	Silver	Narrow quartz veins cut highly altered quartz parallel to closely-spaced, northeasterly-striking fissures. The oxidized ore near the surface consists of quartz, cerargyrite, lead carbonates, and iron oxides. The primary sulfides are galena, tetrahedrite pyrite, and chalcopyrite. In the 1870's, considerable rich ore was mined from surface pits and processed in nearby silver mills (Granger and others, 1957, p. 119).

Table 1--Descriptions of metal mines and prospects in the Mountain City district, Nevada (Continued)

Name	Location	Commodity	Description and remarks
16 Rio Grande copper prospect	N1/2 sec. 12, T. 45 N., R. 53 E.	Copper	Country rock consists of limestone, quartzite, shale, and conglomerate beds, which strike approximately east-west and dip steeply north. Mineralized zones in the shales contain pyrite, quartz, and sooty chalcocite. Pyrite is disseminated in the sediments, but is also found in tiny fractures and seams. No production (Matson, 1947, p. 1-6).
17 Unnamed placer mines	Secs. 26 and 35, T. 46 N., R. 53 E., in Grasshopper Gulch.	Gold	See main text for description.

about 177,043 tons of ore averaging 26 percent copper were shipped directly to a smelter in Utah. Remaining ore was concentrated at the mine (Coats and Stephens, 1968, p. 1079).

During the mid-1950's, small amounts of tungsten were mined and shipped from the Mountain City district (USBM, 1952-60, Minerals Yearbooks). Molybdenum has been reported from several prospects and mines (see table 1), but there has been no production. Antimony minerals have been found in the Mendive and Merritt Mountain prospects, 8 to 10 miles northeast of Mountain City (see figure 2 and table 1).

From 1869-1949, total production from the Mountain City district was as follows (Granger and others, 1957, p. 114-115):

	Amount		Value
Copper	189,847,231 lb		$21,319,358
Silver	1,472,589 oz		1,586,134
Gold	11,077 oz		315,911
Lead	192,863 lbs		12,794
		TOTAL	$23,234,197

Mines and prospects.--The Mountain City mining district is underlain by a thick series of Paleozoic rocks, intruded by Cretaceous quartz monzonite, and later largely buried by Tertiary volcanic rocks. The Paleozoic rocks include chert, slate, siltstone, quartzite, limestone, phyllite, shale, and breccia. The volcanic rocks consist primarily of tuff, rhyolite, andesite, and dacite. The Paleozoic rocks tend to strike west and dip north. They are cut by thrust faults and high-angle normal faults (Granger and others, 1957, p. 113; Coats, 1971, map).

The silver-bearing veins in the district generally occupy sharply defined fissures near the quartz monzonite-sedimentary rock contacts, or within the intrusives. Contacts are sharp, with little evidence of replacement, even where the wall rock is limestone. Alteration along the veins cutting the quartz monzonite is slight, except for some sericitization, alteration of the ferromagnesian minerals, and the introduction of pyrite (Granger and others, 1957, p. 118).

The unoxidized zone contains pyrite, galena, sphalerite, tetrahedrite, arsenopyrite, and a little chalcopyrite. Argentite and free gold are found in a quartz gangue. The oxidized zone contains quartz, chalcedony, cerargyrite, pyromorphite, iron oxides, native gold and silver, lead carbonate, copper carbonate, copper silicate. Stephanite (brittle silver) and pyrargyrite have also been reported (Granger and others, 1957, p. 118). The mineralized zone is very siliceous; quartz may constitute as much as 90 percent of the rock. The decomposed chloride and lead carbonate minerals yield the highest silver assays. Free gold is locally abundant in the iron-stained, siliceous rock (Emmons, 1910, p. 81).

Oxidation of the deposits extends from a few feet below the surface to depths greater than 250 feet. The veins tend to be faulted, primarily by normal faults, at angles to the veins. In places, the quartz has been shattered and brecciated by movement along the walls of the fissure (Granger and others, 1957, p. 118). According to Emmons (1910, p. 81), the faulting and brecciation have locally reduced the siliceous rock to a white sand containing small, rounded fragments of quartz.

The deposits of the Mountain City copper mine are in a stratigraphically restricted zone of black and gray phyllite, associated with minor quartzite lenses of the Ordovician Valmy Formation. The primary sulfide bodies occur as disc-shaped lenses which strike N. 65° W. to N. 85° W. and dip, commonly parallel to the bedding, at angles of 65° to 85° N. The largest lens, known as the '"200" ore body'. is continuous for about 1,000 feet along the strike of the bedding and has a width of 92 feet (Coats and Stephens, 1968, p. 1085).

The two principal hypogene sulfide minerals are pyrite and chalcopyrite. A little sphalerite is associated with the massive sulfides. The supergene copper sulfide minerals (chalcocite, bornite, and covellite), which largely replace primary sulfides, are most abundant in the 50 feet immediately below the top of the present ground water table in the '"200" ore body'. The proportion of supergene minerals generally decreases with depth beneath the water table (Coats and Stephens, 1968, p. 1091 and 1093).

The nonsulfide copper minerals (cuprite, native copper, malachite, and azurite), which were formed largely from the oxidation of the supergene copper sulfides, are found with chalcocite in the footwall shales (the shales underlying the "ore horizon"). Much of the chalcocite appears to have filled openings in carbonaceous shales (Coats and Stephens, 1968, p. 1093).

The "footwall supergene ore body" has an estimated 600,000 tons of resources containing approximately one percent copper. Part of this body has been mined (Coats and Stephens, 1968, p. 1096).

The Mountain City copper deposit bears no resemblance to other nearby deposits. Most of the latter are either gold-quartz veins in quartz monzonite with minor galena, sphalerite, pyrite, and chalcopyrite, or contact metamorphic scheelite deposits in calcareous country rocks with very small amounts of copper sulfide minerals. The gold and silver content of the Mountain City copper mine ore is very low. No individual silver minerals have been recognized.

The lack of significant mineral discoveries in the area since 1932 portends a rather bleak future for the Mountain City mining district. No other minable copper deposit such as the Mountain City copper mine has been found in the Paleozoic rocks of the district. The ore body at the Mountain City mine is localized in the Valmy Formation which does not extend onto the Duck Valley Reservation. Small amounts of pyrite and chalcopyrite are present in metavolcanic rocks of the Nelson Formation, a few thousand feet west of the Mountain City copper mine (Coats and Stephens, 1968, p. 1098).

Aura mining district

History and production.--The Aura district (not shown on figure 2) is on the east slope of the Bull Run Mountains in sec. 3, T. 44 N., R. 52 E., approximately 10 miles south-southwest of Mountain City. Ore was discovered in the district in 1869, and in 1870, ten mines were in production. The first ore mined was extremely rich in gold and silver (Granger and others, 1957, p. 27). Total production from the district is estimated to have been 4,293,056 ounces of silver, and 67,265 ounces of gold, having a total combined value of $6,032,795 (Granger and others, 1957, p. 28).

Mines and prospects.--The country rocks in the Aura district consist primarily of Paleozoic sedimentary rocks, which, to the north, have been intruded by a granodiorite stock several square miles in area. The mines are in limestone adjacent to the western contact of the stock (Granger and others, 1957, p. 28).

The mineral deposits are of three types: (a) fissure veins that cut across the limestone bedding, (b) bedding plane replacement deposits that follow stratification, and (c) fissure veins in granodiorite. The deposits are of two general classes: (a) gold in very siliceous rock, which contains a small percentage of silver and galena, and (b) silver deposits with a higher percentage of pyrite and galena together with sphalerite and small amounts of arsenic and antimony minerals. Normal faults cut most of the deposits (Granger and others, 1957, p. 28).

Edgemont (Centennial) mining district

History and production.--The Edgemont (Centennial) district is in secs. 19 and 20, T. 44 N., R. 52 E., on the west slope of the Bull Run (Centennial) Range, about 10 miles southwest of Mountain City, and west of the Aura district. Gold was discovered in the district in the 1890's (Granger and others, 1957, p. 52).

From their opening until 1908, the mines in the Edgemont district yielded ore, chiefly gold, valued at about $1,000,000. Total production from 1900 to 1949 was (Granger and others, 1957, p. 54):

	Amount		Dollars
Gold	43,832 oz		$928,295
Silver	35,988 oz		21,355
Copper	9,252 lb		1,265
Lead	545,081 lb		25,756
Antimony	13,680 lb		1,915
		TOTAL	$978,586

Mines and prospects.--The country rocks in the area are primarily Paleozoic quartzite, limestone, and shale. A Cretaceous granodiorite intrusive, about one square mile in area, crops out at the north edge of the district (Granger and others, 1957, p. 53).

Ore deposits in the district occur as fissure veins in quartzite. Pyrite, galena, and arsenopyrite are the principal sulfide minerals. The gold is associated with the sulfides and their oxidized products, which assay from 0.25 to 0.5 ounce gold per ton (Granger and others, 1957, p. 53 and 55).

Nineteen tons of ore containing 36 percent antimony were produced in 1940 from the Blue Ribbon mine, about 5 miles south of Mountain City. The antimony is found primarily as stringers of stibnite in quartz veins, but it is also sparsely disseminated throughout the quartz. The stibnite is coarse-grained and is oxidized for only a few feet below the surface. The quartz veins cut a medium-grained granite and range from 8 inches 2.5 feet wide (Granger and others, 1957, p. 57).

Van Duzer mining district

The Van Duzer mining district is on the east slope of the Bull Run Mountains, adjacent to the southern part of the Mountain City mining district, of which it is commonly considered to be a part. Van Duzer Creek traverses the district and flows into the North Fork of the Owyhee River, about 6 miles south of Mountain City.

Several miles of the main fork of Van Duzer Creek have been mined by placer methods. The alluvial deposits are about 10 feet thick and are composed of fine gravel and sub-angular to well-rounded pebbles. Bedrock is probably limestone. The gold ranges from fine dust to nuggets weighing five or six ounces. The source is probably the gold-bearing quartz veins in the Bull Run Mountains at the head of the drainage. Some gold may have been derived from ancient fluviatile gravels (Vanderburg, 1936, p. 76).

Indian manganese prospect

Information on the Indian manganese prospect has been obtained from unpublished data in the files of USBM, Western Field Operations Center. A USBM engineer examined the prospect in September 1949. At that time, four local prospectors had made arrangements to lease 2,560 acres of land on the Duck Valley Indian Reservation, and they were hoping to secure financial aid for development.

According to the property files, the prospect is reached by way of State Highway 1 to the Fawn Creek turnoff, about 13 miles northwest of Mountain City.

The Fawn Creek road extends west and south to the manganese road turnoff. A fair but steep road leads south and east to the prospect, on the crest and east side of a north-trending ridge, at an elevation of about 7,000 feet.

Topographic maps show several roads leading to the Fawn Creek area. Unfortunately, the location of the particular Fawn Creek road mentioned in the property files cannot be determined. If the description given in the original report is plotted on the Owyhee 15-minute quadrangle map, the most likely location for the prospect is in sec. 23, t. 46 N., R. 52 E. about 5 miles south of the town of Owyhee (figure 2). However, because road locations have undoubtedly changed in the last 30 years, the exact location cannot be determined without a field search.

Country rocks in the vicinity of the manganese prospect consist of limestone, shale, and quartzite. The formations are steeply dipping and have been intruded by quartz porphyry dikes.

The manganese occurrences are in siliceous, thin-bedded limestones adjacent to the quartz porphyry intrusions. Three manganese-bearing zones are present in an area 600 feet wide and 1,000 feet long. The zones strike about N. 45° E., and dip between 60° and 70° northwest. The northern exposure, which is the largest, can be traced for about 1,000 feet and is from 4 to 6 feet thick. The other two zones, which lie to the south, are spaced about 200 feet apart. They strike N. 30° E. and range from a few inches to 3 feet in thickness.

The manganese minerals consist chiefly of wad (an impure mixture of manganese and other oxides) and psilomelane, associated with quartz and iron. The property files indicate that samples of the manganese-bearing rock averaged 19.6 percent manganese, 0.106 percent phosphorous, 0.028 percent sulfur, and 37.33 percent insoluble material. Because of its low grade, the manganiferous rock would require beneficiation before shipment.

Development at the time of the property examination consisted of two surface cuts 500 feet apart, 15 to 20 feet long, 6 to 8 feet wide, and about 8 feet deep. Narrow manganese-bearing zones were exposed in silicified limestone on the walls of the cuts. Most of this work was apparently done in the early 1940's. No record of any prospecting activity since 1949 was found.

Island Mountain mining district

After the discovery of gold in 1873, the Island Mountain area became one of the most productive placer areas in Nevada. Production records for this early period are not available. The placers were idle for many years. From 1934 to 1941, total recorded production, including both placer and lode mines, was 529 ounces of gold, 552 ounces of silver, 1,900 pounds of lead, and 300 pounds of copper (Granger and others, 1957, p. 75).

Nonmetallic mineral resources

Topographic maps show several gravel pits on the Duck Valley Reservation, especially near Highway 51 and along the Owyhee River (figure 2). These pits have probably been the source of crushed rock and gravel for road material and local construction purposes. The rock products probably consist of alluvial material and crushed volcanic rock.

ENERGY RESOURCES

Uranium

During the 1950's, most of Nevada's uranium ore was mined and shipped from claims in the Mountain City area (Davis and Ashizawa, 1959, p. 606). In 1961, ore was shipped from the South Fork property about 6 miles east of Mountain City (Davis, Ashizawa, and Giorgetti, 1962, p. 677).

Brief descriptions of 14 uranium claims and prospects in the Mountain City district are given in table 2; their locations are plotted on figure 2.

No reports of uranium minerals are known from the Duck Valley Reservation. Garside (1973, p. 43) mentions an airborne survey showing a radiometric anomaly on reservation land. The location, however, is given as sec. 20, T. 46 N., R. 56 E., which would be about 15 miles to the east of Mountain City. The radioactivity measured about 500 counts per second above background (Garside, 1973, p. 43).

Most of the uranium deposits consist primarily of secondary uranium minerals and occur in the contact zones between either ash-flow tuffs and granitic rocks, or tuffaceous sedimentary rocks and granitic rocks. The uranium source may have

Table 2--Uranium mines, prospects, and claims in the Mountain City district, Nevada

[Numbers correlate with locations on figure 2]

Name	Location	Description and remarks
18 Autunite group (1-16) and October group (1-22)	Unsurveyed sec. 32, T. 46 N., R. 54 E., 1.5 miles northeast of Mountain City.	Autunite, torbernite, and metatorbernite occur along an altered and silicified fracture zone in Cretaceous quartz monzonite. The mineralized zone strikes N. 12° W., dips vertically, and contains small amounts of quartz, molybdenum, and iron oxides (Garside, 1973, p. 41).
Garnet tungsten mine (not shown on figure 3)	Secs. 16 and 17, T. 45 N., R. 56 E.	Uraninite occurs along a fault that strikes N. 75° W. and dips 65° E. in a body of tactite, which has replaced limestone near a contact with granitic rock. Pyrite, molybdenite, bismuthinite, and chalcopyrite are found with finely disseminated scheelite. Development consists of 2,600 feet of diamond drilling and 700 feet of workings. Exploration was for tungsten (Garside, 1973, p. 43).
19 Granite group (nos. 1-18)	Secs. 25 and 36, T. 46 N., R. 53 E., and secs. 19 and 30, T. 46 N., R. 54 E., about 1/2 mile east of Mountain City.	Autunite occurs in Tertiary volcanic rocks (Cougar Point welded tuff) near the contact with underlying quartz monzonite. Development consists of several small trenches (Garside, 1973, p. 41).
20 Happy Joe No. 1 (Happy Mendive, Big Joke) claims	Secs. 19, 20, 29, 30, 31, T. 45 N., R. 55 E., about 9 miles scutheast of Mountain City.	Autunite occurs in fault zones in rhyolite. About 225 tons of ore containing 0.5 percent U_3O_8 have been shipped (Garside, 1973, p. 42).
21 Hawk group (nos. 1-3), Denis claims (nos. 1 2)	NE1/4 sec. 33, T. 46 N., R. 54 E., about 4 miles east of Mountain City.	Autunite occurs in conglomerate and Tertiary volcanic rocks overlying quartz monzonite. Minor drilling and trenching (Garside, 1973, p. 42).

Table 2--Uranium mines, prospects, and claims in the Mountain City district, Nevada (Continued)

Name	Location	Description and remarks
22 Hot Ash group (nos. 1-4)	Secs. 27 and 34, T. 46 N., R. 54 E.	Minor autunite occurs along the contact of Tertiary volcanic rocks with underlying quartz monzonite. Development consists of several small trenches (Garside, 1973, p. 42).
23 Hot Spot No. 1 claim	Sec. 2, T. 45 N., R. 53 E., southwest of Mountain City.	Autunite is associated with clay minerals in a 2.5-foot-wide fault zone separating granodiorite from pyroxene andesite. Development consists of four bulldozer cuts (Garside, 1973, p. 41).
24 Jackpot and Hotwater claims	Sec. 5, T. 45 N., R. 54 E., about 3 miles east of Mountain City.	None.
25 Race Track mine (Lucky Lager, Speedway claims)	Sec. 1, T. 45 N., R. 53 E., east of Highway 51, about 1 mile southeast of Mountain City.	Anomalous radioactivity is present along a 15-foot-wide by 200-foot-long shear zone between Tertiary volcanics and Cretaceous quartz monzonite. In 1958, a 100-ton shipment of ore was made from the mine. An ore sample reportedly assayed 0.755 percent U_3O_8 (Garside, 1973, p. 41).
26 Rim Rock mine	SW1/4 sec. 26, T. 46 N., R. 54 E., about 6 miles east of Mountain City.	Autunite occurs in Tertiary arkosic sedimentary and volcanic rocks which overlie quartz monzonite. Development consists of an open pit. In 1960, about 500 tons of uranium ore were produced (Garside, 1973, p. 42).
27 South Fork claims (nos. 1 and 2) and Pixley No. 1 claims	Sec. 35, T. 46 N., R. 54 E.	Uraninite and yellow secondary uranium minerals occur in a Tertiary bentonitic tuff, which overlies quartz monzonite. In 1960, development consisted of an open pit and 4,000 feet of rotary drill holes. Less than 2,000 tons of uranium ore has been produced (Garside, 1973, p. 42).

Table 2--Uranium mines, prospects, and claims in the Mountain City district, Nevada (Continued)

Name	Location	Description and remarks
28 Tag, Pam, Pat, and Sam claims, DWG (Last Chance) group (nos. 1-3)	Sec. 5, T. 45 N., R. 54 E., about 3 miles southeast of Mountain City.	A radioactive zone occurs in a 400-foot-long section of an exposed contact between a Cretaceous quartz monzonite stock and the basal zone of a rhyolitic air-fall tuff. Autunite is concentrated in a 2- to 3-inch thick bentonitic zone just above a thin carbonaceous layer. Development consists of two bulldozer cuts and a 30° inclined shaft filled with water to within about 25 feet of the surface (Garside, 1973, p. 41).
29 Top claims	Unsurveyed sec. 15, T. 45 N., R. 54 E., about 5 miles southeast of Mountain City.	None.
Unnamed location (not shown on figure 2)	T. 46 N., R. 53 E. (approximate)	Monazite-bearing placer gravels (Garside, 1973, p. 41).

been either the ash-flow tuffs, the granitic rocks, or both. Under certain conditions, the uranium could have been carried in solution by ground water to areas favorable for deposition, such as faults, basal nonwelded zones in the tuffaceous rocks, ash-flow tuffs, or poorly consolidated sedimentary units below the ash-flow tuffs (Garside, 1973, p. 39 and 41).

The contacts between Tertiary volcanic rocks, especially the tuffaceous units, and the underlying granitic or sedimentary rocks in the eastern and southern parts of the Duck Valley Reservation might be favorable uranium exploration targets. In addition, a scintillometer or gamma-ray spectrometer survey of the entire reservation might detect additional radiometric anomalies.

Geothermal potential

All indications are that the geothermal potential of the Duck Valley Reservation is low. No references could be found in the literature to any warm or hot springs or to any warm water wells on the reservation. Topographic maps indicate numerous springs, but no information about the waters is available.

Several warm springs flow from Paleozoic limestone in secs. 20 and 30, T. 45 N., R. 54 E., about 5 miles southeast of Mountain City (figure 2). The waters have a temperature of 104°F - 106°F (40°C - 41°C), and a flow of about 20 gallons per minute (Waring, 1965, p. 33; Garside, 1979, unpub. data).

The Wild Horse hot springs are near Hot Creek in the SE1/4, SE1/4 sec. 4, T. 43 N., R. 55 E., about 0.7 mile east of Wild Horse Reservoir and 21 miles southeast of Mountain City. The spring waters have a temperature of 129°F (54°C), and the estimated thermal reservoir temperature is 198°F (92°C) (Garside, 1979, unpub. data).

Favorable indicators for the existence of a thermal convection system in the Mountain City area are as follows: 1) the presence of Tertiary volcanic rocks, 2) abnormally high heat flow in the Snake River Plain to the north and the Battle Mountain area to the south, 3) Basin and Range type faulting, and 4) the existence of hot and warm springs to the east and southeast.

RECOMMENDATIONS FOR FURTHER WORK

Because of the lack of published information about the mineral resources of the Duck Valley Indian Reservation, additional studies may be warranted. Specific recommendations regarding a possible field study of the reservation are as follows:

1) Study of courthouse records for claim locations made when the reservation was open for mineral entry.
2) Detailed geologic mapping of areas of the reservation underlain by Tertiary volcanic rocks, with special attention to contacts, faults, and alteration zones.
3) Stream sediment geochemical sampling, including panned concentrates, of the Owyhee River and its tributaries, especially in the eastern half of the reservation.
4) Examination and evaluation of the gold placers along the Owyhee River and its tributaries, between the towns of Owyhee and the southeast corner of the reservation.
5) Sampling of spring and well waters, with application of chemical geothermometry.
6) Appropriate geophysical studies to aid in search of uranium, disseminated ore bodies, and massive sulfides.
7) Examination and evaluation of the Indian manganese prospect.
8) Soil and rock geochemical sampling of areas having known mineral occurrences, or as a follow-up of anomalous stream samples.

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