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NBMG OPEN-FILE REPORT 83-9

A MINERAL INVENTORY OF THE ELKO RESOURCE AREA,
ELKO DISTRICT, NEVADA

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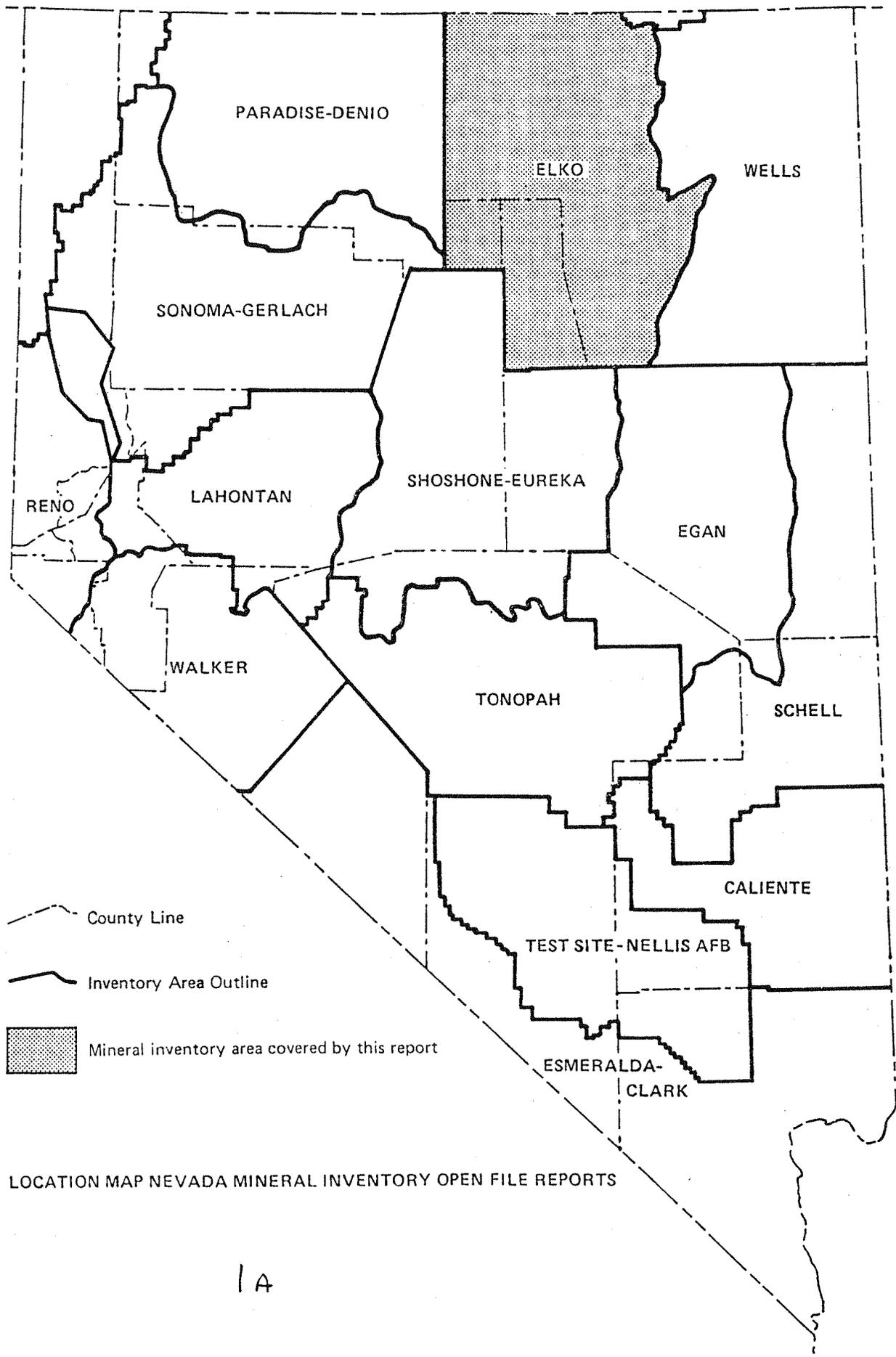
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Prepared for the UNITED STATES DEPARTMENT OF THE INTERIOR,
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NEVADA 89801, under Contract #YA-553-CT1-1058.

This information should be considered preliminary. It
has not been edited or checked for completeness or accuracy.

See NBMG 83-10 for Geochemical Sampling.

(Rm. 310)



-  County Line
-  Inventory Area Outline
-  Mineral inventory area covered by this report

LOCATION MAP NEVADA MINERAL INVENTORY OPEN FILE REPORTS

1A

Summary of Work Performed
Mineral Inventory Elko Resource Area
Contract #YA-553 CTI-1058
U.S. Bureau of Land Management

Work was completed on the Elko Mineral Resource Inventory in two complementary stages. First, search of the literature was made, and data on mineral occurrences within the project area were compiled on short form Nevada CRIB forms. Courthouse records were then examined to obtain names and locations of active mining claims within the inventory area. All of the information was plotted on maps for field use. Folios were then prepared for each mining district, which included the CRIB forms, notes on mining claims, and pertinent references. This material provided the basis for planning the second stage of the inventory, the field examinations.

During the field stage of the project, every mining district within the Resource Area was visited and selected properties were examined. Important properties as well as outlying prospects were examined and described in order to provide more complete and accurate information on the occurrences beyond that provided in the literature. During the examination, emphasis was placed on collecting geologic information on the mineral occurrences and on noting current activity.

Photos were taken in each area to document activity, type of mine workings, and geologic relationships. In addition, samples showing typical mineralization were collected from most of the visited properties. All of the samples were high-graded and usually taken from dumps, ore piles, or outcrops. Some samples of nearby intrusive rock or altered material were collected for comparison purposes.

The samples were then prepared for analysis by the Nevada Mining Analytical Laboratory, UNR, Reno and analyzed for 31 elements (semi-quantitative spectrographic technique) by the Branch of Exploration Research, U.S. Geological Survey, Denver, Colorado. We would like to express our gratitude to these laboratories, for without their cooperation important information on element interrelationships within mining districts and between the various districts would not be provided. The laboratory, flooded with samples from wilderness programs from all over the west, has returned only a portion of our results in time to include with this report. These data are grouped together in a separate section of this report. We will continue to forward the remaining sample information as soon as it is received in our office.

The information collected during the course of the Elko project has been compiled and is presented in this report in the following form:

- 1) Summary report organized by mining district includes location, history, field observations, and current mining status of each district.
Several reference lists for the Elko area are included in the back of the summary report, in addition to a list of selected references following individual district write-ups.
- 2) Mining District folios:
 - a) Prospect forms describing each mine property examined in the field.
Sample descriptions accompany forms of sampled properties.
 - b) CRIB forms containing location & brief description of mine properties as gathered from literature sources.

- 3) Maps
 - a) Planimetric maps, 30' series, showing location mining districts, and sample locations.
 - b) USGS 7 1/2' and 15' topographic maps showing sample locations and prospect names.

- 4) Photo Album, organized by mining district, containing slides of visited properties and documentation of new work.

- 5) Geochemical Data
 - a) Sample description sheets arranged in numerical sequence.
 - b) Analysis sheets arranged in numerical sequence.

- 6) Card file of prospects, E-Z Sort index cards with summary information for each mine/prospect/location within the area. This part of the data set is largely complete, but some cards remain to be typed (see attached list for completed/not completed file list).

In addition to this information, topographic field sheets and field notes are on file at the Nevada Bureau of Mines and Geology. Also, splits of all the samples taken as well as selected hand specimens have been retained at the Nevada Bureau of Mines and Geology. This material may be useful for additional studies in selected areas.

In reporting on this project, no attempt has been made to compile detailed geologic information on the districts. Since this project was a mineral inventory, our efforts were confined to acquiring new information on prospects, and no time was available to collect new regional geologic data. Local or regional geologic interpretations were derived from published geologic maps or other pertinent literature sources.

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Special thanks is given for the use of field and analytical data published in BFEC (DOE) National Uranium Resource Evaluation reports PGJ/F-045(82), June 1982, McDermitt quadrangle; PGJ/F-046(82), July 1982, Elko quadrangle; PGJ/F-070(82), August 1982, Wells quadrangle. Also, Keith Papke, NBMG geologist, was kind enough to provide descriptions of barite properties within the Elko Resource Area. This information is included within the mining district folios.

MINING DISTRICTS

ELKO RESOURCE AREA

Alder	Hicks
Argenta	Island Mountain
Aura	Ivanhoe
Beaver	Izenhood
Beowawe	Larrabee
Bootstrap	Lee
Buckhorn	Lime Mountain
Burner Hills	Lynn
Burns Basin (Jerritt Canyon)	Maggie Creek
Carlin	Marys Mountain Area
Cave Creek	Merrimac
Charleston	Mineral Hill
Coal Mine	Modarelli-Frenchie Creek
Cornucopia	Mountain City
Corral Creek	North Battle Mountain Area
Cortez	Railroad
Divide	Robinson Mountain
Edgemont	Rock Creek
Elko	Ruby Valley
Gance Creek Area	Safford
Gilbert Canyon	Scraper Springs Area
Gold Basin	Snowstorm Mountain Area
Gold Circle (Midas)	Swales Mountain
Good Hope	Tuscarora
Halleck	Union

ALDER DISTRICT

The Alder district is located in the Humboldt National Forest in northern Elko County. The district boundaries are not well defined, but most mining activity has occurred in the north half of T45N, R56E and in several scattered areas within T46N, R56 and 57E. Several mines south of the district and placer workings north of the district, although proximate to the Alder mine workings, are assigned by Smith (1976) to the Island Mountain and Gold Basin districts, respectively.

Early activity in the district centered on placer mining. Several drainages were explored including Lost Gulch and Tennessee Gulch, where several patented placer claims still exist. The actual production of gold from placer mining is not known but thought to be small. Lode mining of silver-gold vein deposits continued intermittently from the early 1870's through the 1930's. Much of the lode ore was produced from mines located on the lower north flank of Tennessee Mountain. According to Granger, 1957, seventy-five tons of ore recovered from these deposits during the thirties yielded 27 ounces of gold and 503 ounces of silver.

More recent activity in the district focuses on the exploration of scheelite and molybdenite-bearing tactites located on the north, west and south-west flanks of Tennessee Mountain. The tactites are developed in sediments intruded by a "granitic" stock. Since the discovery of the tungsten deposits in 1949, several companies and individuals conducted underground exploration work, drilling and surface trenching along the contact zone. In the 1950's the Garnet Hills property, which contains the Garnet or Tennessee Tungsten mine, was extensively drilled by Union Carbide. According to Stager,

(in press), the only known production from the Garnet Mine was between 1970 and 1977 when 6,024 units of WO_3 were produced. Sustained interest in the area is evident by continued active claim holdings and minor exploration and mining.

The Tennessee Mountain area lies in the southwest quarter of the Rowland 15' topographic quadrangle. The quadrangle was mapped by Bushnell in 1955 and later published as a Nevada Bureau of Mines Bulletin in 1967. His work clearly shows that the main tungsten deposits lie along the arcuate, northwest-trending contact between lower Paleozoic sediments and a quartz monzonite intrusive body. The sediments which host the deposits are assigned to the Tennessee Mountain Formation. They are described as a "thick sequence of highly deformed, interbedded, thinly bedded limestone and argillaceous rocks" (Bushnell, 1967). North and east of the summit of Tennessee Mountain the sediments are intruded by an elongate, east-west trending igneous body named the Coffeepot stock. The stock is 8 miles long, 6 miles wide and locally overlain by Tertiary volcanics. A lead date obtained from zircons indicates a middle Cretaceous age for the body (Coats, 1972).

Bushnell, 1967, notes that interfingering of sediments and intrusive rock is common along the contact zone of the Coffeepot stock. In addition, the contact zone is intruded by numerous dikes and sills. In fact, one author suggests mineralization may in part be controlled or enhanced by the intrusive dikes and sills. Post-mineral and post-intrusive faults are also observed in the mineralized areas. Uraninite and weakly radioactive chloritic gouge were discovered in underground exposures of fault zones cutting the tactite (Garside, 1973).

At the mine sites and elsewhere in the district quartz veins, calcite veins and aplitic or porphyritic dikes cut the intrusive and the sediments. The dikes and veins are especially common near or within the contact zone. They are most likely products of the last stage of magmatic activity associated with the stocks (Bushnell, 1967). Where observed, they are altered or mineralized.

The veins often are iron-stained, contain pyrite and occupy fault zones. Some carry silver, gold and some lead. Although the exact location of the Clipper Group is not known, a high-grade quartz vein from this deposit reportedly contained as much as 30 ounces of silver and 3 ounces of gold per ton (Safford, no date).

The Garnet Tungsten or Tennessee Tungsten mine was visited briefly during our examination of the area. The mine is the best developed and most productive tungsten deposit in the district. Roadcut exposures of sediments observed enroute to the mine site consist of thin-bedded, light-colored silty limestones, platy shales and phyllites. At the mine site, a small open pit exposes dense, maroon-colored tactite composed of garnet, epidote, quartz and calcite. Much of the tactite is coarse-grained with individual garnet and epidote crystals measuring up to 2" in length. An east-west striking dike of altered (kaolinized?) and iron-stained, coarse-grained quartz monzonite is exposed at the southern end of the cut.

The tactite body explored at the Garnet mine is about 50-100' wide, trends northwest, dips southwest and has an exposed strike length of about 500'. The body is parallel to the original bedding of the sediments. The banded tactite exposed in the pit is cut by hematite-filled fissures and scheelite and sulfide-bearing, grey to white quartz veins.

Disseminated crystals and lenses of scheelite and fine to coarsely crystalline rosettes of molybdenite are present in the dense, highly silicated tactite, in gouge zones cutting the tactite and in the later developed quartz veins that cut the tactite. Pyrite, chalcopyrite and bornite also occur as thin lenses in the tactite and vein material. A 1950's report (unpublished) on the Garnet Tungsten property states that scheelite is "sparsely to moderately disseminated throughout the tactite" but is most abundant in silicated zones directly adjacent to the main intrusive body and associated dikes and sills.

Reports indicate that although the scheelite content varies throughout the strike length of the Coffeepot contact zone, ore grade concentrations appear to be confined to favorable host beds or lenses parallel to the bedding. These zones comprise only relatively narrow (15-30') bands within the tactite bodies, but have been explored as far as 400' down dip. The molybdenum content of the scheelite ore sometimes exceeds 0.10% MoS₂.

Moderate reserves have been outlined for the Garnet Tungsten property, including estimates of 224,000 tons at 0.5% WO₃ and 540,000 at 0.4% WO₃ (Johnson, 1963 and an unpublished report). However, production from the property has been limited. An estimated 16,000 tons of ore were removed during the 1960's and 70's from underground and open pit workings. The ore was treated at a small mill in Mountain City. Under more favorable economic conditions, further exploration and mining in the area could prove profitable.

Selected References:

Bushnell, K. (1955) The geology of the Rowland quadrangle: Ph.D. thesis, Yale.

Bushnell, K. (1967) Geology of the Rowland quadrangel, Elko County, Nevada:

NBMG Bul 67.

Coats, R. R. and McKee, E. H. (1972) Ages of plutons and types of mineralization, northwestern Elko County, Nevada: USGS PP 800-C, p. C165-C168.

Selected References (continued)

Garside, L. J. (1973) Radioactive mineral occurrences in Nevada: NBMG Bul 81.

Granger, A. E. et al (1957) Geology and mineral resources of Elko County, Nevada: NBMG Bul 54, p. 26.

Johnson, A. C. and Benson, W. T. (1963) Tungsten resources of Nevada: unpub. USBM report.

Safford, J. L., Report on the Clipper Gold-Silver Group: NBMG Mining District Files.

Schilling, J. H. (1968) Molybdenum resources of Nevada: NBMG open-file 79-3.

Smith, R. M. (1976) Mineral resources of Elko County, Nevada: USGS open-file 1976-56.

Stager, H. (in press) Tungsten deposits of Nevada: NBMG Bul, in preparation.

Stuart, J. (1962) Bryozoa from the lower Permian limestone in the vicinity of the Sunflower Reservoir, Elko County, Nevada: M. A., Bowling Green State University.

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ARGENTA DISTRICT

The Argenta district is located in the north end of the Shoshone Range about 14 miles east of Battle Mountain. Many mines and prospects of the district are clearly visible from Interstate 80 and can be seen south of the Interstate, high on the range front above the highway.

The district name is historically credited to silver discoveries in the area about 1867. The literature background for this is obscure, however, and the location of the early silver prospects is unknown. No silver production is credited to the district, and none of the mines in the district are known to contain silver mineralization.

Barite was discovered here in 1930, and barite has been mined from that time up to the present. The large Argenta mine, located along the ridge crest south of Argenta siding, is credited with 1,000,000 to 2,000,000 tons of barite ore.

The north end of the Shoshone Range in the area of the Argenta district is underlain by siliceous and volcanic assemblage rocks of Ordovician and Devonian age that occur in a complex array of thrust slices in the upper plate of the Roberts Mountains thrust. In the eastern part of the district these rocks are overlain by a thick sequence of Miocene basaltic andesites. The principal rocks exposed in the areas of the major mines are thin-bedded dark radiolarian chert, with some interbedded argillaceous chert and limestone beds of the Slaven Chert of Devonian age.

Thin to thick beds of massive barite interbedded with the chert have been mined where the beds are of sufficient thickness.

The largest mine in the district, the Argenta mine, has produced barite from several large open pits on the west side of Mosquito Canyon. Beds of

barite as much as 40 feet thick occur interbedded with dark-gray limestone and chert in the Slaven Chert (Stager, 1977).

Selected References:

- Gilluly, J. and Gates, O. (1965) Tectonic and igneous geology of northern Shoshone Range, Nevada: USGS PP 465.
- Horton, R. C. (1963) An inventory of barite occurrences in Nevada: NBMG Rpt. 4, p. 10.
- Ketner, K. B. (1963) Bedded barite deposits of the Shoshone Range, Nevada: USGS PP 475-B, p. B38.
- Mitchell, A. W. (1977) Geology of some bedded barite deposits, north-central Nevada: Masters Thesis, UNR, 58 p. (Contains geologic map of Argenta area.)
- Papke, K. G. (in press) Barite deposits in Nevada: NBMG Bull, in preparation.
- Stager, H. K. (1977) Geology and mineral deposits of Lander County, Nevada: NBMG Bull. 88, p. 62.
- Stewart, J. H. (1969) Geologic map of the Battle Mountain and part of the Dunphy quadrangles, Nevada: USGS open-file rpt.
- Zimmerman, R. A. (1969) Stratabound barite deposits in Nevada: Mineralium Deposita, v. 4, no. 4, p. 402-409.

Possibly Relevant:

- Dunham, A. C. and Hanor, J. S. (1967) Controls on barite mineralization in the western United States: Econ. Geology, v. 62, p. 82-94.

AURA DISTRICT

The mines of the Aura district are located on the east slope of the Bull Run Mountains north of Bull Run Basin and west of the Maggie Summit road. All the mines in the district occur in the northeast quarter of the USGS Bull Run 15' quadrangle on National Forest land. West of Porter Peak the district adjoins the Edgemont district. Some authors refer to these districts collectively or separately as the Centennial or Bull Run districts.

Since the mines of both the Aura and Edgemont districts generally lie at elevations between 6,500 and 8,000 feet, much of the local geology is obscured by low growing vegetation and trees. Also, many of the workings are caved making structural observations difficult. In general, the mines in both districts explore quartz or fissure vein and replacement deposits in limestones, quartzites and shales situated near intrusive stocks and dikes. The veins in the Aura district are generally silver rich with lesser amounts of gold and base metals. Those in the Edgemont district are gold-sulfide dominated (Decker, 1962).

Many of the mines in the Aura district are patented. During our examination of the district in September 1982, we observed recently staked claims and shallow exploration work on the land adjacent to a few of the minesites. Old drill roads (probably 5-10 years old) lie above Blue Jacket Creek in the southern half of section 23 and the northwest quarter of section 35 in T44N, R52E. Some minor trenching and reworking of dumps has occurred at a few of the properties. The most active mine in the district is the Big Four Mine located about one-half mile north-northeast of Columbia Ranch. The mine is currently being mined for gold and silver on a small scale. Ownership of the mine is private and access to the property is limited.

Silver and gold-bearing lode deposits were first discovered in June 1869 and by 1870 there were ten producing mines in the district (Granger, 1957). A short time later, placers were explored along Blue Jacket Creek, California Gulch, Colombia Creek and eventually Bull Run Basin. The placers were relatively unproductive. In contrast, the lode deposits were described as "comparatively rich" in gold and silver. Granger (1957) reports that 4,293,056 ounces of silver, 67,265 ounces of gold and some copper and lead were produced from 174,638 tons of ore mined through 1949. The district ranks as the second most productive silver camp in Elko County through 1939 (Granger, 1957). Minor production from the Aura Queen Mine, Big Four Mine and possibly a few others has occurred since that time.

The geology of the Bull Run 15' quadrangle has been mapped by Decker (1962). The area underlying the Aura district is composed of Cambrian through Devonian quartzites, phyllites and limestones with some intervening units of chert and shale. The bedding generally strikes east-west and dips to the north. The rocks are likely autochthonous, but represent a transition between the eastern and western assemblages. Correlations between these sediments and rocks elsewhere in Nevada, including nearby mapped quadrangles, has not been adequately done.

In the eastern part of the district, western assemblage cherts and argillites are thrust over the transitional assemblage along the Antler-style Trial Creek Fault (Decker, 1962). The upper plate rocks are overlain by rhyolitic tuffs and flows of Miocene age.

Throughout the district, the Paleozoic rocks are folded (locally and regionally), faulted and display a low-grade, early regional metamorphism which is locally overprinted by contact aureoles produced from the intrusion of at least five dioritic to granodioritic stocks. The stocks and their associated dikes and sills

lie in an east-west trending belt through the center of the district. The largest of these bodies, the hornblende-biotite quartz diorite Columbia stock, has been dated as mid-Jurassic in age (Coats and McKee, 1972). The stocks intrude both upper and lower plate sediments.

Several large range-front faults lie along the east-west margins of the Bull Run Mountains. In addition, a series of east and northeast-striking, high-angle faults are located east of Porter Peak in the most actively mined area. We observed that several of the vein deposits are emplaced along these high-angle structures and Decker (1962) notes the presence of gossan and silicification along their traces.

The most notable feature of the vein deposits in the Aura district is their consistent similarity from one deposit to another. The veins are typically composed of white milky quartz which contains a moderate to abundant amount of unoxidized sulfides. Their massive texture and great width (ranging from 1-6') indicate they are deep-seated in origin. The veins generally strike northeast and are emplaced forcibly across bedding or along faults. The host rocks are limestones, dolomitic limestones, quartzites and shales. Adjacent to the veins the sediments are bleached, marbelized, recrystallized or silicified. They show fracturing, iron-staining and veining by calcite and less commonly quartz.

The vein material sampled from the dumps contains pyrite, galena, copper carbonate, sphalerite and some tetrahedrite and chalcopyrite. Some oxidized material showed gossany portions and iron and manganese oxides. One unpublished mine report indicates the silver occurs as chlorides. The best exposed vein we observed was at the adit of the Aura King Mine. The vein, which was 1-2' in width, was folded and cross-cut by small faults. Post-intrusive deformation of the veins makes them difficult to follow along strike (NBMG Mining District Files, see Edgemont district).

A few mines explore replacement deposits developed in limestones along faults or bedding planes. At the Aura Queen Mine the limestone is brecciated and altered along a high-angle, east-west striking fault. A sample of altered rock from the dump was iron-stained, silicified and contains pyrite and cerussite. The replacement deposits, like the vein deposits, are said to carry high values in silver and gold (Emmons, 1910).

In the eastern part of the district, the numerous workings at the Golden Eagle Mine explore grainy, weakly mineralized, upper plate calc-silicate rocks adjacent to the granodiorite Trial Creek Stock. Mineralized quartz vein which cut the intrusives are said to occur at this locality and the Big Four Mine although this was never directly observed.

Decker (1962) suggests the mesothermal veins in the Aura district are products of late-phase solutions which emanated from the crystallizing intrusive stocks.

Selected References:

- Aeromagnetic map of the Wilson Reservoir, Bull Run and Owyhee quadrangles and part of the Hat Peak quadrangle, Elko County, Nevada: USGS OFR, 1968.
- Coats, R. R. and McKee, E. H. (1972) Ages of plutons and types of mineralization northwestern Elko County, Nevada: USGS PP 800-C, p. C165-C168.
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Lincoln, Francis C. (1923) Mining Districts and Mineral Resources of Nevada:

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Whitehill, H.R. (1875) Biennial Report of the State Mineralogist of the State of

Nevada for the years 1873 and 1874, p. 29.

BEAVER DISTRICT

The Beaver district is located on the east side of the Tuscarora Mountains about 15 miles due south of Tuscarora. The district encompasses a large area but only contains a few mines.

Most of the (past and present) activity centers on the exploration and mining of bedded barite deposits. The Lakes and Beacon barite mines are located near Lake Mountain along the boundary between T37N and T38N in R51E. The smaller Coyote mine is southwest of these deposits in section 7, T36N, R51E. All three mines are active or recently active and productive. The Lakes mine is the most significant deposit, having produced almost one-half million tons of barite between 1959 and 1981 (unpub. data, USBM). The mine has expanded and a new deposit was recently discovered by drilling southwest of the old pit (Papke, in press). Exploration for similar barite deposits continues actively along the eastern rangefront in several areas near the existing mines. At least one (and probably more) property was being drilled during our examination of the district in 1983.

Turquoise was produced from the Stampede mine sometime before 1968 (Smith, 1976). This mine is located north of the barite mines between Road Canyon and Dip Creek (sec. 9?, T38N, R52E). Less than \$500,000 was actually produced and, at present, the mine is abandoned.

The rangecrest area of this part of the Tuscarora Mountains is underlain predominately by Ordovician, western facies siliceous sediments. The sediments are overlain or faulted against Tertiary volcanic rocks especially in the northern part of the district near the Stampede, Lakes and Beacon mines. The

volcanics consist of rhyolitic to dacitic ash-flow tuffs, latite - basalt flows and minor conglomerates. In the southern part of the district there are a few isolated, faulted exposures of Pennsylvanian and Permian limestones and clastic rocks. Northwest and northeast-striking high-angle faults cut both Paleozoic and Tertiary rocks. Extensive basin and range normal faults trace the range front on the east. There are no intrusives mapped near the minesites (Hope and Coats, 1976).

The three barite mines of the Beaver district were visited by Papke in the summer of 1980. The information contained in this report regarding the barite deposits are derived from his descriptions of the properties. The mines are open pits or stripped areas developed in cherts (some black), mudstones and argillites of the Ordovician Vinini Formation. The barite occurs in units which are generally conformable with the bedding of the host rocks. The units vary considerably in thickness from one mine to another. At the Lakes mine, the barite horizon is about 30' thick. Some of the rocks exposed in the pits are sheared or iron-stained. White barite veins occur locally.

The Stampede mine is developed by several benches and trenches oriented in a northeast-southwest direction. The trenches explore a section of siliceous sediments consisting of cherts and siltstones interbedded with platy shales and mudstones. The rocks are probably part of the Ordovician Vinini Formation. The bedding in the pit generally strikes N20E and dips 25° NW. In a few places the rocks are fractured along northeast-striking high-angle faults. Light blue and dark blue siliceous turquoise occurs in light-colored siltstones and shales. The turquoise forms small pods, lenses and veinlets which were deposited along pre-existing fractures, like bedding planes or shear

zones. Some jarosite crystals are also present on fracture surfaces in the siltstones. Some bleaching, iron-staining and minor silicification of the wallrocks is evident.

Selected references:

- Hope, R. A. and Coats, R. R. (1976) Preliminary geologic map of Elko County, Nevada: USGS open-file 76-779, sheet #1.
- Horton, R. C. (1963) An inventory of barite occurrences in Nevada: NBMG Report 4 (out of print).
- Morrissey, F. R. (1968) Turquoise deposits of Nevada: NBMG Report 17, p. 5.
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- Smith, R. M. (1976) Mineral resources of Elko County, Nevada: USGS open-file rpt 1976-56, p. 25.

BEOVAWE DISTRICT

The main mining activity in the Beowawe district is centered near Beowawe, a town located at the northern end of Crescent Valley in Eureka County, Nevada. The district also encompasses some small prospects located 3 miles east of town and mines and prospects located in the Dry Hills, a low ridge which extends out into Crescent Valley 12 miles southeast of Beowawe.

The geology of the Beowawe district is characterized by both active and inactive hot spring systems. Most of the commodities produced from the district are genetically related to these hydrothermal systems. More than 132 flasks of mercury were produced from the Red Devil Mine between 1929 and 1932. The mine is located in the low hills about 1 mile south of town. Although there are other mercury prospects in the area, the Red Devil Mine is the largest underground mine in the district, consisting of several thousand feet of underground workings. A sulfur deposit was explored in 1966(?) by Southwestern Exploration Company on the extreme southwest tip of the Dry Hills. At that time a "small tonnage of fairly high-grade material had been sorted out" (Papke, 1966), but the amount of production, if any, is not known. For almost twenty years, several companies have pursued the development of geothermal energy from venting geysers located 6 miles west of town. Recent plans by NORNEV Demonstration Geothermal Co. to build a 10-megawatt binary geothermal power plant at the site have temporarily been put on hold (Garside, in press).

The Sansinena barite mine located about 2 miles east of town has produced about 30,000 tons of barite through May, 1980.

The oldest rocks exposed in the district are cherts, shales, and argillites of the Ordovician Vinini and Valmy Formations (Stewart and Carlson, 1976). The rocks are host to several of the mineral occurrences in the district, including barite at the Sansinena Mine and mercury at the Red Devil Mine. Tertiary volcanic rocks overlie the sediments locally. Above the Sansinena Mine and in the western

portion of the Dry Hills the flows are andesitic or basaltic in composition. Upper Paleozoic detrital and carbonate rocks compose the west-central portion of the Dry Hills. These rocks are overlain by felsic tuffs and flows of Cenozoic age (Muffler, 1964) and intruded by rhyodacite to granodiorite plutonic rocks of Early Cretaceous age (Spengler, et al, 1979). Active hot springs are located at "The Geysers" west of Beowawe, on a ranch near Beowawe and along the western margin of Hot Springs Point. The hot springs are located along major northeast-striking range-front faults.

The mercury deposit at the Red Devil Mine is well described by Bailey and Phoenix (1944) and Roberts (1967). The deposit will not be redescribed in this report. However, it is interesting to note that there is revived interest in the area surrounding the deposit because of the association of some gold deposits with mercury and hot spring environments. During our examination of the district in June, 1982, the area surrounding the mine site was staked by Chevron Resources Co. in June, 1981. Their Rag claims extend eastward and include a prospected area in siliceous sediments about 3 miles northeast of Beowawe. The prospects explore a low-angle fault in black siliceous shales and cherts of the Ordovician Vinini Formation. The thrust zone is silicified, iron-stained and dips about 15° to the north. Breccia from the dump (sample 177) contains fragments of cherts and coarse-crystalline barite. The fragments are cemented by quartz, barite and iron-oxides. A select sample from a small pit nearby contained a trace amount of gold and 0.20 oz. Ag (Southern Pacific Co., 1964). The sample was taken from a limonite zone along a quartzite-andesite contact.

The sulfur deposit at the extreme south-western tip of the Dry Hill is characterized by intense hydrothermal alteration. Bulldozer cuts expose an altered rock face upto 50' high which contains abundant native-sulfur distributed irregularly throughout (Papke, 1966). The host rocks were probably originally an andesite or basalt but are now completely altered to a punky mixture of silica, clays,

iron-oxides and sulfur. The altered rock reportedly contains minor amounts of cinnabar and antimony also. During 1981, Homestake Mining Co. (?) built several drill roads and holes above the sulfur deposit along the south-western edge of the Dry Hills. The holes were drilled in rubbly, brecciated and silicified outcrops of Ordovician cherts, shales and quartzites. Cuttings found on the drill road (sample 175) consist of siliceous sediments with finely crystalline pyrite deposited on fracture surfaces and disseminated throughout. The cuttings may also contain some mercury minerals. Active hot springs along the western margin of the Dry Hills are presently forming calcareous sinter (Garside and Schilling, 1979). The hot springs and sulfur deposit are located along the trace of two range-front faults which intersect at the tip of the Dry Hills.

Barite veins hosted by a quartz latite intrusive (?) are prospected in the northern part of the Dry Hills. Several veins of good quality barite are explored by shallow workings on the White Knob claims in sections 9 and 10, T30N, R50E (Papke, in preparation).

The history of the development of the Beowawe geysers area is described by Garside and Schilling, 1979. Much of the area is covered by an expansive siliceous sinter deposit which reportedly contains 300 ppm tungsten and high beryllium (Garside and Schilling, 1979).

The Sansinena barite mine consists of two open pits developed in cherts, argillites and shales of the Ordovician Vinini Formation. The bedding of the sediments is horizontal or shallowly south dipping. Barite occurs in two units which together total about 26' in thickness. The host rocks are notably iron-stained and cut by high-angle iron-filled fissures. The mine showed recent signs of activity during our examinations in 1980 and 1982.

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BOOTSTRAP DISTRICT

The Bootstrap district is located on the west slope of the Tuscarora Mountains, generally along Boulder Creek north of the Elko-Eureka county line. The district is just to the north of the Lynn district in Eureka County. The area was called the Boulder Creek district from 1953 to about 1960 but became known as the Bootstrap district after the Bootstrap mine became a major gold producer in 1958. Beginning in 1953, the district became an important barite producer, with most of the production coming from the Rossi mine (Smith, 1976).

Although Smith (1976) makes reference to gold placer deposits along Boulder Creek, nothing can be found in the literature concerning these deposits, and the earliest activity in the district may be the antimony production credited to the Bootstrap mine. Lawrence (1963) mentions that one carload of antimony was mined in 1914, hauled to the railroad at Dunphy, but never shipped.

Starting again in 1972, the Bootstrap mine was explored and mined by the Newmont Mining Co. for gold. The deposit is a disseminated occurrence similar to the large Carlin mine to the south in the Lynn district. No mining is now underway at the site, but dumps are being heap-leached. In 1983, a new deposit discovered about one mile northwest of the old Bootstrap was under development by the Dee Gold Mining Company (Cordex). This occurrence, similar geologically to the one at Bootstrap, has announced ore reserves of 2.7 million tons averaging 0.117 ounce per ton gold (Pay Dirt, April 1983). This deposit, known as the Boulder Creek or Dee Mine, is scheduled for production in 1984.

In the Bootstrap mine area, thick-bedded limestones of Devonian age are exposed in a window through the overlying cherts, shales, and limestones of the Ordovician Vinini Formation. The Vinini strata are cut by many steep north-trending faults and intruded by quartz latite to dacite dikes. At Bootstrap, gold occurs, mostly as microscopic particles, along fractures in the dikes and in the cherts and shales near the dikes. According to Bonham (1982), the nearby Boulder Creek deposit is also in upper plate rock. The barite at the Rossi mine also occurs in rocks of the Vinini Formation. The sediments in the mine area are intruded by dikes and are overlain by volcanic tuffs. Several barite units are present, the main one reaching a maximum thickness of 40 feet (Papke, in preparation).

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BUCKHORN DISTRICT

The Buckhorn district is situated on the lower east flank of the southern Cortez Mountains about 5 miles east of the Cortez Gold mine. Mines, prospects and drill holes are scattered throughout the canyons and low ridges occupying the northwest quarter of the Horse Creek Valley 15' quadrangle, but the extensive underground workings and glory holes which comprise the central district are located in section 31, T27N, R49E. The entire property consists of 7,700 acres of patented and unpatented lode claims (Minesearch Report, 1983). The central district is currently held by Cominco American Exploration Co.

The early history of mining activity is well documented by vanderberg (1938). The district was first discovered in 1908-1909 and by 1913 the Buckhorn Mines Co. had "done considerable development work and blocked out a body of low-grade gold-silver ore" (Vanderberg, 1938). Between 1914 and 1916, ore was mined from a glory hole and milled on site. The mill was powered by electricity derived from a 700-horse power steam plant located at Beowawe. The next surge of activity at the mine was during the 1930's and since that time there has been sporadic mining of the deposit and some reworking of dump material. The total known production for the deposit through 1950 is 39,024 oz. Au, 311,278 oz. Ag and minor copper (Roberts, R.J., et al, 1967). Most of the ore produced was derived from the north and south glory holes which together comprise the Buckhorn mine.

In recent years, Bethex Corp., in joint venture with several other companies, drilled 246 exploration holes totaling 40,865' in 3 or 4 separate zones in the district (E and MJ, 1981). Cominco later acquired Bethex's claims and continued with exploration work during the summers of 1982 and 1983. At the time of our examination of the district in July, 1982 their work included geologic mapping of the claim area, geochemical sampling and core drilling within and near the existing glory holes. A 1982 estimate on the potential ore reserves is 2.5 million

tons at 0.082 oz Au/ton and 1.05 oz. Ag/ton (Bonham, 1982). However, Comincos' recent exploration work on the deposit indicates considerably different reserves (Oral comm., Scott Monroe).

According to Wells and Elliott (1969) the geology of the Buckhorn area is as follows:

"Rocks in the Buckhorn area consist of a series of Pliocene basaltic andesite flows that overlie Tertiary sedimentary rocks. The mineralized area is along three faults that trend N. 10° W. The Tertiary sedimentary rocks are exposed along a horst that is cut by a medial fault. They consist, in descending order, of laminated bedded chert, tuffaceous sandstone (possibly interbedded with the chert), sandstone, and conglomerate. The sandstone and conglomerate are tightly cemented by silica. These rocks dip 10°-35° E., are locally deformed, and are intruded by vesicular basalt that is altered and silicified. Some of the basalt near the medial fault zone has been altered to pure white kaolin. The altered rock grades from kaolin through white swelling clay, brown swelling clay (montmorillonite), and partially altered basalt to fresh basalt."

Resistivity surveys by the USGS indicate the basalts in the Buckhorn area are about 350-400' thick (Wells and Elliott, 1969).

The volcanic rocks at Buckhorn are part of a sequence of basaltic andesite flows which cover the east flank of this part of the Cortez Mountains. This sequence is shown on the eastern margin of the Cortez 15' geology map (Gilluly and Masursky, 1965). At Buckhorn and Cortez, the basalts directly overlie Tertiary gravels and less commonly, Paleozoic rocks. The basalts are known to be correlative with similar rocks exposed in the Shoshone Range (Wells, et al, 1971). K-Ar age determinations on basaltic andesites collected southeast of Horse Ranch and on the east flank of the northern Shoshone Range yielded identical ages of 16.3 my (Wells, et al, 1971 and McKee and Silberman, 1970).

These identical data support correlations of the volcanic stratigraphy between the two ranges and indicate that the host basalts at Buckhorn are late Miocene in age. Furthermore, it has been suggested that the mineralization at Buckhorn is associated with intrusive rhyolites of Miocene age which outcrop about 3 miles southwest in Horse Canyon (Wells, et al, 1971). This suggestion seems plausible since adularia from a "chalcedony-adularia vein" near the Buckhorn mine yielded a 14.6 my age date which, "within the limits of analytical uncertainty" is essentially the same as the Horse Canyon rhyolite dated at 15.3 my. (Wells and Silberman, 1973).

The mineralization at the Buckhorn mine occurs within a highly altered, chaotic breccia zone. The deposit is centered along a vertical or steeply east-dipping, north to north-west striking reverse fault which lies along the central axis of a north trending structural block shown as a horst by Wells and Elliott, 1969. Recent mapping in the area by Cominco geologists indicates that the faulted block may actually be a graben (oral comm., Scott Monroe).

The breccia zone is well exposed in the north end of the south glory hole. The zone is completely oxidized by supergene processes. Boulder to pebble size fragments of altered amygdaloidal basalt are cemented and veined by a mixture of grey chalcedonic silica, clay, iron oxides and iron sulfates (jarosite). The matrix contains abundant limonite in addition to goethite and hematite. The breccia fragments are altered to an argillic assemblage of kaolinite and montmorillonite. Unusual green and yellow coatings on the fragments are probably arsenic or sulfur minerals. Some microfossils were identified in pulverized rock from the zone indicating that sediments also comprise a portion of the host rocks. At the south end of the pit, bedded siltstones faulted against the basalts along a steeply east-dipping structure.

Free gold at Buckhorn occurs with limonite along fine fractures and veinlets

within the breccia zone. The oxide zone extends for about 100' below the surface. Below this depth, the zone contains abundant pyrite and marcasite. Sample 1514 was taken from the dump of underground workings located just east of the Buckhorn glory holes. The dumps contain ore from the unoxidized zone consisting of silicified sedimentary breccias with abundant unoxidized pyrite in fragments, veinlets and within the siliceous cement. The gold content in the ore zone reportedly decreases with depth while the silver content generally increases. Results of geochemical sampling within and near the ore zone reveal some high gold values (several in the range between 1-10 ppm Au) and anomalous amounts of Hg, As and Ag (Wells and Elliott, 1969).

Approximately 1 mile northeast of the Buckhorn mine there are beds of opalite which lie directly on basalts. The opalite beds strike northwest and contain fossil reed and snail impressions. According to Cominco, the opalite contains anomalous quantities of Au, Ag and Hg. Hydrothermal explosion breccias, sinter deposits and opalized conglomerate outcrop elsewhere in the district. The presence of these rock types in the mine are evidence for the existence of a shallow, hot-springs environment during the time of mineralization at Buckhorn.

Several shallow workings and drill holes are located in a north-south drainage about 4 miles east of the main district. Exposures are poor, but in general the workings explore fault zones in quartzites, cherts and shales of the Penn-Permian Brook Canyon Formation or the Ordovician Vinini Formation. Sulfides were noted in some drill cuttings and in silicified breccia found on the dumps. The canyon follows the trace of a northwest-striking, high-angle fault. Several intrusive bodies are located just north of the mines and may be related to the mineralization (Roberts, et al, 1967).

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BURNER HILLS DISTRICT

The Burner Hills and the mining district of the same name are located in western Elko County about 16 miles north of Midas and 10 miles west of the Good Hope district. The hills form an elongate, north-south trending prominence above the generally featureless Owyhee desert which extends to the north into Idaho.

Rocks exposed in the Burner Hills consist of chert, shale, argillite, and quartzite of the Ordovician Valmy Formation which form a structural high or window surrounded by Tertiary andesite flows and sediments. The andesite is shown on the Elko County open-file map to be in either flow or fault contact with the older Western facies siliceous rocks. There is a possibility, however, that some andesite porphyry seen in the area of the mines is intrusive.

The earliest activity in this district dates to the 1880's when about \$30,000 in lead-silver ore was mined from the Mint mine and shipped to smelters. Little work appears to have been done in the district since that time. Smith (1976) reports exploration activity in the area in 1961-64, and evidence of fresh claimstaking was seen when the property was visited first in 1979 and again in 1982. The area south of the Mine mine showed evidence of fairly recent (probably post-1969) trenching and drilling.

At the Mint mine on the north end of the district, mining was done along a N25°E fissure vein which cuts propylitically altered andesite. The vein zone is brecciated, with sulfides filling around fragments of altered andesite.

There appears to have been multiple brecciation and vein filling with sulfide mineralization followed by a barren quartz stage. High-grade ore from a dump near the main portal contained galena, sphalerite, pyrite, and chalcopyrite in a quartz-cemented vein breccia. Both pyrite and arsenopyrite are reported to be present in andesites in the walls of the vein structure.

To the south of the Mint mine area, in the southern part of the Burner Hills, small workings explore narrow quartz-filled fissures which cut both siliceous sediments and andesite. The fissures follow north-east trending structures and the wall rocks display local silicification. Fluorite was seen in float near sample site 139.

At the Willow claims, located about four miles to the south of the center of the Burner Hills district, recent claim activity is centered around an area of older trenching on silicified jasperoid outcrops. The silicified rocks appear to mark the trend of a fault zone, and massive manganese and hematite occur in pods along the structure.

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BURNS BASIN (JERRITT CANYON) DISTRICT

Since the discovery of disseminated gold mineralization at Jerritt Canyon in the northern Independence Mountains, the Burns Basin district of Smith (1976) and Lawrence (1963) is now simply referred to as Jerritt Canyon. For the purposes of this report the district is expanded to include the entire north half of the Independence Mountain range between Taylor Canyon and Jacks Creek. The approximate length of this segment of the range is 30 miles. The extension of the district is necessary in order to include the barite mines near Taylor Canyon, the Jerritt Canyon area, the antimony deposits of Lawrence (1963), and the new disseminated gold project located near Jacks Creek. The mineralization of the Gance Creek area on the east slope of the range is summarized in a separate section of this report (see Gance Creek area).

Antimony mines and prospects are located along the entire length of the Independence Mountains north of Taylor Canyon. Some of the deposits are described by Lawrence, 1963. In general, the deposits are vein or fracture fillings of quartz in silicified limestones and quartzites of lower Paleozoic age. Long, bladed crystals of stibnite and yellow and white antimony oxides occur in the quartz and are commonly intergrown with barite. According to Smith, 1976, the Burns Basin mine (sec. 22, T40N, R53E) produced 20 tons of antimony in 1918 and 12½ tons in 1945. Production from the other mines was apparently insignificant.

In recent years the north half of the Independence Mountains have been the focus of enthusiastic prospecting for barite and gold. Deposits of bedded barite are scattered throughout the range. A cluster of barite mines are located in the southern portion of the district just north and south of Taylor Canyon. Several of the deposits were productive, but all are currently inactive. The largest producers in the district were the Taylor Canyon (Fantastic; sec. 14, T39N, R52E)

and Snow Canyon (sec. 17, T41N, R53E) mines. The most active years for barite production were between 1977-1980.

A "Carlin-type" disseminated gold deposit was discovered in the early 1970's by FMC in the Jerritt Canyon area of the Independence Mountains. Their initial interest in the area was for antimony. Attention soon focused on the gold potential of the district, which was later confirmed by favorable geochemical results obtained in the North Fork of Jerritt Canyon (Hawkins, 1982). In 1976, FMC formed a joint venture with Freeport Exploration Co., who assumed management of the project. Subsequent sampling, detailed mapping and exploratory drilling in the latter half of the 1970's successfully outlined three separate but adjoining areas of low-grade gold mineralization named the Generator, Marlboro and Alchem ore bodies. Subsequent development of an open pit mine area ensued. The mine area, collectively known as the Bell Mine, is approximately 2 miles long (E-W direction) and $\frac{1}{2}$ mile wide. It is located in sections 33, 34 and 35 of T4N, R53E. The mill, located on the lower east flank of the range, began operation in June 1981. The initial cost of development was 105 million dollars.

According to figures obtained in late 1982, the Bell mine has estimated reserves of 12.5 million tons of grade 0.231 oz Au/ton or better (Bonham, 1982). At the time of our August, 1982 visit, the Marlboro pit was being stripped and most of the ore was coming from the Generator pit which has ore reserves of 35,000-37,000 tons at 0.2 oz Au/ton or better. The output from the mill was approximately 800 oz. Au/day, with an estimated production capacity of about 200,000 oz. Au/year.

Active exploration continues on other portions of Freeports' claim block north and south of the Bell Mine. The claim block encompasses a 15 mile by 10 mile area along the ridge crest of the range. The entire claim block is on National Forest land.

The geology of Jerritt Canyon is similar to that exposed in the remainder of

the north half of the Independence Range. Large areas of the range are underlain by Ordovician-Devonian, western facies, eugeosynclinal rocks which form the upper plate of the Roberts Mountains Thrust. The sequence consists of bedded clastic and siliceous sediments and includes minor greenstones. Throughout the range there are lower plate exposures of miogeosynclinal carbonate and clastic sediments ranging from Ordovician through Mississippian age. Both the upper and lower plate rocks are cut by several sets of high-angle faults. Unaltered Tertiary volcanic rocks, consisting predominately of andesite tuffs and flows, lie east of the range and overlie the sediments to the south near Taylor Canyon.

The geology of the Jerritt Canyon area was studied by Hawkins (1973) and more recently in detail by Collord (1979) and Birak (1979). The existing mines are developed in the Jerritt Canyon window which is an eroded, uplifted block bounded by high-angle and low-angle faults. Within the window the lower plate stratigraphy consists of the middle Ordovician Eureka Quartzite and continues upward through the Silurian Hanson Creek and Roberts Mountains Formations. The mineralization at the Bell Mine is hosted by the upper portion of the Hanson Creek Formation and the lower 60 meters of the Roberts Mountains Formation. From oldest to youngest the host rocks consist of banded carbonaceous limestones, dolomites, interbedded cherts and carbonates, and calcareous siltstones and dolomites. A major portion of the ore grade mineralization is hosted by banded, carbonaceous limestone and a chert-carbonate unit in the upper Hanson Creek Formation.

Gold mineralization at the Bell Mine is localized along steeply dipping normal faults, but extends out laterally into favorable stratigraphic horizons. Three high-angle fault systems are recognized, an older but still active east-west system and two younger northeast and north-striking systems. Two of the northeast-

striking faults, the Marlboro Canyon and Mill Creek Faults, lie in the heart of the district and are important ore controls. Since faulting physically improves the permeability and porosity of wallrocks, the largest concentration of ore grade material is commonly localized along structural intersections. Thrust faults enhance the ore zone, but are not an important locus for mineralization.

Jasperoids and jasperoid breccias are abundant and well exposed in the claim block and at the minesite. Many of the jasperoids are developed in the uppermost Hanson Creek Formation (Hawkins, 1982). The jasperoids form bold, rugged outcrops on the barren hillsides north of the two existing open pits. The east-west trending "Generator Hill" jasperoid lies along the surface trace of the Bell Fault. At the time of our tour, the Bell Fault was exposed at depth in the north end of the Generator pit. Jasperoids and remobilized carbonaceous ore are localized along the fault zone. The jasperoids exposed above the fault zone are dark grey in color, contain abundant barite and stibnite crystals, are fractured or brecciated and cut by numerous open-spaced, cross-cutting quartz veinlets, some containing pyrite. Coarse, white barite crystals up to 2" in length fill iron-stained, quartz encrusted vugs. Jasperoids occur on top of or beneath the ore bodies and commonly are directly underlain by a hard-pan clay zone. The silica is porous to massive chalcedony and comprises as much as 98% of the total volume of rock. Many of the jasperoids are anomalous in gold, but some are barren. In the Generator pit, jasperoids contribute less than 5% of the total mined gold.

Within the open pits the rocks are hydrothermally altered and show effects of bleaching and leaching, in addition to silicification. Areas of ore grade mineralization are characterized by decalcification and remobilization of carbon (Hawkins, 1982). We observed large, lense-shaped bodies of carbon localized along fault structures in the Generator pit. The carbonaceous material is dark grey to black, greasy to the touch, generally pyritic and contains arsenic sulfides. About 50-60% of the ore grade material is carbonaceous, the remaining is oxidized.

The carbonaceous ore is usually higher grade and contains as much as 30 gr. Au/ton (Hawkins, 1982). The processes which led to the formation of the oxide ore are not exactly known.

The gold at Jerritt Canyon is micron or less in diameter. The deposit contains no visible gold and almost no silver. The gold is associated with realgar, orpiment, arsenopyrite, cinnabar and thallium. Stibnite, barite and quartz were deposited during the last stages of mineralization. According to Freeport, the best indicator element for exploration is gold, but antimony is also useful.

A few small intrusive bodies have been mapped in the area but none are exposed at the minesites. Travertine and hot spring deposits are reportedly located near the mineralized areas (Hawkins, 1982). The characteristics of the deposit indicate it originated from a shallow, low-temperature hydrothermal system. However, further studies are needed in order to determine more accurately the origin of the deposit.

Exploration and drilling continues on other parts of the claim block. Several areas were drilled last summer, including the sites of a few antimony deposits cited by Lawrence, 1963. Freeport informed us that they have found mineralized structures extending as far down as the Eureka Quartzite and as much as 0.5 oz Au/ton in drill core (?) from upper plate rocks.

In February 1983, a Canadian exploration firm named Bull Run Gold Mines, Ltd., announced a new area of disseminated gold mineralization located in the Independence Range approximately 10 miles north of the Bell Mine. Freeport conducted exploration work on Bull Runs' Mesona claims during 1982. Two drill areas were defined on the basis of geological mapping and surface sampling. The drill results are encouraging. Near surface, ore grade mineralization was encountered in approximately 50% of the 58 vertical rotary holes drilled (press release, Bull Run Gold Mines, Ltd, Vancouver, British Columbia, Feb.1983). Further exploration work is necessary in order to define the potential of the project, but the discovery is good

evidence for the existence of deposits similar to that at the Bell Mine in other portions of the Independence Mountains.

The bedded barite deposits located throughout the range are all hosted by upper plate cherts, argillites, mudstones, shales and quartzites of the Ordovician Valmy Formation. In general, the barite occurs in units 2-6' in thickness. Some of the units contain chert or shaley interbeds or organic material. The deposits consist of one or more units which are discontinuous because of faulting. The host rocks are generally sheared and iron-stained.

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CARLIN DISTRICT

The Carlin district encompasses the southern end of the Independence Mountains north of the town of Carlin and the northern end of the Pinon Range immediately south of Carlin. There are reported occurrences of coal, manganese and lead-silver in the district but the location of these deposits are not known. The only known workings explore deposits of uranium, vanadium, diatomite and barite. A newly discovered disseminated gold property, the Rain claims, lies in the extreme southeast corner of the district.

Hot springs with temperatures recorded as 174° or boiling are located 3-4 miles southwest of Carlin (Garside and Schilling, 1979). Coal occurrences cited by early workers in the area (Lee, et al, 1916; E and MJ, 1887), could not be located by NBMG geologists who specifically searched for the deposits in 1975 (person. comm., Larry Garside, 1983). The only known production from the district is from diatomite deposits located in low hills about 3 miles northeast of Carlin. Mining of the deposits occurred between 1921 and 1952 (Smith, 1976). During a field trip to the Tri-O-Lite diatomite plant and mine in 1932, Smith and Stoddard (1932) made the following observation:

"Although the mill has a large capacity, depressed market conditions have resulted in only 10 or 12 carloads of specially prepared grades of diatomite being shipped during the past year."

The mines are presently inactive, but are covered by active claims.

Uranium occurrences are explored by shallow trenching at the Black Kettle and Deerhead prospects in the northern Pinon Range. On the Black Kettle claims, numerous exploration cuts and drill roads are located in the western half of section 34, T32N, R52E and in the central portion of section 4, T31N, R52E. The claims are currently held by Santa Fe Mining Co. However, the exploration work which is 5-10 years old was probably done by Union Carbide Corp. in their search

for vanadium in black shales.

In addition, there are several active claims for barite in the northern Pinon Range. Barite veins are present in minor amounts in the host rocks in Woodruff Creek (Deerhead Prospect) and Cole Creek Canyons, but the best developed deposit is at the Evans Mine located in section 36, T32N, R53E on the northeast slope of the range where barite occurs as replacement bodies in Devonian limestones. The property is developed by trenching and drilling. As yet, there has been no production.

In 1979, an area of disseminated gold mineralization was discovered on Newmont Explorations' Rain claims in the northern Pinon Range. There are two areas of exploratory drilling on the claims; one area is in section 3, T31N, R53E and the other more extensive drill area is in section 33, T32N, R53E. Drill results indicate reserves of 8.3 million tons at 0.083 oz. Au/ton and 3.4 million tons at 0.147 oz Au/ton (Bonham, 1982). Further development of the deposit is forestalled until production begins at Newmonts' Gold Quarry mine, located in the Maggie Creek district about 10 miles northwest of Carlin.

The diatomite deposit located less than two miles north of Vivian siding is explored by numerous open cuts, trenches and drifts. The deposit occurs within the Miocene Humboldt Formation and is best exposed in the area of the Try-Light and Great White Hope claims. The main diatomite bed is pure white in color, thinly bedded to platy in character and about 20' in widest total exposure. It strikes north-northwest and dips 30° to the northeast. Grey silty mudstones and layers of unconsolidated sand overlie, underlie and are interbedded with the deposit. The deposit is explored almost continuously for 1½ miles along strike. Several high-angle faults cause minor displacements of the bed but in general, the unit is undeformed. Several small prospects located a few miles northwest of the main working are also developed in diatomaceous sediments.

The northern Pinon Range is predominately underlain by Ordovician through Permian shales, siltstones, sandstones, limestones and conglomerates. The sediments are faulted along Antler-related thrusts and numerous high-angle structures. (Smith and Ketner, 1968). The host rocks in the vicinity of the Black Kettle and Deerhead prospect are black and tan shales, limey siltstones, and minor fine-grained quartzites and cherts of the upper plate Devonian Woodruff Formation. At the Deerhead prospect, yellow to yellow-green carnotite occurs as fracture fillings in a highly fractured and locally silicified shale. Moderate iron and manganese oxides are present. The 50' shaft on the Black Kettle claims (Garside, 1973) was never found since the original property is redeveloped by numerous exploration cuts and drill roads which extend for more than 1½ miles down Cole Creek canyon. The shales and siltstones exposed in the cuts are fractured, brecciated and veined by white crystalline calcite and barite. Although no uranium minerals were directly observed, anomalous radioactivity 2 to 3 time background was measured in the black shales (see Uranium occurrence report-Black Kettle). Samples of shale collected from the area in 1980 under the NURE program contain as much as 3500 ppm vanadium. "The area was determined privately to contain 20 million tons of measured, indicated, and inferred reserves of material averaging 0.8% V₂ O₅" (Brooks and Potter, 1974).

Newmonts' new disseminated gold discovery, the Rain property, is located in the northern Pinon Range at the head of Ferdelford Creek. The host rocks for the deposit are siltstones, shales and minor sandstones of the lower Mississippian Webb Formation which is currently considered to be an allochthonous unit of the Roberts Mountains thrust (Ketner and Smith, 1982). In the drill areas, the rocks are notably bleached, iron-stained, fractured and silicified. Two separate areas were drilled, but the western drill roads are more numerous and closely spaced than the eastern area. A conspicuous outcrop of jasperoid breccia lies along the northern margin of the western drill area. The jasperoid contains abundant iron (hematite

and jarosite), barite, dussertite and quartz. The barite and quartz occur as late stage vug and vein fillings. The outcrop displays internal zones of veining and brecciation. Slicked surfaces have a persistent N40W strike. The jasperoid outcrop probably represents the siliceous cap to a northwest-striking fault zone which may have been a conduit for mineralizing fluids. Although the ore zone appears tightly structurally controlled, mineralization may extend southwest from the jasperoid body into favorable sedimentary horizons.

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CAVE CREEK DISTRICT

The Cave Creek district is located on the east side of the Ruby Mountains just north of the Elko-White Pine County line. The only known mine workings in the district are on barite claims in section 5 and 10, T26N, R57E. The district lies within the Humboldt National Forest.

The district was formed in 1869 following the reported discovery of lead-copper-silver deposits in the vicinity of Cave Creek by soldiers stationed at Fort Ruby. However, at the time of our examination of the district, a ranger living at the Ruby Lake National Wildlife Refuge headquarters near the mouth of Cave Creek informed us that, to his knowledge, there is no evidence of mining in the Cave Creek area other than very minor weekend prospecting. It is this authors opinion that the reported deposits do not exist or are undeveloped occurrences only accessible by foot or horseback. The most recent mining activity in the district focuses on the exploration for barite in the southern part of the district.

At the Judy claims, grey and white barite occurs in veins and irregular replacement bodies within a roughly stratiform horizon in grey, fetid, sandy dolomites of Devonian age. The mineralized zone which conforms with the moderate south-dipping beds of the host rock, is estimated to be 85' thick. Barite is not uniformly distributed in the zone, making up less than 1/10th of the horizon exposed in a N25E trending bulldozer cut at the minesite. Coarse white barite also cements breccia along fault zones exposed in the cut. A high-angle fault terminates the deposit to the north. The property has probably produced less than 3,000 tons of barite (Papke, in press).

A similar barite deposit is located on the B and P claims located just west of the ridge line about 2½ miles northwest of the Judy claims. The minesite is

accessible through Mitchell Creek on the west side of the range. The claims are developed by some trenching and drilling. There has been little or no production from the deposit (Papke , in press).

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CHARLESTON DISTRICT

The Charleston district covers the mountainous portion of northern Elko County between Jarbidge and Charleston. The main part of the district is centered approximately 15 miles south-southwest of Jarbidge. In the past, the district was known as the Copper Mountain and Cornwall districts. The southern half of the district, which contains the townsite of Charleston, is BLM administered. The northern half, which contains the most productive lode mines in the district, is within the boundaries of the Humboldt National Forest.

The district was first organized following the discovery of placer deposits along Seventy-six Creek probably in 1876. Post-volcanic gravels located along the Bruneau River and its' south-west draining tributaries yielded an estimated 300 oz. of gold before 1900 (Johnson, 1973). Mining of the fine gold from these and other placer deposits was revived in the 1930's. The most productive placers were worked thoroughly during these periods due to the availability of water in Seventy-six Creek.

Numerous shallow prospects and several mines were developed in lode deposits proximate to the Copper Mountains in the early 1900's. Small quantities of gold, silver, copper, tungsten and antimony were produced. The most productive mines of this type are situated on the lower south and east flanks of the Copper Mountains.

Although the early production figures for gold, silver and copper are not known, the Batholith mine, located in the northern part of the district, is known to have produced 452 units of WO_3 between 1954 and 1956 (Stager, in press). In more recent years some barite has been produced from the

Seventy-six Creek barite mine located on the east side of Seventy-six Creek. At the time of our examination of the district, both the Seventy-six Creek barite mine and the Prunty mine showed current or recent evidence of activity.

The Copper Mountain area is underlain predominately by lower Paleozoic quartzites which are interbedded with schists, phyllites and slates. Remnants of younger Paleozoic limestones and argillites occur locally, especially along the base of the Copper Mountains. Throughout the entire area, the sediments are typically highly deformed, steeply tilted, folded and cut by numerous high-angle normal faults. At the mine sites, the rocks are recrystallized and hornfelsed due to the intrusion of granitic or dioritic dikes and quartz veins. The dikes and veins may be related to the Cretaceous Coffee Pot stock located at the north end of the Copper Mountains or to the later extrusive episode of mid-Cenozoic volcanics which cover the southern and eastern portions of the district.

One of the major structural features of the southern part of the district is the presence of a northwest-striking normal fault which follows the western edge of the Copper Mountains. This fault downdrops Tertiary volcanic rocks against Cambrian and upper Paleozoic sediments. In trenches developed near the Rescue mine, limestones are intruded by dioritic dikes along an orientation which mimicks this fault zone. Recrystallization of the limestone is evident and both the limestone and intrusive rock are notably altered and iron-stained. Quartz veins cutting the exposed intrusive contain pyrite, chalcopyrite and gossan. Samples of vein material collected by Lawrence, 1963, contained 18.44% antimony, 15.7% zinc, 0.12 ounce gold/ton and 2.88 ounce silver/ton.

The Prunty and St. Elmo or Slattery mines are the major group of workings in the district. The mines are collectively referred to as the Virginia mine by Smith, 1976. They are located on the west side of Seventy-six Creek about 3.3 miles north of Charleston. In 1907, 30-40 tons of antimony were produced from one of the mines in the area, but production of gold, silver or copper is not known. Unpublished sources of information (see NBMG Mining District Files, #47, Charleston district) indicate the mine was quite active in the early 1930's. At present, the underground mines are actively being worked for gold and silver on a small scale.

Outcrops near the lower adits of the Prunty mine consist of steeply dipping, fractured, hornfelsed slates and argillites. The sediments are cut by near vertical monzonitic and dioritic intrusive dikes and quartz veins. Some of the dikes are iron-stained and contain sulfides, mostly pyrite. The orientation of the workings up slope from the creek suggests a vein (fault?) strike of N20-30W. Quartz vein from the dump is in part brecciated and contains unoxidized pyrite, arsenopyrite, galena, chalcopyrite, sphalerite, stibnite and pyrrhotite. Coarse needles of stibnite are especially abundant in calcite and barite gangue found with the quartz vein material. Although the mine has a long history of activity, the ore is high-grade and apparently still profitably mined for its precious metal content.

Less than one mile south of the Prunty mine, the Seventy-six Creek barite mine is actively being developed. There is some recorded production from the deposit since it was examined in late 1980 (see field write-up for Seventy-six Creek barite mine). The barite occurs in stratiform deposits which reach up to 12' in thickness. The host rocks are argillites, cherts and limestones of the probable northern equivalent of the Ordovician Vinini

Formation (?). (Papke, in press). Although the property was not visited in the field examination of the area in 1982, trenching and dozer roads can be seen along the east side of the creek in the vicinity of the mine.

The northernmost mine in the district is the Batholith mine. According to Stager, (in press), almost 1,000 tons of tungsten ore averaging 1.0% to 0.5% WO_3 was mined from open pit and underground methods in the 1950's. Molybdenite and powellite are associated with the scheelite (Schilling, 1968). The mine is situated on the contact between limestones, shales and quartzites and a small body of quartz monzonite. The intrusive is eroded and overlain by Pleistocene moraine deposits. Its close proximity to the Coffee Pot stock (see Alder district) and similar compositional character may indicate the small body is connected at depth to the larger stock.

The Batholith mine was visited and sampled in the summer of 1980. A small hill at the mine site is composed of a bedded section of tactite and silicated shales and quartzites. The altered sediments are cut by northwest-striking quartz veins. A sample of massive garnet tactite collected from the mine was analyzed and found to contain 1000 ppm molybdenum and 50 ppm tungsten in addition to high manganese and moderate zinc.

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COAL MINE DISTRICT

The Coal Mine district is located about 25 miles north of Elko in the north end of the Adobe Range. On the earliest map made of the area, King (1876) located a coal mine on the east side of the range north of the mouth of Coal Mine Canyon. The early reported coal occurrence resulted in a plethora of coal-related geographic names for this part of the Adobe Range. Although oil shale and phosphatic rocks occur in the southern and northern Adobe Range, there is no known occurrence of coal in the Coal Mine district.

"Oil shale in the Tertiary deposits is exposed in places along the east side of the Adobe Range and around the Elko Hills" (Ketner, 1970). In 1969, the U.S. Geological Survey cut a 500' long trench between Sec. 2, T37N,R56E and Sec. 35, T38N,R56E approximately one-half mile northeast of Coal Mine Road. The trench exposes "Tertiary kerogen-bearing sediments" correlative with the upper portion of the Elko Formation (Moore, 1983). Moore (1983) concluded that since the deposit is faulted and of "low-oil-yield oil shale," it is not likely to be further developed "at this time nor in the foreseeable future".

According to Ketner's preliminary geologic map of the Coal Mine Basin 7 1/2' quadrangle, this part of the Adobe Range is composed as a sequence of Ordovician through Triassic clastic sediments, cherts and limestones. The sediments generally strike northeast but are cut by numerous northeast and northwest-striking, high-angle faults. Several northeast-striking thrust faults occur in the central portion of the quadrangle. The thrusts bring older Ordovician shales and cherts in contact with younger Mississippian and Silurian clastic rocks. Southeast of the thrust rocks, younger Paleozoic and Triassic clastic rocks are folded into a northeast-trending syncline, named the Adobe Range syncline (Ketner and Ruben, 1983). Oil shale and volcanic rocks of Tertiary age are exposed southeast of the Paleozoic rocks in the area of the Coal

Mine Canyon prospect.

The only significant workings in the district are the Coal Canyon and Garamendi mines located in the south half of section 18, T38N, R56E on the lower west flank of the range. The mines are closely spaced and appear to explore the same oxidized sulfide replacement zone developed along an undulatory, but generally east to northeast striking, north to northwest-dipping fault. Ketner, 1983, has mapped the structure as a pre-fold thrust fault between upper plate Silurian shales and cherts (undifferentiated) and lower plate sandstones and quartzites of the Mississippian Chainman shale. South of the thrust, the Chainman Formation is intruded by several northeast-trending Tertiary dikes (Ketner and Ruben, 1983). The mines are located just north of the thrust in brecciated, silicified and replaced host rocks of the upper plate.

The host rocks at the Garamendi mine are well exposed in a north-south trench about 100' long and 25' wide. They consist of fine-grained quartzites interbedded with limey shales and limestones. The beds are relatively flat-lying but are fractured along several east-west structures. Within the trench the rocks are highly altered to gouge and gossan. Replacement deposits (gossan) have formed along bedding and parallel to the east-west fault structures. The replaced horizon is entirely oxidized to gossan. Jagged "jasperoid" outcrops occur on the ridge above and south of the mine. The silicified and brecciated outcrops mark the trace of the north-dipping thrust fault mapped by Ketner (1970).

Silicification of the sediments is even more evident at the Coal Canyon mine located less than one-half mile east of the Garamendi. Dump rock on the lower adit is mostly composed of recrystallized or silicified limestone and siliceous hematitic gossan. The gossan is quite dense, displays boxwork structures and contains pods of partially oxidized pyrite and minor galena. Vugs in the gossan are filled with finely crystalline barite. An open cut at the top of the hill explores a

northeast-striking, northwest-dipping fault zone in Ordovician cherts and shales. The fault is more steeply inclined than a thrust and may represent an imbricate high angle structure developed parallel to the thrust in the upper plate rocks. The fault is capped by a very resistant rib of siliceous breccia or "jasperoid". The "jasperoid" has a highly siliceous matrix and contains breccia fragments of cherts, siltstones and shales. The body outcrops boldly along the entire trace of the structure east and west of the mine.

At the mine site, the "jasperoid" is cut by numerous gossan and breccia zones. A gossany replacement deposit occurs directly below the siliceous cap. The replaced horizon parallels the bedding of the host and dips about 45° to the north (west). West of the open cut, the "jasperoid" contains vugs and fracture coatings of opaline silica and is cut by banded opaline veins which range from 1" to 1' in width. Minor sulfides were observed in the opaline veins, but were too fine-grained to identify with a hand lens. Although no unoxidized ore minerals were observed at the mine and no known production is recorded for the deposit, the considerable gossan found along the thrust fault indicates the former presence of abundant sulfides.

The area surrounding and including the Garamendi and Coal Canyon mines was staked by TexasgulfWestern, Inc. (Golden, Co.) in July 1980. During 1981 they drilled the central part of the district. Most of the drilling occurred at the mine sites and continued northeast along the western range front. At the time of our examination of the area in June, 1982, Texasgulf was conducting geophysical studies in the area. Results of their work indicate the presence of a massive sulfide deposit. The sulfide deposit is possibly the unoxidized extension of the oxidized sulfide replacement deposit observed on the surface.

The Q-Bar prospect is located less than 4 miles north of the central part of the district. Six or eight lens-shaped units of barite occur within black cherts

of the Ordovician Vinini Formation (Papke, in preparation). The barite units are conformable with the bedding of the host rocks. Brecciated and silicified chert "jasperoids", like those observed in the main part of the district, occur south and parallel to the barite-rich interval.

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CORNUCOPIA DISTRICT

The Cornucopia mining district is located about nine miles south of Wilson Reservoir in the low mountains bordering the south-east margin of the Owyhee Desert. Access to the district is good along a dirt road which heads west at the southern end of the Bull Run Mountains. The main mines in the district are patented. The patented mines are concentrated in two groups occupying sections 18 and 19 of T42N, R51E. Some minor prospects and unpatented claims exist in the area surrounding the center of the district.

The high-grade silver veins of the Cornucopia district were first discovered in July, 1873 (Whitehill, 1873 & 74). One of the first claims staked was the Leopard property which turned out to be the most productive vein deposit in the district. The value of the silver and gold-bearing ore produced between 1875 and 1882 exceeded one million dollars (Couch and Carpenter, 1943). From 1937 to 1940, 10,000 tons of mine tailings were reworked. The tailings yielded an additional 0.13 oz. gold and 9 oz. silver per ton (Smith, 1976).

Activity in the district resumed in 1973, when Spartan Exploration, Ltd. conducted geologic mapping, EM surveys and rock-chip sampling of bulldozer trenches in the heart of the district. Rock chip assays defined a broad area of disseminated precious metals mineralization which reportedly averaged 3.24 oz. silver and 0.034 oz. gold per ton (EMJ, June 1974). Favorable waste dump samples were also obtained. Exploratory drilling commenced in the summer of 1974 in a target area located just south and east of the Cornucopia (Leopard) Mine. Calculated reserves exceeded 3 million tons of ore grade material.

The shafts on the Leopard vein have been inaccessible since before 1908 (Emmons, 1910). At the time of our summer 1982 visit, the underground workings

of the Cornucopia, or Leopard, Mine were further obscured by recent reworking of the voluminous tailings pile and excavations related to the drilling program conducted 8 years earlier. We observed that the disseminated ore zone delineated and drilled by Spartan Exploration was never developed beyond the exploration stage.

The geology of the south-east quarter of the Wilson Reservoir 15' topographic quadrangle is described in USGS Circular by Coats, 1967. His revision of the volcanic stratigraphy and observations on the ore deposits at Cornucopia has provided new insight on the geology of the district.

Cornucopia is a typical epithermal, volcanic-hosted precious metals camp. The host rock for the vein deposits are porphyritic pyroxene andesites. Throughout the entire mine area the rocks are bleached and altered. Near the veins, the wallrocks are kaolinized and silicified. Bleaching and argillization extends for some distance beyond the mined areas. Less proximate andesites are propylitized.

The best exposure of the altered andesites is along the drill roads and trenches adjacent (uphill) to the Cornucopia Mine. The rocks here are a light buff color, notably sheared and altered to a mixture of clays, iron and calcite. The rocks nearest to the faults and veins are pyritized and sericitized. Pods of secondary quartz occur locally, making it easy to mistake the bleached rocks as rhyolite (Coats, 1967). Gossany fissures cut the altered volcanics at a high-angle along north and west orientations. Abundant quartz vein material is scattered along the drill roads. The vein is sheared, pyritized and iron-stained.

Post-mineral tuffs of rhyolite and rhyodacite unconformably overlie the altered andesites (Coats, 1967). The tuffs occur south and west of the Cornucopia Mine where they form the hanging wall of an extensive, north-striking, post-mineral fault. Nowhere in the mine area are the younger flows mineralized or significantly altered.

The formational contact between the older and younger volcanics is not well exposed. The absence of a well exposed contact in the mine area combined with the masking effect of the alteration led Emmons to conclude that the ore-bearing andesites are intrusive into the rhyolites.

There are numerous faults in the center of the district. The Cornucopia (Leopard) Mine is situated at the intersection of at least two premineral (?) north and north west-striking faults (Coats, 1967). The faults were in part responsible for localizing or controlling the mineralizing fluids. According to Thomson and West, 1881, the original strike of the Leopard vein is northeast with a dip of 45° to the SE. Post-mineral fault(s) terminate the vein directly north of the mine (Coats, 1967).

The second main area of mineralization, the Panther Group (?) is located about one-quarter of a mile northeast of the Cornucopia Mine. The area is developed by several adits, stopes and shallow prospects. Sample 1600 was collected from a stope which follows a sheeted quartz vein system about 2-3' in width. The andesite host rocks exposed in the stopes are intensely kaolinized, bleached and have a punky texture. The veins, which are explored along strike for about 50', strike N75E and are vertical. Individual veins within the system average 1" in width. They are typically sheared, iron-stained and display open-spaced and comb quartz textures. The sheared material collected from the dump contains dark grey sulfide lenses. A fault truncates the veins east of the stope. Emmons, 1910, observed that the Panther vein is segmented and displaced northward (?) along several northwest striking faults.

The vein ores from Cornucopia were described by Thomson and West, 1881, as "mostly free-milling, silver-bearing, and carrying some gold". The main silver minerals are argentite, ruby silver and horn silver. They are accompanied by pyrite and grey copper (Emmons, 1910). Lawrence, 1963, reports pyrargyrite

and a near surface vein assemblage of cerargyrite, pyromorphite and yellow antimony oxides. Buchanan, 1981, further recognized chalcopyrite, tetrahedrite, bornite, galena, stephanite and sphalerite in the vein ore. The maximum grade of milled ore was 400 oz. per ton (Emmons, 1910). The ratio of silver to gold was about 68:1.

Coats, 1967, suggests that extensions of the rich veins at Cornucopia could possibly exist beneath the yet unexplored and unmineralized pile of younger volcanics. Since the veins are faulted and the thickness of the overlying volcanics is variable, further exploration in the area would be costly but possibly ultimately profitable.

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CORRAL CREEK DISTRICT

The Corral Creek district is on the west slope of the Ruby Mountains, in the drainage of Corral Creek, in the south half of T28N, R57E. It has also been called the Ruby Range district (Smith, 1976). The workings are generally short adits or shallow shafts; the Summit King and Summit View are the main mines in the district. The only recorded production from the district was in 1948-52, from the Summit View mine. The only recent activity noted in 1982 was some minor bulldozer work near one portal.

The mineral deposits in the Corral Creek district are base-metal replacements in limestone and minor interbedded siltstone. Granitic rocks of the Harrison Pass pluton intrude the Cambrian rocks a short distance from the Summit King mine. The majority of the ore minerals recognized are oxide copper, lead, and zinc minerals, although galena was noted locally. The deposits were probably worked mainly for their silver content. The only recorded production (108 tons of lead-zinc ore) was from the Summit King mine in 1948-52 (Smith, 1976). The ore averaged 2.5% Pb, 1.1% Zn, 0.15% Cu and 3.0 oz/ton Ag. The base-metal mineralization is probably related to the Harrison Pass pluton, which is early Oligocene in age (Willden and Kistler, 1969).

A pegmatite dike in the granitic stock near the head of Corral Creek contains lepidolite. Other dikes were examined for beryl, but none was found (Olson and Hinrichs, 1960, p. 171).

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CORTEZ DISTRICT

The Cortez mining district is located in the southern Cortez Mountains about 30 miles south of Beowawe. The district contains 4 main areas of mineralization which surround Mt. Tenabo, the highest peak in the range. These areas are the old Cortez silver mines on the steep west flank of Tenabo, the Cortez gold mine on the northwest flank, the Mill Canyon area which lies along the northeast flank and the new Horse Canyon property located east of the peak. The district is bisected by the Lander-Eureka county line with mines occurring in both counties.

The geology and mineralization at Cortez has been studied in detail by numerous authors (see Selected References). Some interesting facts on the early history of the district are reported by Vanderburg (1938) and Emmons (1910). The geology of the Cortez 15' quadrangle was mapped by Gilluly and Masursky (1965) and the text includes a discussion on the ore deposits written prior to the development of the Cortez Gold mine. The USGS studies which led to the discovery of the large tonnage, low-grade gold ore body on the northwest flank of Mt. Tenabo are contained in Erickson and MARRANZINO (1961) and Erickson, et al (1961, 1964 and 1966). Numerous studies of the gold ore body and surrounding areas ensued, including a geochemical investigation of the Mill Canyon area (Elliot and Wells, 1968).

The extensive underground workings of the Cortez Silver mines are entered through the Garrison and Arctic Tunnels on the west side of Mt. Tenabo. The mines were worked fairly continuously since their discovery in the early 1860's through January 1930, when the "low price of silver and depletion of ore reserves" forced the mill to shut down (Vanderburg, 1938). Nevertheless, from 1862 through 1958, 14 million dollars worth of gold, silver, copper, lead and zinc were produced from the district (Stager, 1977). A small amount of the total production includes ore derived from the mines in Mill Canyon also.

The ownership of the Cortez Silver mines changed hands several times after the main production and during this period the mines were reopened, reworked and redrilled. When the USGS discovered geochemical indications favorable for gold mineralization, Placer Amax Inc. auspiciously held the controlling claims in the district. In joint venture with three other companies, Amax drilled the area during 1965-1968 and successfully outlined a large disseminated gold ore body in section 13, T27N, R47E with inferred reserves of 3.4 million tons of ore containing 0.29 oz Au/ton. The Cortez Gold mine was soon developed and between 1968 and 1982, 3,562,100 tons of ore averaging 0.279 oz Au/ton were mined (Bonham, 1982), resulting in a production of almost 1 million ounces of gold. Currently, the main deposit is mined out, but leaching of stockpile ore continues. At the time of our examination of the district, the millsite was predominately being used to process ore from the Gold Acres deposit, located in the Shoshone Range about 8 miles northwest of Cortez.

In addition to the gold production, a small production of turquoise is recorded for deposits located south west of Cortez Canyon (vanderberg, 1938). Also, some antimony was produced as a by product of smelting the early silver ores (Lawrence, 1963). In 1941, a mercury deposit, named the Rossi mine, was discovered and explored on the east slope of the range, but was probably never productive (Bailey and Phoenix, 1944). The mercury occurs as cinnabar in bleached and silicified calcareous shales of the Vinini (?) Formation. Autunite (?) was uncovered by bulldozers during the development of the gold deposit, but the exact location of the occurrence is unknown (Garside, 1973).

The geology of the Cortez area, as mapped by Gilluly and Masursky (1965), consists of thrustsed Paleozoic sediments which are intruded along the north flank of Tenabo by a Cretaceous intrusive stock and associated dikes and veins. The general geology of the area is well described by Elliot and Wells (1968, p.3) as

follows:

"The Paleozoic sedimentary rocks comprise two distinct facies which are approximately equivalent in age; these facies are separated by the Roberts Mountains thrust fault. One facies includes formations that range in age from Cambrian to Devonian and consist predominantly of carbonate rocks with minor quartzite. The second facies includes formations that range in age from Ordovician to Silurian and consist predominantly of siliceous rocks. In adjacent areas, Devonian rocks of the siliceous facies are also represented. The carbonate facies is considered to be autochthonous and the siliceous facies allochthonous. The siliceous facies has been transported into juxtaposition with the carbonate facies from the west along the Roberts Mountains thrust (Gilluly and Masursky, 1965, p. 10). The rock unit mapped as Paleozoic undifferentiated occupies the thrust zone and is not directly assignable to either the carbonate or the siliceous facies.

In general, the sedimentary units strike north and dip moderately east. The Roberts Mountains thrust has been warped into an antiform (Gilluly and Masursky, 1965, p. 89), and later erosion has formed the Cortez window in which the carbonate facies is exposed below the thrust. The lower plate rocks are cut by many faults, most of which are probably related to the period of thrusting. The upper plate is structurally more complex and is composed of many slices of western facies, all faulted together with little apparent system (Gilluly and Masursky, 1965, p. 93).

Rocks of Jurassic age are the quartz monzonite of the Mill Canyon stock and the satellite bodies of alaskite and intermediate dikes associated with the stock.

The Mill Canyon stock intrudes the lower plate rocks in the axis of the Cortez window and crosscuts the Roberts Mountains thrust to the east. The stock is composite and consists of two parts: (1) a discordant western part, roughly rectangular in outline, and (2) an eastern laccolithic or bysmalithic lobe (Gilluly

and Masursky, 1965, p. 68). Several mineralized veins are near the junction of the two parts of the Mill Canyon stock."

Radiometric dating of biotite from the Mill Canyon stock yielded an age of 151 m.y. (Gilluly and Masursky, 1965). Two slightly younger ages of 124 and 147 m.y. were obtained from the same body a few years later by Armstrong (1963, unpub.) and published in Schilling (1965). Biotite and sanadine from a rhyolite porphyry dike adjacent to the ore zone yielded ages which date the mineralizing event at about 35 m.y.a. (Silberman, et al, 1976).

The Cortez Gold mine was visited only briefly during our reconnaissance of the district. For this reason, a description of the geology and mineralization of the deposit is taken from Roberts, et al (1971, p. 76):

"The host rocks of the Cotrez gold body are described by Gilluly and Masursky (1965), Elliott and Wells (1968), and Wells, Stoiser, and Elliott (1969) as altered calcareous silstone and limestone of the Roberts Mountains Formation and limestone of the Wenban Limestone. These rocks are cut by intrusive igneous rocks of Jurassic and early Tertiary age and overlain by Tertiary volcanic rocks. The ore may be genetically related to biotite-quartz porphyry dikes and sills of Oligocene age (34 m.y.) that cut the Roberts Mountains and Wenban Formations in the ore zone, or to younger igneous rocks in the area (Wells, Stoiser, and Elliott, 1969).

The zone of gold metallization is not controlled by any obvious structural feature, but it trends north-westward, parallel to the strike of the Roberts Mountains thrust at the mouth of Mill Canyon nearby. Wells, Stoiser, and Elliott (1960, Fig. 6) show the ore body in a tight, overturned fold in the Roberts Mountains Formation; the overlying Wenban Limestone was apparently not involved in this fold, indicating that the two units may be separated by a reverse fault. Roberts believes that the Roberts Mountains thrust plate probably covered the area at the time of

metallization and may have exerted an important structural control on ore deposition. In addition, the Cortez district lies within the Battle Mountain-Eureka mineral belt that trends N35°-15°W in this area; this belt apparently lies along a deep-seated fracture zone which localized plutonic bodies in Mesozoic and Tertiary time and localized ore deposits during several metallogenic epoches (Roberts, 1966; Roberts et al., 1967).

Gold ores of the Cortez deposit are characterized by quartz, metallic gold, various iron oxides after pyrite, and small amounts of remnant carbonates and clays. Fine-grained gold is dispersed through the oxidized and hydrothermally altered carbonate rocks. Coarser grained metallic gold occurs in small quartz veins and is intergrown with partly oxidized hydrothermal pyrite scattered through the host rocks.

Radtke considers that most of the carbonaceous materials in the host rocks were destroyed either by a process of "weathering oxidation" or by thermal metamorphism induced by igneous intrusion prior to gold mineralization. Thus, the influence of organic carbon on the deposition of gold at Cortez was less than that at Carlin. Details of the genesis of the Cortez ores will be discussed in a paper by Radtke, Scheiner, and Christ (unpublished manuscript). "

The Mill Canyon area was visited and sampled during the course of this project. Many of the mines in the canyon are patented. The owner, Allen Russell, limits access to the mines by a locked gate at the entrance to the canyon. Prior permission is advised before entering the property.

"Deposits in the Mill Canyon area have been prospected and mined for the past 100 years. The estimated total production from the area is approximately \$800,000. Most of the mining has been in gold and silver, the gold predominating in dollar value. The ore deposits are of three types: (1) fissure veins in quartz monzonite that contain silver, lead, zinc, and gold, (2) silver, lead, and zinc replacement

deposits in limestone (Vanderburg, 1938, p. 27), and (3) gold deposits along fault zones in limestone. The most productive deposits have been near surface oxidized ore along faults in limestone near the quartz monzonite limestone contact."

(taken from Elliott and Wells, 1968, p. 3)

Although many of the workings in Mill Canyon are caved, several adits are still open at their portals. Most of the adits explore north, northeast and northwest faults, fractures and fissure zones in bleached, recrystallized or silicated limestones and silty or carbonaceous sediments of the lower plate, Devonian Wenban Limestone. The structures are generally made by the development of clay, calcite and abundant iron-oxides. The bedding of the host rocks near the minesites is generally highly contorted by folding and faulting.

The quartz monzonite Mill Canyon stock outcrops in the central part of the canyon. Along the irregular southern margin of the body, the stock is intruded by a north-trending alaskite porphyry dike about 3/4 of a mile in exposed length. Some of the western workings in the canyon lie along the contact of the dike with limestones and quartz monzonite. South of these workings at the head of Mill Canyon, Homestake conducted exploratory drilling during 1980 and 1981 in altered Wenban Limestone. Drill holes are concentrated at higher levels where the limestones are cut by several high-angle faults.

By sampling the dumps in the area, we noted that quartz veins which cut intrusive rocks carry pyrite, galena and sphalerite. The ore derived from the limestone replacement deposits typically contains pyrite, galena, chalcopyrite, bornite and arsenopyrite. Argillized porphyry dikes occur locally and contain fine disseminated pyrite. In addition to these minerals, minor amounts of boulangerite ($Pb_5 Sb_4 S_{11}$), bournonite ($Pb Cu Sb S_3$), argentian tetrahedrite, pyrargyrite-proustite ($Ag_3 Sb S_3$ - $Ag_3 As S_3$), gold, stibnite, argentite and stephanite ($Ag_5 Sb S_4$) are reported for the deposits (Elliott and Wells, 1968). Anomalous

amounts of Au, Ag, Pb, Zn, Cu, As, Sb, Hg and Te and local concentrations of other elements were discovered by Elliott and Wells (1968) geochemical study of the area. Their informative article outlines the mode of occurrence of the gold and silver, geochemical indicators for mineralization and favorable areas for prospecting within Mill Canyon.

In the fall of 1982, Cortez Gold Mining Co. announced its plans to start production on its newly discovered gold ore body at Horse Canyon on the east side of Mt. Tenabo. Mining of the deposit is expected to begin in mid-1983, hopefully coinciding with the final mining of their Gold Acres property located on the other side of Crescent Valley. Ore reserves for the Horse Canyon deposit are estimated at 3.4 million short tons of 0.0555 oz. Au/ton. An annual recovery of 40,000 oz. Au/year is expected.

The Horse Canyon property was visited by NBMG geologists in July, 1982. At that time, the haul road which circumnavigates the south end of Mt. Tenabo was near completion. Drill roads lie along the southeast flank of Mt. Tenabo and extend for more than 1½ miles from the saddle between Mill and Horse Canyons to the southeast along the Horse Canyon drainage. The tight pattern near the saddle area suggests this may be the future site of the open pit mine.

Most of the southeastern drill roads are developed in contorted, thin bedded black carbonaceous shales, cherty shales and fine-grained siltstones of the upper plate, Ordovician Vinini Formation. Intrusive and extrusive rhyolite underlie a prominent peak about 1 mile east of the drill roads. A K-Ar age determination on sanadine from the rhyolite yielded an age of 15.3 m.y. (Wells, et al, 1971).

The most conspicuous geologic feature in the area is the presence of a bouldery, resistant rib of "jasperoid" breccia which trends northwest along (or above) most of the entire length of drill roads. The jasperoid rib lies

along the approximate trace of the Roberts Mountain thrust (mapped by Gilluly and Masursky, 1965) which juxtaposes Wenban Limestones (to the west) and the Vinini Formation (to the east). Upon close examination, the jasperoid is highly silicified, has a jumbled, bouldery appearance, displays quartz-encrusted open-spaces between breccia fragments and fractures and is heavily iron-stained. Near sample locations 1518 and 1519, the open vugs and fractures in the jasperoid and silicified host rocks are coated by abundant euhedral red, jarosite crystals. White barite vein material is found throughout the area.

Drill cuttings sampled from the area consist mainly of siliceous and carbonaceous shales. One sample contained fine-grained, disseminated sulfides. All of the drill holes observed bottomed out in siliceous facies rocks. Bedded limestones of the Wenban Formation are exposed only in the drill roads located near the saddle between Mill and Horse Creek Canyons.

The Horse Canyon deposit is hosted by upper plate rocks which are mineralized adjacent to the Roberts Mountain thrust or possibly along a high-angle structure east of the thrust contact. Mercury is present locally (re: Rossi Mine) and the mineralization may be associated with the altered rhyolitic dikes of Miocene age which outcrop along the drill roads and on the east side of Horse Canyon.

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DIVIDE DISTRICT

The Divide district is located along the ridgecrest area of the Tuscarora Mountains about seven miles northwest of Tuscarora. The major mine in the district is the Divide mine. The mine lies at an elevation of 7,400' on the north flank of an 8,400' peak named Dry Creek Mountain. Some very shallow prospects exist about three miles south of the mine in section 21, T40N, R50E (see write-up for sample location 1590). Two mine symbols are shown on the USGS McDermitt two degree sheet. The symbols are located just west of Mt. Blitzen in sections 19 and 29, T40W, R51E. These mines were not visited during our reconnaissance of the area, but are mentioned here for others who intend to examine the area in the future.

Silver and some gold was produced from the district in 1918 and 1929, but the value of the total production is less than \$5,000 (Smith, 1976).

The Divide district shares its western boundary with the Rock Creek district and its eastern margin with Tuscarora. All three districts share similarities in both geology and type of ore deposits. Like Tuscarora and Rock Creek, the Divide area is overlain by andesite to rhyolite flows and pyroclastics, including ashflow tuffs. Most of the volcanics belong to the older (Eocene) sequence of extrusives (Hope and Coats, 1976). Faulted exposures of western facies rocks are present near the Divide mine and three miles to the south when they are intruded by a partially concealed, granodiorite pluton, named the Mt. Neva pluton. The body is Tertiary in age (Coats and McKee, 1972) and also intrudes volcanics of Eocene age.

The Divide mine workings consist of older shafts and adits which were recently redeveloped by bulldozed cuts and trenches. The deposit is hosted

by rhyolitic ash-flow tuffs and minor flows. In some places, the rhyolite displays coarser and more homogeneous textures possibly indicating some of the rocks are hypabyssal in origin. However, in most exposures, the volcanics are light grey in color, flow laminated and contain quartz and sanadine phenocrysts in addition to flattened pumice and accidental sedimentary fragments. Few mafic crystals were observed.

The mineral deposits are a series of fissure veins, stockworks and breccia zones developed along a silicified north-striking fault in the volcanics. Outcrops of silicified rhyolite tuff at the Ruby claims, just south of the main Divide mine workings, display a flow foliation (defined by flattened pumice) oriented approximately north-south with a dip of 25° E. The rocks are cut by abundant vitreous grey to milky white fissure veins. Most of the veins strike north or west and are about 1" or less in width. The veins are banded, have sharp contacts with the volcanic host and show open spaced centers and cockscomb structure of the quartz. The quartz veins observed in outcrop contain pyrite and a few dark lenses of finely crystalline sulfides not readily identifiable with the handlens. Barite crystals occur in gossan cementing a breccia found on the shaft dump (sample 1591B). The breccia contains iron-stained fragments of rhyolite and quartz vein.

At the main workings of the Divide Mine, the rocks are more highly altered and brecciated. Quartz is present as stockworks and in sheeted vein systems which cut the silicified volcanics. A wide, chaotic (bouldery) breccia zone is exposed in the wall of the main trench. The zone is north or north-east-striking. Siliceous breccias scattered along the floors of the trenches contain both volcanic and sedimentary fragments. Some of the breccias show

multiple stage brecciation and veining. Often, open centered, drusy quartz veins are the last stage of veining observed. Also, late-stage aplitic dikes and barite veins intrude the breccia zone. Pyrite, iron-oxides and unidentified fine sulfides are present in the massive and vuggy quartz veins and in the fragments and matrix of siliceous breccias. Minor cinnabar and copper was also observed.

South of the main workings there are several shallow trench-like prospects developed in the area occupied by the Mt. Neva pluton. Several igneous (volcanic and intrusive?) rock types are found in the trenches, mostly andesitic in composition. No significant mineralization was observed. The prospects are most likely developed along surface shows of pyrite or iron-oxides.

Current interest in the district is evidenced by recent shallow exploration of the mineralized areas and claim staking within and surrounding the mined areas.

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- Granger, A. E. (1957) Geology and mineral resources of Elko County, Nevada: NBMG Bul 54, p. 50 and 133.
- Hope, R. A. and Coats, R. R. (1976) Preliminary geologic map of Elko County, Nevada: USGS open-file 76-779, sheet #1.
- Smith, R. M. (1976) Mineral resources of Elko County, Nevada: USGS open file-rpt 1976-56, p. 54.

EDGEMONT DISTRICT

The Edgemont district is located in northern Elko County in the central part of the Bull Run Mountains. The district encompasses a narrow area extending north from Bull Run Reservoir to Silver Creek Canyon. Most of the major mines in the district lie on the ridgecrest area or in canyons incised on the west slope of the range. The district adjoins the Aura district on the east. Because of the many similarities between the two districts, the reader is referred to the Aura district summary for further information on the geology and mineralization of the Bull Run Mountains.

The gold ores of the Edgemont district were discovered in the 1890's, almost thirty years after the discovery of silver deposits in the Aura district (Granger, 1957). Two stamp mills and cyanidation plants were erected in 1902 at the most active and productive minesites, the Bull Run and Lucky Girl Group. More than 42,000 ounces of gold and almost 33,000 ounces of silver were produced between 1900 and 1909 (Granger, 1957). Production of gold, silver and minor lead, copper, tungsten and antimony has occurred intermittently since that time.

Like the Aura district to the east, the main mines and millsites of the Edgemont district are patented. Although no activity other than claim staking was observed in most of the southern part of the district, some drill roads (exploration cuts?) were observed near the prospect located in sections 6 and 7, T43N, R52E, south of Bull Run Canyon. Additional exploration cuts, probably one to three years old, exist at several localities along the slopes of White Rock Canyon. Also the western part of the district has been the site of exploration and some mining in recent years.

The rocks underlying the Edgemont district consist of an upfaulted block of Cambrian through Devonian-aged sediments. The lower and thickest part of the section is dominated by orthoquartzites and pebbly sandstones of the Cambrian Prospect Mountain Quartzite. These rocks are abundant in the southern part of the district where they form massive, jointed outcrops and scree slopes. Phyllites and limestones overlie the quartzites to the north and are intruded by several small, mid-Jurassic stocks. All of the sediments are regionally metamorphosed, folded and cut by high-angle normal faults. South of the district, Miocene clastic rocks, mostly shales and siltstones, are domed along an anticlinal structure. In 1922 and 1956, petroleum test wells were drilled along the crown of this structure in the southern Bull Run Basin. Both wells encountered either gas or oil, but at that time the restricted Cenozoic reservoir was not deemed worthy of further exploration (Decker, 1962).

The main gold-bearing vein deposits of the Edgemont district are described in detail by Emmons, 1910. The quartz veins at the Lucky Girl and Bull Run mines are emplaced along sheeted quartzites and minor phyllites of the Prospect Mountain Quartzite. The milky white, massive quartz veins crosscut the east-striking beds of the host. The vein edges are sharp and contain some sericite. The veins range in width from 2-7' and generally strike northeast with southeast dips. They are oxidized in their upper portions and have been mined to depths of 400' or more. Their strike lengths extend for several thousand feet but are segmented by post-mineral faults. Quartz composes almost 90% of the veins. The gold is sometimes free and usually intimately associated with galena, pyrite, arsenopyrite, and occasionally iron-oxides. The silver values are usually much less than the gold. The veins may be genetically related to the White Rock stock which outcrops a few miles north of the gold

lode deposits.

At the time of our visit, we noted that some fairly recent surface exploration had been done on previously unmined vein deposits in the district. On the Burns Group of claims, a 5-10' wide pyritized and fractured quartz vein is explored by trenching for almost 150' along strike. The exposed vein strikes N5W, is steeply east dipping and occurs in phyllitic sediments of the Ordovician Aura Formation. The prospect is wedged between two dioritic stocks and as a result, both thermal and deformational (folding) effects are displayed in the host rocks.

In addition to gold and silver, there are reported occurrences of uranium, antimony and molybdenum within or near the district. The uranium occurrence, named White Rock Canyon Prospects, is located south of the White Rock stock between Echo and White Rock Canyons. The deposit was not visited, but is described by Garside, 1973.

Seven tons of antimony were produced in 1940 from the Blue Ribbon mine located in the northern part of the district near Pennsylvania Hill. Pods, veinlets and discrete crystals of stibnite occur in quartz veins which cut argillized biotite granite of the Silver Creek stock (Lawrence, 1963).

A few miles north of the district, the Indian Creek prospects (see Hat Peak 15' quadrangle for location) are developed along molybdenite-bearing quartz stringers localized in window exposures of altered Paleozoic (?) slates. The veins also contain pyrite, chalcopyrite, galena, sphalerite and the rare mineral nicollite (Ni As) (Schilling, 1968).

North of the Bull Run and Lucky Girl Group of mines the mineralogy of the fissure veins is markedly different. Scheelite and some powellite occurs in faulted quartz veins and gossan at or near the Burns mine located northwest of Porter Peak. The vein material we collected from this site contains pyrite,

galena, gossan and dark lenses of dispersed sulfides (possibly silver chlorides?). When lamped, small flecks of scheelite and powellite were observed. A minor production of tungsten (3 units of WO_3 in 1953) and a small production of lead and zinc are recorded for the deposit (Stager, in press).

Zinc-rich veins were mined in White Rock Canyon at a location described as "a few miles east of the White Rock post office." This site is probably now known as the Nevada mine (see Bull Run 15' topographic map). An unpublished report on the deposit lists assay values of vein samples which contain between 3 and 17% zinc, in addition to some silver and minor gold and copper (unpublished report from NBMG Mining District Files, #44, Report on Zinc Mine of Nevada Zinc Corporation, 1942, Elko County, Nevada). The fissure veins occur in the dioritic White Rock stock near the contact with Ordovician limestones.

Presently there are no active mines in the district. However, during 1981, small-scale mining of lead and silver was conducted by Duck Valley Ltd. at a location which is the same as or near to the Nevada mine described above.

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ELKO DISTRICT

The Elko district, which takes its name from the town nearby, includes portions of the Adobe Range and Elko Mountains which surround the town. Workings in the district are mainly associated with the oil shales to the south of town.

The following description is taken from Smith (1976).

"Oil shale and interbedded lignite were discovered in the Elko Mountains about 1870 and were explored by the Central Pacific Railroad Co., Southern Pacific Co., and others until about 1920. The oil shales were developed through inclined shafts and several thousand feet of drifts. Several types of distillation plants were tried during the years 1914 to 1920. Shale oil valued at \$1,920 was produced during 1917 and 1918, and about 15,000 gal was produced in an experimental plant in 1919. Lignite was prospected in numerous pits and shafts in hope of obtaining good fuel for locomotive and domestic use but without success. Conglomerate was quarried in the Elko Hills 2½ miles south of Elko from the Diamond Peak Formation for use as building stone prior to 1923 (Winchester, 1923, p. 93). A copper prospect about 5 miles north of Elko was explored by trenching during 1957. (This prospect could not be located in 1982). Additionally, phosphorite deposits were noted (Ketner, 1970, p. B108) in the southern Adobe Range."

The oil shale deposits of the Eocene Elko Formation are well described in several reports, the most recent being Moore and others (1983). They estimate

that the total in-place shale oil is 600 million barrels. Of this total, 228 million barrels are from beds that average at least 15 gal./ton over a 15-foot thickness; the remaining 373 million barrels represent low-grade shale that averages only 5 gal./ton over a thickness of 260-280 feet.

The oil shales of the Elko Formation could be petroleum source rocks if buried deeply enough in the surrounding valleys to generate oil. An oil well was drilled near Elko by Ladd Petroleum Corp. in 1976, but no oil shows were reported (Garside and others, 1977).

Elko Hot Springs and the adjacent Hot Hole area southwest of the town of Elko have a long history of use for spas, space heating, and other low-temperature uses (Garside and Schilling, 1979). Recently, the Elko Heat Co. began supplying heat to a laundry, bank and hotel in downtown Elko. The 80°C water is supplied by a geothermal well 1 km west of downtown Elko (Garside, 1983). Other geothermal heating customers may be added to the system in the future.

Selected References:

Garside, L. J., et al (1977) Oil and gas developments in Nevada, 1968-1976:

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Bul 91.

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Industry, 1981: Nevada Bureau of Mines and Geology Special Publication MI-1982.

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Hills and adjacent areas, Elko County, Nevada: USGS PP 700B, p. B105-B108.

Selected References (continued)

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- Lincoln, F. C. (1923) Mining districts and mineral resources of Nevada: pub. by Nevada Newsletter Pub. Co., Reno.
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- Soloman, B. J. (1979) Geology and oil shale resources near Elko, Nevada: M.S. thesis, San Jose State Univ. and USGS open-file rpt 81-709, 152 p.
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- Soloman, B. J. and Moore, S. W. (1982) Geologic map and oil shale deposits of the Elko East quadrangle, Elko County, Nevada: USGS MF-1421.
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GANCE CREEK AREA

Gance Creek is located on the east side of the Independence Range about 40 miles north of Elko via the Mountain City Hwy. The area is actually within the boundaries of the Burns Basin district but, for simplicity, is regarded as a separate area of mining activity. A few mines and prospects are scattered within and adjacent to the Gance Creek drainage. The area lies within the Humboldt National Forest.

The rocks exposed along Gance Creek are predominately siliceous, western facies sediments. The sediments consist of interbedded argillites, siltstones, shales, cherts and mudstones. Above the creek bed to the north and west, siltstones and calcareous rocks of the Roberts Mountains and Hanson Creek Formations are exposed in windows within the upper plate sequence. A north-trending range front fault runs along the base of the range just west of Saval Ranch. East of the fault the valley is underlain by rhyolitic tuffs and flows, tuffaceous sediments and coarse clastic units all of Tertiary age.

Recent activity in the Gance Creek area is related to exploration for gold and barite. The window areas in upper plate rocks near the ridgecrest are covered by Freeport Exploration Co's extensive Cal group claim block. The claims are the site of recent exploratory drilling resulting from Freeports continued search for areas of disseminated gold mineralization like that currently being mined at their Bell Mine located about 5 miles to the north (see Burns Basin district).

Within Gance Creek there are exploration cuts and prospects developed in areas of barite mineralization. The best developed barite property in the district is the Pie Creek Mine located on the divide between Pie and Warm Creek about 1 mile

southwest of Gance Creek. At this property, two small open pits explore barite-rich intervals within argillites, siltstones and shales of the Ordovician Valmy Formation (Papke , in press). The property was active during a field exam in August, 1981, but no production had resulted.

The deposit on the Black Beauty claims deserves special mention because of its unique mineralogy and occurrence. The claims are developed by several trenches which explore a bedded-sulfide deposit hosted by black shales, cherts and mudstones of Ordovician age.

Very fine-grained, unoxidized pyrite occurs in laminated rock samples with dolomite and quartz (Papke , in press). Also, pyrite and minor chalcopyrite occur in thick lenses and masses within quartz, barite and calcite vein material (sample 1607). Some of the rocks found within the trenches contain more than 50% sulfides per volume. Fluorite vein and antimony oxides are associated with the sulfide-bearing vein material. According to Papke (in press) the bedded-sulfide zones, which occur as "conformable bodies within the cherts," are rarely found within siliceous facies rocks in Nevada. Sulphur, ilmenite and sphene are also reported for the deposit. Analyzed samples contain as much as 1.0 to 1.25% titanium dioxide (Beal, 1963). A small tonnage of sulfide-rich material was produced from the deposit and used as soil additive.

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GILBERT CANYON AREA

The Gilbert Canyon area is within the Humboldt National Forest on the west slope of the Ruby Mountains about seven miles east of Jiggs.

Pegmatites containing beryl and minor amounts of columbite-tantalite and uraninite occur in the vicinity of Gilbert Creek, McCutcheon Creek and the divide between the two creeks. Two of several pegmatite dikes, one near each creek, were explored for beryl by small pits and trenches prior to 1942 (Smith, 1976). No production has been reported from the area. No recent activity was noted at the time of the field examination in August, 1982.

The area covers the northern portion of the Harrison Pass intrusive and the contact area between it and the older granite to the north. The pegmatites occur in the Harrison Pass intrusive and in migmatites which have formed along the contact of the two intrusive bodies.

In the area of our sample 1579, the pegmatite and workings related to it followed a N75°E trend. In the area between our two sample locations, the Harrison Pass pluton graded from granodiorite, quartz monzonite into migmatite, with pegmatitic zones and quartz veins. Huge perthitic feldspar weathered out from the intrusive can be seen in float. At sample site 1580, pegmatite dikes containing smoky quartz, perthitic feldspar, muscovite, and small tantalite crystals cut a large outcrop of quartz monzonite. Beryl crystals up to ½ inch in diameter occur intergrown in the pegmatite.

The Gilbert Canyon area is one of many small beryl occurrences which seem to be associated with the Harrison Pass stock. Other areas are near Corral Creek to the south, in Dawley Canyon and Hankins Canyon on the east side of the Ruby Range, and at the Star tungsten mine in Harrison Pass.

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GOLD BASIN DISTRICT

The Gold Basin or Rowland mining district is situated on BLM land in northernmost Elko County. The main workings in the district lie above the Bruneau River near the town of Rowland. A few prospects are located east of Rowland between Taylor Creek and Deep Creek and on the north side of Bearpaw Mountain.

Production of a "small amount of gold" in addition to some silver and copper are credited to the district. Most of the production came from the Bruneau mine, the best developed mine in the district. A stamp and amalgamation mill was constructed in 1927 at Rowland to process ore from this mine. Three years later a cyanide annex was added (Smith and Stoddard, 1932). Some placer work was done in the early years along parts of the Bruneau River and smaller tributaries. Production from these deposits was apparently insignificant (Vanderburg, 1936).

The geology of the region is moderately complex. The oldest and best mineralized rocks are Paleozoic sediments. The sediments have undergone at least three periods of deformation and are therefore folded, faulted and, in several locations, thrust. (Bushnell, 1967). The lack of fossils and complicated structural history of the area make correlations with known stratigraphy difficult. In addition, the sediments display an early, low-grade regional metamorphism which is locally overprinted by contact effects produced by the intrusion of the mid-late Cretaceous Deep Creek stock. The basement geology of the area is further obscured by deposits of recent pyroclastic flows erupted during the Tertiary.

According to literature sources, the gold is localized in quartz veins and fissure fillings which commonly occupy secondary fractures or faults developed in the upper Paleozoic sediments. The host sediments consist of argillaceous rocks and interbedded shales, limestones and quartzites.

The Bruneau mine was visited in June, 1932 and later described in an unpublished report by Smith and Stoddard, 1932. They describe the deposit as follows:

"The vein is in a shear zone in Paleozoic sedimentary rocks, here principally interbedded quartzite and limestone. The strike is N. 40° W., and dip about 70° NE, width about 4 feet. On the south side of the vein the Paleozoics dip steeply to the south or stand vertically. On the north side they are rather flat, indicating much movement and a strong fault. The vein material and ore is brecciated, iron-stained quartz, shale, quartzite and limestone. The ore is said to run \$8.00 per ton.

A lower tunnel is 600 feet vertically above the river level, and 900 feet long, driven on the vein. An upper tunnel, about 100 feet above the lower, is 100 feet long. One substantial ore shoot has been stoped out between these tunnels."

The relative unproductivity of the vein deposits in the district may be explained by Bushnell's observation that the Deep Creek stock was emplaced at a lower temperature and contained less fluids than the Coffeepot stock located to the south (see Alder district). Contact metamorphism adjacent to the Deep Creek stock produced hornfelses and marbles, but no tactite bodies.

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GOLD CIRCLE DISTRICT

The Gold Circle mining district is located in western Elko County at the townsite of Midas. Some authors and many Nevadans simply refer to the district as Midas. The low ridges just east of Midas are covered by extensive underground and surface workings which are concentrated in a northwest trending belt approximately 4 miles long and 1 to 2 miles wide. This belt of mineralization occupies the central portion of T39N, R46E. Two mines, the Eastern Star and Red Arrow, are located outside of the main district about 3 miles to the northeast of the town of Midas.

In terms of the total quantity of silver and gold produced prior to 1949, Gold Circle ranks third in Elko County, outranked only by the Tuscarora, Jarbidge and Aura districts (Granger, 1957). Between 1950 and 1965, existing stockpiles and dumps were reworked and contributed an additional 242 oz. gold, 4,484 oz. silver and some copper and zinc to the districts' total recorded production (Smith, 1976).

Small scale mining of a few vein deposits has occurred intermittently since the last actual production. During 1982, the Ripsaw mine, located in a canyon one-half mile northeast of Midas, was an active open-pit gold operation employing 4 persons. However, when we visited the district in the summer of 1982, most of the mines were inactive. Nevertheless, many of the properties are covered by valid claims. Recent assessment work has been done on several of the claims and a few dumps show evidence of recent sampling.

The geology and ore deposits of the Gold Circle district are well described by Emmons, 1910, Rott, 1930 and Smith 1976. The district is entirely underlain by Tertiary volcanics. Rott, 1930, recognized three stratigraphic

divisions in the main part of the district. From oldest to youngest, these units are pre-andesite rhyolites, andesites and post-andesite rhyolites. All the units are altered or mineralized, faulted and intruded by dikes. The rhyolites are the most dominant lithology in the district. They consist of flows, ignimbrites and pyroclastics interbedded with minor tuffaceous sediments and clastic rocks. Throughout much of the district, the rhyolites host the majority of vein deposits, but because of extensive alteration at the minesites it is extremely difficult to distinguish between the pre and post-andesite rhyolites in the field. Felsic and mafic dikes intrude fault zones within and near the mineralized areas. Some of the dikes are altered or pyritized and are probably, in some way, associated with the process of mineralization.

The Tertiary volcanic group described above is unconformably overlain by unaltered and unmineralized rhyolitic welded tuffs (Cougar Point Tuff) dated at 12.2 m.y. (Roberts, et al., 1971). These rocks are little disturbed by faulting.

The individual ore deposits of the central district display similarities in their mineralogy and occurrence. In most cases, adjacent mines explore separate portions of the same vein along strike. Rott, 1931, describes five or more of these extensive vein systems and their related ore shoots.

The veins typically fill sheeted, shattered, or brecciated zones developed along faults. The mineralized structures generally have strikes which range from N10W through N40E and are steeply inclined or vertical. In general, the zones are explored for widths of 10' or less. The faults often form rhyolite-andesite contacts and are avenues for intrusive dikes.

Rott, 1930, states "the veins were formed along open fissures or zones of brecciation which existed during the period of mineralization." Milky white to glassy grey quartz is the main constituent of the veins, although calcite, adularia and rarely chlorite also occur (Rott, 1931). The quartz often has a sugary appearance. In outcrop, the fissure veins have sharp contacts with the altered wallrocks, are typically open-centered, and display cockscomb or ribbon structure of the quartz. Siliceous breccias are also common. The breccias contain fragments of altered volcanic rock, pyritized quartz vein and gossan. They are cemented by chalcedonic or prismatic quartz, which often encrusts fragments. Several generations of brecciation and veining are evident, indicating repeated periods of movement and silicification along the fault zones. Altered wallrock and vein material collected from the dumps contained sparse to moderate amounts of pyrite, some arsenopyrite, gossan and iron-oxides.

Alteration of the wallrocks at the minesite is intense and often traceable along strike for several thousand feet. The vertical extent of the veins reach up to 550' (Buchanan, 1981). Immediately adjacent to the veins, the rocks are strongly silicified, argillized or sericitized and show abundant pyrite or iron-oxides. Fine stockworks of vitreous grey quartz extend outward from the main veins into the bleached and silicified wallrock. The rocks exposed in the steep-sided walls of the stopes are generally highly fractured but uncaved. Occasionally the rhyolite is kaolinized to soft, friable masses. Away from the veins alteration decreases rapidly and the rocks are typically propylitized or bleached.

The vein mineralogy, as described by Rott, 1931 and Buchannan, 1981, includes pyrite, stromeyerite (CuAgS), native gold, tetrahedrite, argentite,

native silver, stephanite (AgSbS), and polybasite (AgCuSbS). Few metallic minerals other than pyrite were observed in dump samples from the district. This may indicate that the narrow high-grade vein deposits were entirely mined out. Only the mineralized breccia material which is of lower grade than the vein deposits remains (Roberts, 1971).

The deposits at the Eastern Star mine and Red Arrow claims deserve special mention as these deposits differ from those of the central district.

At the Eastern Star mine, an outcrop of highly siliceous, hydrothermal breccia forms a resistant knob directly north of the main shaft. The breccia contains both volcanic and sedimentary fragments suspended in an iron-rich matrix composed of grey silica and comminuted rock fragments. The sedimentary fragments consist of fine-grained quartzites and siltstones. The age and origin of the fragments are not known but it is possible they are pre-Tertiary in age and were brought up from depth along the breccia zone.

Numerous north-striking, vertical fissure veins cut across the breccia outcrop. The veins are about 1" in width; have open centers filled with prismatic quartz and display quartz-sulfide banding. The veins cut across breccia fragments and are (themselves) crosscut by a network of fine siliceous veinlets. A sample from the dump showed fine-grained, free gold localized in glassy grey aphanitic quartz deposited along the selvage of a limonite-stained, banded vein. In addition, dark lenses of sulfides dispersed throughout the vein may contain abundant silver, as native silver and tellurides are both reported to occur at this location (unpub. report, NBMG mining district files). Sulfides, mostly pyrite, are disseminated in a silicified, dark grey spherulitic rhyolite, which is found in abundance at the minesite. Black

carbonaceous shales are exposed about five hundred feet north of the mine.

The Red Arrow claims are located one mile north of the Eastern Star mine. Rhyolite flows and tuffs are host to a cinnabar-bearing vein deposit which occupies a set of north, northeast and northwest fractures. The veins are white opaline quartz deposited as banded and botryoidal masses along the fracture surfaces of the rock. In addition to cinnabar, the veins also contain marcasite. Near the veins, the host rocks are silicified or altered to clays and iron-oxides. Two retorts are located on the property but appear to have had little use.

An age determination on vein adularia from the main Gold Circle district indicates the mineralization took place 15.0 m.y.a. (Roberts, et al, 1971).

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GOOD HOPE DISTRICT

The Good Hope district is located in a remote area on the northwest slope of the Tuscarora Mountain Range, northern Elko County. The I-L Ranch is located about six miles north of the district and Tuscarora lies approximately fifteen miles to the southeast. The district is bordered on the south by the Rock Creek district.

Silver was produced from the volcanic hosted vein deposits in the early 1880's and again in 1921 (Granger, 1957). A total of about 91,000 ounces of silver were produced. Since tonnage amounts were not recorded, the grade of the mined ore is not known. In addition to silver, several thousand pounds of antimony were produced in 1950 (Smith, 1976).

There are three principal mine areas in the district. The mines occur in various sections of T41N, R49E in the northwest corner of the Mt. Blitzen 15' quadrangle. From west to east the mines are named the Buckeye and Ohio, Good Hope and Amazon. The Buckeye and Ohio is the best developed and was the largest producer in 1880's. A 5-stamp mill was constructed along Chino Creek (?) to process the silver ores from this mine (Emmons, 1910).

All three mine locations were visited briefly during our examination of the district in August, 1982. The workings appear old, are mostly slumped or caved and some are filled with water. Emmons, 1910, reports the mines were inaccessible at the time of his visit in 1908. Although most of the district is covered by current claims, there was no sign of recent exploration activity. Evidence of fairly recent surface work, however, was seen at the Buckeye and Ohio mine.

The geology at the minesites is not well exposed. The poor exposures are due to slumping, weathering and alteration of the wallrocks.

The northern part of the Tuscarora Mountain range is predominately

composed of rhyolite flows, andesite flows, and ash-flow tuffs. Paleozoic sediments are exposed locally in windows or in faulted blocks. At Good Hope, there are a few, small exposures of siliceous, western-facies rocks localized in the north-central part of the district. The rocks are mainly quartzites of the Ordovician Valmy Formation. (Smith, 1976).

A large portion of the district is covered by a sequence of Eocene (?) volcanic rocks composed of rhyolite to dacite ignimbrites and andesite flows and pyroclastic rocks (Hope and Coats, 1976). These units are overlain by younger Oligocene equivalents, which are best preserved in scattered erosional remnants lying outside the main district. According to Knox, 1970, the contact between the younger and older volcanic packages is an unconformity. Younger basalts (10±0.5 my) flank the range to the north. (Hope and Coats, 1976).

Mineralization in the district is apparently hosted only by older (Eocene) densely welded, rhyolitic ash-flow tuffs which are cut by andesitic dikes (Knox, 1983). The ore minerals occur in narrow quartz veins and gangue localized along north to northeast - striking, high-angle faults. The zones are sheeted and contain altered and mineralized wallrock fragments (Emmons, 1910). The veins reportedly contain dark ruby silver, pyrargyrite, freibergite (argentiferous tetrahedrite), arsenopyrite and stibnite (Lawrence, 1963; Emmons, 1910). Dump samples collected from the district consist of sheared milky white to vitreous grey, vuggy quartz vein and bleached, silicified and sericitized wallrock. The samples contain abundant unoxidized pyrite and are coated by red and green-colored oxides possibly derived from iron, arsenic or antimony minerals. Some of the samples are so rich in pyrite they smell of sulfur. Clots of unidentified fine-grained metallic minerals were unidentified in hand sample but are probably silver or antimony sulfides.

The silver and antimony bearing veins of the Buckeye and Ohio Mine are described by Lawrence, 1963 and Emmons, 1910. Lawrence erroneously named the mine the Good Hope but gives a location and description which fits the Buckeye and Ohio. Quartz veins were deposited along two cross-cutting faults. Antimony oxides occur in the northeast cross structure and pods, veinlets and crystals of stibnite associated with white and yellow antimony oxides occur in the main north-northeast-striking fault zone. The ore-bearing portion of the main vein is about a foot in width (Emmons, 1910). Vein material collected from the dump contains abundant prismatic and twinned crystals of arsenopyrite.

Although the geology at the Good Hope mine is poorly exposed, rhyolite north of the mine and andesite to the south are notably bleached, silicified and iron-stained. The main shaft is sunk on a northeast-striking, northwest-dipping shear zone which is highly iron-stained. One half to 1" wide, east-west striking quartz veins cut the altered andesites. These veins are possibly post-mineral as indicated by their compact, sugary appearance (which differs from the more vitreous vein material found on the dump), cross-cutting orientation and lack of obvious mineralization.

The workings at the Amazon mine are badly slumped and weathered. Argillized and sericitized rhyolite tuff is the predominant rock type in the mine area. The workings are oriented along a northeast-striking fault shown on the geologic map of Hopes and Coats, 1975. The minesite consists of several prospects. The northeastern prospect is developed in black, indurated (silicified?), massive, carbonaceous shale or mudstone of probable Paleozoic age. The rock (sample 1598 A) contains minute discontinuous quartz encrusted vugs filled with fine-grained sulfides.

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HALLECK DISTRICT

The Halleck district of Whitehill, 1875 and Smith, 1976 covers a small area adjacent to Secret Creek in the north western portion of the Ruby Mountains and the west portion of the East Humboldt Range. Much of the area is under private ownership.

The district was first organized in 1873 after soldiers discovered gold and silver-bearing "vein" deposits "on the northwestern slope of the Ruby Range, about 6 miles from Fort Halleck" (Whitehill, 1875). The deposits apparently didn't warrant further development or may never have existed as currently the district contains only one patented placer mine and a few very minor prospects. The placer mine, named Hawthorne Placer, is located in the south western East Humboldt Range in sections 35 and 36, T35N, R59E.

The northern most part of the Ruby Mountains south of Secret Creek are predominately underlain by Precambrian through Ordovician metaquartzites and schists. Biotite-quartz monzonite gneiss of Mesozoic age encircles the Secret Peak area. North of Secret Creek the rocks consist of Mississippian through Permian limestone conglomerates and siltstones overlain on the flanks of the range by Tertiary sedimentary and volcanic rocks. The rocks in both areas are complexly deformed along numerous high-angle and low-angle faults.

Several areas within the Halleck district were examined for signs of past or present mining activity. Locations of mine areas cited in CRIB (see mining district folder for Halleck district) and the one or two active claims in the area were briefly examined. No sign of any mining activity was noted in any of the areas except for two shallow prospects located in sections 30 and 31, T35N, R60E about 1 mile north of the Secret Pass Hwy. The prospects are developed along a silicified fault contact between thickly bedded dolomitic limestones of Permian (?) age and chert-quartzite conglomerates of the Diamond Peak Formation (?). Calcite and quartz veinlets cut the bleached limestone at the prospect. Some samples show

slickensides. The conglomerate forms low ledges directly north of the sampled prospect. It is heavily iron-stained and cut by fine siliceous veinlets. No significant mineralization was noted in either rock type.

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- Howard, K. A., et al (1979) Geologic map of the Ruby Mountains, Nevada: USGS MI Map I-1136.
- Smith, R. M. (1976) Mineral resources of Elko County, Nevada: USGS OFR 1976-56. p. 80.
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HICKS DISTRICT

Information on the mines and history of the Hicks district is very sparse. It is likely that because of its' small size and production, the district never achieved distinct recognition and was simply regarded as part of the proximate Mountain City, Alder or Gold Basin districts. The district was probably named after Hicks Mountain and Hicks Creek, which are located along its northern boundary. The entire district lies within the Humboldt National Forest.

The exact locations of the mines are not known but most of the mining activity probably occurred in the McDonald Creek area, especially on Enright Hill. Two mines are shown on Enright Hill on the Wells 2° sheet (1970), although none appear in that area on the more dated Mountain City 15' quadrangle (1936). Since we were not able to visit the properties during the course of this project, nothing is known about the current status of the mines. Smith (1976) includes the Silver King mine in the Hicks district. However, an active lead-silver mine named the Silver King is located some distance southwest of Mountain City (Ungina Wongo 7½' quad) and this mine is more appropriately included in the Mountain City district. The best located mine in the district is the McDonnell, or McDonald lode and millsite. The mine and millsite are patented. The claims are located on Enright Hill in section 8, T46N, R55E. A few recent unpatented claims are scattered throughout the rest of the district.

The district produced small quantities of gold, silver, lead and zinc. Some copper was also produced as a by-product.

The mines on Enright Hill are shown on the preliminary geologic map of Elko County (Hope and Coats, 1976). Several east-west directed thrusts are mapped in the area. The northern mine, called the Silver King by Smith (1976),

occurs in limestones and conglomerates of the Mississippian Banner and Nelson Formations. The southern mine, named the McDonald, is located less than one mile to the south. It is developed in siltstones and shales of the Mississippian Chainman shale. Approximately one mile southwest of the mines the sediments are intruded by a small body of Jurassic(?) diorite. The mineralization may be related to the intrusive body or to the numerous faults which dissect Enright Hill.

At the Mendive prospect located north of McDonald Creek, yellow antimony oxides reportedly occur from the oxidization of antimony-silver sulfosalt (Lawrence, 1963).

Selected References:

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- Lawrence, E. F. (1963) Antimony deposits of Nevada: NBMG Bul 61.
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ISLAND MOUNTAIN DISTRICT

The Island Mountain mining district is located in northernmost Elko County. It occupies the southeast flank of Tennessee Mountain and the dry, mountainous area south of Tennessee Mountain which includes Cornwall Mtn., Cornwall Basin and Rosebud Mtn. The north half of the district is in the National Forest, the southern half is under BLM administration. The district's present name is derived from a prominent hill located along its southern boundry. Various portions of the district were formerly known as the Wyoming, Gold Creek and Mardis mining districts.

Between 1873, when the first placer deposits were discovered, and 1900, two boomtown settlements, Penrod and Gold Creek, sprouted in the southern part of the district. The towns were created in response to the discovery and mining of prosperous placer deposits located along Gold Creek, Hammond Canyon, Coleman Canyon, Penrod Creek, Big Ben Creek, Poorman Creek, Mill Creek and Martin Creek. Although the unavailability of water hampered mining of the placers, an estimated 40,000 ounces of gold were recovered by 1901, making it one of the most successful placer areas in the state of Nevada. Intermittent mining of the deposits through 1958 produced an additional 740 oz. of gold and 252 oz. of silver (Smith, 1976). Today, the area is blanketed by numerous patented claims and mining of the deposits occurs on an occassional basis.

Replacement and vein-type lode deposits, which are probably the source for the placer gold, were discovered early in the history of the district, but not actively developed until the mid 1900's. The best developed mines of this type are located on the southeast flank of Tennessee Mountain and on Rosebud and Cornwall Mountains. In addition to the main mines, numerous prospects and exploration cuts are present on the hillsides throughout the area.

The area underlying the district, as mapped by Coash (1967) and Bushnell (1967), is composed of a highly segmented, commonly fault juxtaposed section of lower and upper Paleozoic limestones and fine clastic sediments. The sediments are deformed and overlain by extensive Tertiary rhyolite flows and tuffs, minor andesite flows and small pockets of placer gravels and bouldery alluvium. Northeast-striking faults cut the sediments and volcanics and are displaced by more recent northwest-striking structures. Apparent recent movement of the north and northwest-striking faults is indicated by the tilting of gravels along one of these structures in the lower Gold Creek drainage (Coash, 1967).

The St. Elmo Mine, located on the northeast flank of Cornwall Mountain, is developed in gold and silver-bearing quartz vein hosted by Cambrian Prospect Mountain quartzites. The veins are emplaced along a northwest-striking fault which parallels one of the younger faults mapped in the area. The source of the vein is not certain since the mine is situated several miles from the nearest outcropping intrusive. Production from the mine is not known. During 1980 and 1981 the mine was worked on a small scale as an underground operation. (Schilling, 1980 and 1981).

Located one mile north of the St. Elmo Mine are the most productive workings in the district, the Rosebud and Diamond Jim (formerly Mardis) mines. The mines explore fissure vein and shear zone deposits that contain lead and silver sulfides, in addition to some copper and gold (Bushnell, 1967). At the Diamond Jim mine, mineralized quartz gangue fills a northwest-striking structure about 9 feet wide (Bushnell, 1967). The mine has been productive intermittently since 1950 and was listed as a small scale, open-pit gold and silver operation during 1980 and 1981. (Schilling, 1980 and 1981).

Coash (1967) notes that the mineralization found along fault zones in the district is post-volcanic. However, the vein deposits, which usually occupy fault

structures, occur only in pre-Tertiary rocks. These deposits may in fact be related to an earlier intrusive episode, being emplaced prior to or during volcanism.

A small stock intrudes thin-bedded Permian sediments in the west-central part of the district. This body is less than one square mile in area and underlies the ridge between Hammond and Coleman Canyons. Coats (1972) states that the intrusive ranges in composition from a hornblende-biotite diorite to a quartz monzonite. The body is probably Jurassic or Cretaceous in age. The siliceous sediments lying within one mile of the intrusion are hornfelsed and show slight epidotization (Coash, 1967). Where the body intrudes limestone beds, small replacement deposits formed. These deposits have yielded only small amounts of gold, silver and copper. Quartz veins associated with this body carry minor gold and silver with smaller amounts of stibnite, sphalerite and tetrahedrite (Coats, 1972).

The Coffeepot stock forms the northern boundary of the district (see Alder district for a description of the stock). The Little Joe Tungsten mine lies near the contact between the stock and thin-bedded limestones and phyllites. Dikes and veins associated with the stock occur in the mine area. Scheelite reportedly occurs in tactite (averaging 0.11% WO_3), in calcite veins and in quartz veins. The overall grade and size of the deposit is less than similar deposits located to the northwest in the Alder district. Past production from the deposit totals only a few tons of quartz vein material which contained 3% WO_3 (Johnson, 1963).

In 1941 and 1942, a small amount of antimony was produced from the Gribble antimony (Star Metal) mine located on the lower southern flank of Tennessee Mountain. Pods of stibnite occur in quartz veins which occupy a northeast-striking breccia zone within thin-bedded limestone and shale of the Pennsylvanian Tennessee Mountain Formation (Lawrence, 1963). The deposit is apparently within

the contact zone developed adjacent to the Coffeepot stock as scheelite is also present, occurring within fault zones and in stringers of calcite. According to Bushnell (1967), the ore produced from this mine contained 0.9-1.5% tungsten, 27% antimony and small amounts of lead and zinc.

North of Wild Horse Reservoir in the southwest corner of the district are several claims developed by shallow bulldozer pits and trenches. The claims, named Goodluck, Mystery, Good Morning and Pot Luck, explore an occurrence of uranium in Tertiary rhyolites and tuffs (Garside, 1973).

Selected References:

Bushnell, K. (1967) Geology of the Rowland quadrangle, Elko County, Nevada:

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Coash, J. R. (1967) Geology of the Mount Velma quadrangle, Elko County, Nevada:

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IVANHOE DISTRICT

The Ivanhoe district is located in the Battle Creek Range, in T 37-38N, R47-48E about 70 km. northeast of Battle Mountain and 20 km. southeast of Midas. The workings in the district, which are entirely for mercury, consist of numerous open pits, trenches, adits, stopes, and shallow shafts.

Mercury was discovered in the Ivanhoe district in 1915; production was intermittent through 1928, and then continuous until 1947. A few flasks of mercury were produced in the late 1950's and early 1960's (Smith, 1976). Bailey and Phoenix (1944, p. 55-63) describe the geology of the individual properties and their production. Production is also summarized in Smith (1976, Table 29). In 1982, shallow rotary drilling for gold-silver mineralization was conducted in and below blanket-like zones of silicification (opalite) in the southern part of the district. A few drill holes were apparently drilled in this same area in 1979 as part of a uranium exploration effort.

The ore deposits in the Ivanhoe district consist of cinnabar disseminated in amorphous and cryptocrystalline silica (opalite) or coating fractures. The ore bodies are either flat (blanket) or localized along steep faults. Opalite is extensive in the area, but ore bodies reportedly occur only in opalite produced by the silicification of the more rhyolitic of the Tertiary volcanic and tuffaceous rocks which are present in the area. Only the blanket deposits have proven commercial although some of the steep deposits have been extensively explored.

The gangue minerals include chalcedony, alunite, montmorillonite, and rarely sulfur, barite, and quartz. The grade of the Silver Cloud deposit, for example, averaged about 5lb/ton (Smith, 1976).

The Ivanhoe deposits exhibit many of the features of opalite-type mercury deposits as described by Bailey and Phoenix (1944, p. 17-21). The alteration assemblage at this type of deposit is characterized by extensive silification along

faults and of favorable porous strata. Argillic alteration is locally present below or peripheral to areas of silicification. The rocks exposed in the Ivanhoe district consist of Tertiary rhyolitic ash-flow tuff, hypabyssal intrusive rocks, air-fall tuff and tuffaceous lacustrine rocks. The Ivanhoe area may be a caldera, but no detailed mapping of the area has been done.

Several of the deposits exhibit features which suggest that the deposits were formed at quite shallow depths. Siliceous spring sinter was recognized at a locality near the Old Timer Mine; probable subaqueous opalite and cinnabar deposition and hydrothermal brecciation was noted at the Rimrock Mine. Also, the blanket deposit at the Silver Cloud Mine is believed to be the result of hot spring activity in a lacustrine environment. This is suggested by the even, gently sloping bedding of the volcanics and the presence of yellow coatings of mercury chloride which occur with cinnabar and metacinnabar.

The age of the host rocks in the Ivanhoe district is not known; they may be equivalent to 14 m.y. rhyolitic rocks which are dated in northern Lander County about 40 km. to the southwest (McKee and Silberman, 1970). Miocene vertebrate remains are reported from a unit which is probably equivalent to the syngenetically mineralized beds at the Silver Cloud Mine. However, some rhyolitic intrusive rocks may be post-mineral, as at the Rimrock Mine. Thus the age is believed to be that of at least some of the volcanic rocks in the district, probably middle Miocene.

Selected References:

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- Smith, R. M. (1976) Mineral resources of Elko County, Nevada: USGS OFR 1976-56.

IZENHOOD DISTRICT

The Izenhood district is located on the west side of the Sheep Creek Range about 40 km. north of Battle Mountain. The known workings which are confined to the south half of T36N, R45E, consist of a few pits and shallow shafts less than 15 m. deep. Many of the workings are not accessible by motorized vehicle, and can not be readily seen from a distance. The prospects are shown on a map by Anctil (1960).

Wood tin was discovered in 1914 in a wash about 1 km. north of Izenhood Ranch. This discovery led to a small rush, and several shafts and prospects were sunk on both lode and placer properties. There was some renewal of activity in the 1930's, and in 1952 (Stewart and McKee, 1977). The area received some exploration activity in the early 1980's as a possible deep porphyry molybdenum target.

The tin mineralization at Izenhood occurs in narrow veinlets, 1-50 cm. wide, which have erratic strike and dip. Lodes 1-2m. in width made up of several narrow veinlets average less than 0.1% tin and cannot be mined economically. Some sorted ore is reported to contain over 7% tin (Vanderburg, 1939). There is no recorded production from the district, but small quantities of sorted ore and concentrate may have been sold (Stewart and McKee, 1977).

" The following description of the mineralization is summarized from Fries (1942). At Izenhood, minor tin-bearing veinlets occur in topaz-bearing, alkali rhyolite flows and domes. The veinlets contain specularite, cassiterite, sanidine, andradite, cristobalite, tridymite, quartz, chalcedony, fluorite, and opal. All these minerals, except possibly cassiterite, together with topaz and pseudobrookite, are likewise present in gas cavities that are widely distributed in the rhyolite. The deposits are believed to have been deposited from fumarolic gases; these gases were most likely generated from rhyolites comagmatic with the wall rocks or from

gases released during high-temperature devitrification of the rhyolite which contains the veinlets." (Garside, 1982).

The rhyolites which form the wallrock for the tin veins are part of an extensive rhyolite flow and dome complex in the northwestern part of the Sheep Creek Range. These rhyolites occur at the intersection of two major structural elements, the Oregon-Nevada lineament and the Midas Trench. Except for some silicification and argillization along the tin veins, the majority of the rhyolites in this extensive complex are little altered. Anctil's (1960) map shows several bleached and iron-stained areas in the rhyolite for about 3 km. to the north of the tin prospects. The rhyolites have been dated at about 14 m.y. (McKee and Silberman, 1970). Presumably the tin deposits are of approximately the same age, if they are directly associated with the period of silicic magmatism.

Selected References:

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County, Nevada: NBMG Bull. 88, p. 82-83. 120

LARRABEE DISTRICT

The Larrabee district is located in the Sulphur Spring Range in the vicinity of Pony and Hot Creeks. The district lies between the Robinson Mountain district to the north and the Union and Mineral Hill districts to the south. There are only two mines and one prospect in the entire district.

At the Jay claims on the west flank of the range, barite-bearing veins replace Devonian dolomites along an iron-stained, brecciated fault zone. There are two areas within the claims explored by open pits and trenches. At one location, the veins strike N50E and are nearly vertical. Barite makes up a small portion of the vein, the rest consists of brown jasper and veinlets and masses of specular hematite and gossan (Papke, in preparation). Iron-rich jasperoid breccias outcrop near the mine areas.

The Sam, Pat and Mic claims are located on the east flank of the range along Pony Creek. The claims extend over several sections but the old underground workings and recent exploratory drilling are located mainly in sections 15 and 16, T28N R53E. There is virtually nothing known about the early history of the deposit except that in the past the area was known as Copper Creek and is accredited for the production of a small amount of copper and silver (Smith, 1976). During 1981, Mt. Hope Mining Corp. and Webb Exploration Co. conducted fairly extensive exploration work on the property, including rotary drilling on the slopes above and below the old workings. A glory hole at the site exposes a bedded section of gently dipping, light brown dolomitic limestones of Devonian age. The rocks are fractured, sheared and mineralized along a splayed fault zone which is north to northeast-striking and vertical in attitude. The exposed width of the zone is about 10'. Malachite, brochantite, azurite and chrysocolla coat fracture surfaces, occur in veinlets and

replace wallrock and breccia fragments within the fault zone. The best copper mineralization occurs in replaced limestone breccia fragments caught up in the main zone. Some late-stage copper filled veinlets cut across the breccia fragments indicating there were several periods of copper mineralization associated with fault movement. Iron oxides are abundant in the mineralized zone and some barite vein material was also observed. Oxidized and iron-stained material on the dump may contain silver in addition to copper. Across the drainage $\frac{1}{2}$ mile east of the deposit is a conical hill underlain by Jurassic Frenchie Creek Rhyolite (?) (Smith and Ketner, 1978).

Occurrences of zeolitized rock cover portions of sections 17, 20, and 29, T28N, R52E on the east side of Pine Valley. The area is explored by trenching, stripping and drilling. Three zeolitized tuff beds occur with lacustrine mudstones in the Plio-Pleistocene Hay Ranch Formation. Several different varieties of zeolite minerals are present in the deposit, the most common mineral associations being erionite-phillipsite and erionite-clinoptilolite - phillipsite (Papke, 1972).

Selected References:

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Smith, R. M. (1976) Mineral resources of Elko County, Nevada: USGS OFR 1976-56, p.101.

Also see general reference list for Pinon Range.

LEE DISTRICT

The Lee district is located on the western slope of the Ruby Mountains about 10 miles southeast of Lee. The main mines in the district are situated at elevations above 8,000' along the steep slopes of Long and Segunda Canyons. For convenience, a uranium prospect located about 4 miles northwest of Lee is also included in the Lee district. The district is bordered on the east by the Ruby Valley district.

Much of the early production from the Lee district, following its discovery in 1869, was derived from the B.B. and American Beauty mines. In latter years, most of the ore came from the Knob Hill mine. In all, about 1,400 tons of ore were produced containing lead, zinc, copper, silver and minor gold (Smith, 1976). There has been no production from the deposits since 1959.

The rocks exposed along Long Canyon are composed of metamorphosed limestones, dolomites and quartzites of Precambrian through upper Cambrian in age. In this part of the range, the sediments are "complexly folded and extensively intruded by various plutons." (Wilden and Kistler 1979). A stock exposed along the drainage in the west central part of Long Canyon is composed of granite and quartz monzonite. This small body is one of many isolated exposures of a Jurassic pluton which underlies the northern third of the Ruby Mountains (Wilden and Kistler, 1979). Therefore, the sediments are roof pendants and are commonly highly metamorphosed and pervasively invaded by irregular igneous bodies, dikes and veins emplaced during multiple staged intrusive episodes.

The host rocks of the vein mineralization at the American Beauty mine are coarsely crystalline, foliated white marbles and white mica schists. The sediments are locally intruded by irregular bodies of foliated monzonite, quartz monzonite and pegmatic and aplitic dikes of similar composition. The minesite consists of

several east-trending adits, now caved, which explore massive to ledgy, horizontal to gently east-dipping "beds" of marble. No vein was exposed in place but according to Smith, 1976, the mineralized veins strike northwest and dip southwest. From the dumps we collected vitreous grey and white quartz vein material containing irregular lenses and pods of galena, sphalerite and an unidentified fine-grained sulfide or sulfosalt mineral (sample 465). The quartz and sulfide-rich lenses are crudely banded and some samples show late-stage quartz-pyrite veinlets. Iron oxides and gossany portions in the vein material probably indicate that the upper portion of the deposit was oxidized. No activity of any kind was noted at the minesite. The most recent sign of mining activity in the canyon was at the Knob Hill claims where several large cuts were made in the vicinity of the old underground workings.

Anomalous radioactivity of up to 1,000 cps was measured in grey vitrophyre at the Opal and Opal Annex claims located in section 34, T32W, R56E. A sequence of vitrophyre and devitrified tuff are explored by several north-south trenches which are about 5-10 years old. The host rocks according to Garside, 1973, are part of the late Tertiary Humboldt Formation. Locally, the laminated volcanics contain lenses of brown opaline material. Breccia found on the floor of the trench is cemented by volcanic glass which shows early stage devitrification textures.

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LIME MOUNTAIN DISTRICT

The Lime Mountain district is located in northern Elko County. The district occupies Lime Mountain, a 7,000' peak which forms the southern tip of the Bull Run Mountains. The main mines in the district are located in the eastern half of section 1, T42N, R51E about halfway up the east slope of the peak. The Lime Mountain area and most of the rest of the southern Bull Run Mountains is BLM administered. However, a few of the mines and the millsite are patented.

Much of the early history of the district is not known, but Emmons, 1910, indicates the district was discovered at about the same time as the Edgemont district which adjoins it on the north, i.e. circa 1870-1890. Production figures given by Smith, 1976, begin in 1918 and span through 24 years of mining activity. The main commodity produced during this time was copper. Significant quantities of silver, gold and zinc were also produced. In total, almost three times more silver was produced than gold (25,795 oz. Ag/8,423 oz. Au). Ninety-five percent of the recorded production was derived from the Lime Mountain Mine. Prior to 1918, the most productive mine in the district was the Eldorado.

Although the district has been relatively inactive since the 1950s, the presence of patented and unpatented claims in the area suggests at least a limited interest in the deposits. Since the main adits were driven, some minor prospecting has been done adjacent to the mines and east of Lime Mountain.

The geology of Lime Mountain as mapped by Bushnell, 1962, consists predominately of Cambrian sediments which grade from an older basal quartzite unit on the west into younger phyllites and limestones on the east. All of

the prospected ore deposits occur in the limestones of the upper Cambrian Porter Peak Formation. Although not shown on Bushnell's map, several high-angle faults disrupt the otherwise consistent north-east strike and south-east dip of the bedded sediments at the mine sites. The Trail Creek thrust fault lies directly north of Lime Mountain. North of the thrust, the siliceous sediments of the upper plate are intruded by a plug composed of porphyritic andesite. The plug, which forms the southern half of Wilson Peak, is considered to be post-Miocene in age. It is the probable source vent for some of the Miocene and Pliocene andesitic and rhyolitic flows and tuffs which overlie lacustrine deposits south and west of Lime Mountain.

The mineral deposits of Lime Mountain are concentrated in a small area. The ore occurs in contact metasomatic deposits explored by four or more west-trending adits. According to Emmons, 1910, the limestones exposed at the mine sites are metamorphosed to marble with little development of garnet or other contact minerals. However, the latter mines were obviously developed in contact zones as several samples of dense, dark green and brown, garnet-diopside-epidote-tactite were collected from the dumps during our field examination of the area. The tactite contains pyrite, chalcopyrite and galena, all finely crystalline and unoxidized. No scheelite was observed. According to Emmons, 1910, bornite and secondary chalcocite are present, occurring with calcite, quartz and white mica.

The ore zones are enhanced and also disrupted by faults. Numerous north and northeast-striking high-angle faults displace the bedded limestones which outcrop at the mine site. In addition, a pyritized and altered rhyolitic dike (?) intrudes limestones near the mines. The contact between the two rock types strike N60°W and dips 40°SW. The igneous rock is porphyritic in texture and probably hypabyssal in origin. Emmons, 1910, states that other porphyritic and diabasic dikes outcrop above the mine and 1000' to the northwest. The

contact effects displayed in the altered and mineralized limestones may have been produced by the intrusion of dikes or possibly by a buried intrusive body related to the Wilson Peak plug.

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LYNN DISTRICT

The Lynn district is located in the Tuscarora Mountains of northern Eureka County about 19 miles northwest of the town of Carlin. Mines of the district are mainly in T35N, R50 and 51E.

The first record of mineral activity in the area dates from 1907 when placer gold was discovered along Lynn Creek. The Lynn Big Six lode mine was discovered that same year and shipped a small amount of gold ore to Salt Lake smelters (Lincoln, 1923). Barite was mined in the 1930's and 1940's from vein occurrences on Popovitch Hill, site of the present Carlin gold mine, and gem quality turquoise has been produced from the Number 8 and August Berning mines. One of the largest turquoise nuggets ever found was uncovered at the Number 8 mine in 1954, and total turquoise production from the mine is estimated at over \$1,400,000 (Morrissey, 1968). In 1962, geologists for the Newmont Mining Co., following recommendations outlined by the U.S. Geological Survey, discovered the large Carlin disseminated gold deposit, and set off a sequence of gold exploration and discovery that continues to the present. The Carlin gold mine has, between 1965 and 1979, produced over 3 million ounces of gold (Bonham, 1982), and the term "Carlin type gold occurrence" is now commonly applied to all low grade, disseminated gold deposits found in sedimentary host rocks. Similar ore bodies have been found in Utah, Idaho, and in many other locations throughout central Nevada.

The Lynn district is underlain by eastern facies carbonate rocks that range in age from Cambrian to Devonian. These rocks have been overridden by the Roberts Mountains thrust plate which has carried western facies siliceous rocks over the carbonate section. Structural activity coupled with erosion has exposed the lower rocks through a window in the thrust sheet. Locally, small stocks and dikes of quartz monzonite cut the thrust plate, and many high-angle faults

cut both the carbonate rocks and the overlying thrust sheet.

The Carlin gold deposit is in the northeast corner of the Lynn window in the thrust sheet, and gold ore bodies are in the upper part of the lower plate, Roberts Mountains Formation several hundred feet below the thrust contact.

Although gold is dispersed through certain intervals of carbonate host rocks, suggesting local stratigraphic control, crosscutting relations between mineralized zones and bedding, plus the geometric relationship between mineralized areas and certain sets of high-angle faults and intersections of fault sets, indicate that structural controls are critical (Roberts, Radtke, and Coats, 1971). Unoxidized ore bodies at Carlin are characterized by gold-organic compounds plus minor amounts of metallic gold, quartz, barite, realgar, pyrite, and lesser amounts of stibnite, cinnabar, sphalerite, and galena (Radtke and Scheiner, 1970).

A good description of the geology of the Carlin deposit is found in the article by Noble and Radtke, 1978, NBMG Report 32.

At the Blue Star mine (the old Number 8 turquoise mine) north of the Carlin mine, a disseminated gold occurrence in upper plate carbonate rocks has been mined. About two miles north of Blue Star at the Goldstrike mine, gold deposits have been found in granodiorite, skarn, and upper plate Vinini Formation. At both of these occurrences, faults appear to control the location of the gold mineralization. The Big Six mine, about one mile slightly to the northeast of the main Carlin gold mine, was the first lode gold mine discovered in the district in 1907. Gold occurs at the Big Six along a shear zone which cuts rocks of the Vinini Formation. In great contrast to other occurrences within the Lynn district, gold at the Big Six was coarse enough to provide a source for placer deposits in the creeks below it. It is not known, however, if this occurrence is genetically related to the nearby disseminated deposits.

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MAGGIE CREEK DISTRICT

The Maggie Creek or Schroeder district is located on and around Schroeder Mountain in the Tuscarora Mountains about eleven miles northwest of Carlin. Mines and prospects are located in T34N, R51 and 52E and are found both northeast and southwest of Maggie Creek Canyon which cuts through the district. Most of the old mines as well as the new Maggie Creek Gold Quarry gold mine are located in the southwestern portion of the district, southwest of Maggie Creek Canyon. Vanderburg (1938) places the first mining activity in this district in the early 1870's, when several shipments of ore were made from the Good Hope claims. A small amount of ore was produced from the Nevada Star mine between 1906 and 1909, and the Copper King mine produced in 1917. Barite was discovered in the area about 1930, and some mining was done for barite on the Maggie Creek and Good Hope claims between 1930 and 1936 (Vanderburg, 1938). The Maggie Creek claim group also was mined for gold beginning sometime after 1925. Total production of metals from the district up through 1958 is slightly less than \$250,000 (Roberts et al, 1967). In 1962 Newmont Exploration acquired the Maggie Creek area, and began exploration for disseminated gold. A large reserve of low-grade gold ore was developed as the result of this program, and the Maggie Creek deposit was being mined at a rate of 16,000 tons ore and waste per day in 1979 (Carlin Gold Mining Co. mine hand-out), and the Maggie Creek Gold Quarry deposit was active in 1982 (Papke, 1982).

The principal geologic feature of the Maggie Creek district is the roughly circular Carlin window in the Roberts Mountains thrust sheet. The window exposes carbonate rocks of Ordovician, Silurian, and Devonian age which are surrounded by thrust slices containing argillaceous, variably dolomitic limestones, siltstones, shales and sandstones of the Ordovician

Vinini Formation. The window, and its upper plate skirts, form an elongate outcrop of Paleozoic rocks which extend from Schroeder Mountain across Maggie Creek to the northeast, a distance of about 5 miles, and is mainly surrounded by Tertiary gravel deposits. Of all of the known ore deposits in the district, only the old Good Hope mine is reported to occur in carbonate rocks of the lower plate of the Roberts Mountains thrust. The Good Hope is described as silver-lead-barite replacement deposits along a steep, northwest trending fault in limestone (Roberts, et al, 1967). The other occurrences, including the new Maggie Creek Gold Quarry deposit of Newmont's, are all within upper plate rocks.

At Maggie Creek, gold mineralization is controlled by a northeast trending fracture zone but the disseminated zone itself does show stratigraphic control (Newmont Mining Co. mine Hand-out).

As of 1982, Newmont had released reserve figures of 25.1 million tons of 0.106 oz. gold and 150 million tons of 0.036 oz. gold for the Gold Quarry deposit (Bonham, 1982). Exploration activity still continues in the district and it is very likely that other gold deposits will be developed here.

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(For additional references, see Lynn district.)

MARYS MOUNTAIN AREA

Marys Mountain is located in the southern Tuscarora Mountains just south of the Maggie Creek district. The mountain is a north-south elongate ridge composed of two flat-topped peaks which are greater than 7,500' in elevation. The north peak is underlain by upper plate siliceous sediments of the Ordovician Vinini Formation (Stewart and Carlson, 1976). The southern peak is composed of rhyolitic volcanic or hypabyssal rock. South of Marys Mountain toward Hwy 80, there are a few small, isolated remnants of upper Paleozoic limestones and clastic rocks. Throughout the area, the rocks are deformed by folding and high-angle faulting.

A small prospect located on the Sal claims south of Marys Mountain is developed in siltstones, mudstones and conglomerates cut by a N15W, 65SW fault zone. Mudstone breccia on the dump is cemented and veined by abundant radiating crystals of green malachite (sample 1537B). Some sulfides, mostly pyrite, and gossan were also noted.

The north peak of Marys Mountain is the site of the Cherry Springs (Marys claims) barite vein deposit (Papke, in press). The southeast flank of the peak was recently (within last 5 years) developed by terraced dozer cuts and drilling. The host rocks are shale, siltstone, mudstone and some chert of the Ordovician Vinini Formation. The beds are folded near the minesite and display bedding and fracture coatings of iron and manganese oxides. Iron-stained, grey barite vein was sampled from the floor of the cuts (sample 1541), but no vein material was found in place.

The saddle area between the two peaks is underlain by rubbly, silicified outcrops of Vinini cherts and shales. The outcrops are in part brecciated, folded and cut by minor high-angle faults. Recent trenching and drilling in the area was probably done 3-5 years ago as part of a precious metals exploration

program. Silicic volcanic and possibly shallow intrusive rocks form bold outcrops on the southern peak south of the drill area. Although no obvious mineralization other than minor shows of copper oxides was observed, the volcanic rocks and siliceous sediments display effects of hydrothermal alteration.

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MERRIMAC DISTRICT

The Merrimac, or Lone Mountain mining district occupies Lone Mountain, a conspicuous ridge in the southern Independence Mountains about 25 miles northwest of Elko. The ridge is plainly visible west of the Mountain City Hwy. and accessible from fair dirt roads which lead off from the Tuscarora (Taylor Canyon) turnoff. The main mines in the district encircle the 8,780' crest of Lone Mountain. Numerous shallow prospects are peripheral to the minesites and explore the contact zones elsewhere in the district. A few bedded barite occurrences are located outside of the central district within a few miles north, west and south of Lone Mountain.

According to Granger, 1957, the district produced a little over one million dollars worth of lead, zinc, copper, silver and gold between its discovery in 1866 and 1949. The Rip Van Winkle mine, the largest mine in the district, contributed a sizeable portion of the total production. The district ranks as the largest recorded producer of zinc (more than 3 million pounds) in Elko County before 1949. Lead-zinc-silver ore produced since then was derived from sporadic mining of the Rip Van Winkle property. Today, most of the mines are inactive.

In 1954, 6 units of tungsten were produced from the Lone Mountain "open pit" mine located in section 11, T37N, R53E (Stager, to be published). A minor amount of barite was produced from a small open pit on the Dresser Minerals claims located about four miles south of Lone Mountain (oral comm. with Dresser Minerals geologist). The other known barite properties are developed by shallow trenching and drilling and have no recorded production.

A molybdenum occurrence near Dinner Station is reported by Schilling, 1962. The exact location or type of occurrence is not known.

The geology of Lone Mountain was studied in detail by Lovejoy during the latter part of the 1950s. According to his interpretations, the lower flanks of Lone Mountain are composed of thrust eastern and western facies sediments of Ordovician through Devonian age. The lower plate rocks are mainly limestones, calcareous siltstones and shales. Internal overthrusts of these rocks occur locally. The upper plate section consists of cherts and siliceous shales. On the plate margins, the rocks are fractured, brecciated and silicified. Detailed lithologic descriptions of the sediments are provided by Lovejoy, 1958 (a). Ketner, 1975, has since correlated the Lone Mountain sediments with recognized Nevadan stratigraphies; explicitly the Nevada and Roberts Mountains Formations. Tertiary conglomerates and welded ash-flow tuffs cover the low-lying areas adjacent to Lone Mountain.

The ridgecrest area of Lone Mountain is underlain by a multiple intrusive complex which consists of several crosscutting stocks and dikes. The combined outcrop exposure of the bodies is between 6 and 8 square miles. The main intrusive body, named the Nannies Peak intrusive, forms bold, jointed outcrops along the entire north-trending summit of Lone Mountain. The arcuate, dike-shaped body displays a range of compositions and textures but predominately is a quartz monzonite porphyry. Several mines are located along the contact of this body and the older Devonian limestones.

The intrusion along Nannies Peak was both pre-dated and postdated by the intrusion of monzonitic to dioritic stocks and latite or porphyritic dikes outcropping on the east flank of Lone Mountain. All of the igneous bodies are intruded by late-stage aplitic or porphyritic dikes and quartz veins far too numerous to map individually. The dikes and veins are common in the mined

areas where they are altered or mineralized. Some of the dikes occupy high-angle fault structures.

The composite intrusive body of Lone Mountain is dated at 38 m. y. (Coats and McKee, 1972). A much younger and probably less reliable age of 12 m. y. (\pm 20 m. y.) was obtained earlier on biotite from the Nannies Peak pluton at the Lone Wolf mine (Schilling, 1965).

The ore bodies at Lone Mountain are mainly vein or replacement deposits which are localized within the altered intrusive bodies or more commonly along the contact zones between lower plate limestones and the intrusive stocks and dikes. Many of the deposits are gossany replacement zones occurring along bedding planes (faults?) or thrust faults in silty limestones and calcareous shales. Also, copper and iron-rich skarns are developed near the contacts of the larger stocks. A few mines, specifically the Monarch and Rip Van Winkle, are developed along high-angle faults or silicified breccia zones in the upper plate rocks.

The main ore minerals are sphalerite, chalcopyrite, and galena associated with silver and minor gold (Smith, 1976). Emmons, 1910, also notes the presence of copper and lead carbonates, pyromorphite and arsenopyrite. Much of the mined ore was oxidized.

The limestones exposed along the flanks of Lone Mountain are typically silty or sandy, often laminated or mottled, form massive to medium beds (6"- 1' thick) and are interbedded with limey shales. At the minesites, the limestone wallrocks are notably altered. Most commonly they are bleached and recrystallized, forming sugary white marble outcrops. The bedding is generally contorted or folded. Steep bedding inclinations near the ridgecrest are the result of doming by the intrusive mass. Calcite veins cut the wallrocks and also cement breccias. Pyrite, galena and hemimorphite occur in gossans, replaced wallrock and mineralized breccias found on the dumps.

Silicification of the limestone is evident at several locations. The tactites contain variable amounts of pink, red or green garnet, epidote, actinolite, calcite and occasionally tremolite. Mineralized varieties contain copper minerals (sulfides and oxides), magnetite and pyrite. Replacement pods of magnetite, partially oxidized to hematite, were mined in tactites at the Magnetite claim and Lone Mountain "open pit" mine. The tactites developed in silty horizons are generally sugary in texture and light green in color.

Dikes and quartz veins are found in abundance at the minesites. Often the igneous rocks show cross-cutting relationships and are, in turn, cut by finely crystalline siliceous dikes or quartz veins. Some of the dikes at the minesites are bleached, propylitized (chloritic alteration) or sericitized and contain some pyrite.

Finely crystalline purple fluorite occurs in a 10-12" wide quartz vein exposed in the upper workings at sample location 186. Chalcopyrite, pyrite, copper oxides and sphalerite (?) also occur in the vein. At the IM claims, located about 1 mile to the east, yellow antimony oxides were observed in siliceous gossan found on the dump. Lawrence, 1963, reports the occurrence of "small blebs and large lenses" of stibnite associated with galena and pyrite at the Hunter prospect. The location of the prospect, as stated by Lawrence, is confusing. However, the prospect is accredited for the production of twelve tons of lead-silver-antimony ore in 1921 (?).

Throughout the district, many of the caved underground workings are redeveloped by scrapping or trenching. The shallow excavations are between 2-10 years old. Several patented mining claims are held on the north and east flanks of Lone Mountain. Exploratory drilling was conducted probably 5-10 years ago in several areas adjacent to the minesites. Active claims cover the

north-west flank of the mountain. At the time of our exam, Nammco (Casper, Wyo.) geologists were beginning exploration work on their claims located near the Monarch Mine. The southern part of the district is relatively inactive, but everywhere covered by valid unpatented mining claims.

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MINERAL HILL DISTRICT

The Mineral Hill mining district is situated along the lower west-central slope of the Sulphur Spring Range about 40 miles south of the town of Carlin. The district lies within Eureka county and is bordered on the east by the Union district.

The main mine in the district, the Mineral Hill mine, consists of numerous north-south trending open stopes, adits and shafts which occupy the north and west flanks of a small isolated knoll named Mineral Hill. The west side of the hill has been the site of recent (2-3 years old) exploratory trenching and drilling. The other mine sites in the district are little developed by shallow trenching or prospecting.

The early mining history of the district is quite interesting and well documented. The first silver ore was mined in about 1868 and shipped to Austin for treatment in the Manhattan mill by roasting and pan-amalgamation. **The** preparation of the early ore is of significance because an unusually good recovery was made (better than 90%) using the Reese River and Washoe processes. Also several years latter, the tailings or roasted chloridized ores from the deposit were successfully retreated and this was considered a break through in metallurgy (Toll, 1912). Mining of the deposit continued vigorously until about 1872 when the Mineral Hill Silver Mining Co., organized just one year earlier, was unable to locate enough ore to cover accumulating expenses, Mining of the deposit continued sporadically through 1936 (Vanderburg, 1938). The total known production from the deposit through 1938 is valued at 2.5 million dollars mostly in silver but also in lead, zinc, copper and gold (Roberts, et al, 1967).

The Sulphur Spring Range near Mineral Hill and Union Summit is underlain by Ordovician siliceous sediments and Devonian carbonate rocks. The units are generally north-striking and fault juxtaposed. The Roberts Mountains Thrust is exposed along the western flank of Mineral Hill (Roberts, et al, 1967) and is probably an important

control of mineralization at the Mineral Hill mine. Jasperoids and jasperoid breccias form resistant outcrops throughout the district especially along the thrust contact (see field write-up for sample location 135). Extensive, north-striking, high-angle faults bisect the core of the district. Altered igneous dikes are reported to occur near the mineralized areas but none were observed during our brief reconnaissance of the district.

The Mineral Hill mine contains about 2,000' of underground workings which explore a zone of mineralization about 200-300' wide (Emmon, 1910). The discovery deposits outcropped on the surface and the early mining took place at shallow depths (Whitehill, 1873). The host rock for the deposit is Devonian dolomite which, at the minesite, is bleached, sheared, in part recrystallized and generally highly silicified. The bedding of the dolomites, although disturbed by a sheeted shear system strikes northwest and dips steeply northeast. North to northwest-striking, steeply inclined shear and breccia zones cut across the bedding. Replacement of the host rocks by quartz has occurred in the areas of most intense shearing. Massive, irregular-shaped quartz and calcite veins are present in the silicified zones. Sulfide ore from the dump contains irregular stringers and pods of pyrite, galena, covalite, anglesite, barite and cerussite. The gangue mineral is typically massive white quartz. Most samples are fractured or brecciated and contain malachite and azurite on fracture surfaces.

More than 40% of the total mined silver was present as chlorides, although argentite and silver bromide were also mined. Some of the early ore contained as much as 100-200 ounces of silver per ton (Emmons, 1910). Antimony in the form of tetrahedrite, polybasite and stepharite, in addition to molybdenite were also reported to occur in the ore (Lawrence, 1963; Eissler, 1898).

An area of active hot springs just north of Bruffey Ranch is covered by terraced tufa deposits which contain barite and fluorite (Papke, 1979). Several shallow prospects in the area explore sets of narrow, northwest-striking fractures

which cut calcareous spring deposits and underlying hydrothermally altered limestones and minor quartzites. Opaline material is infused along the fractures. Brown translucent lenses of fluorite (?) were noted in opalized breccia in addition to red specks which may be cinnabar (?).

Bulldozer cuts and prospect pits located at the Vict claims about 4 miles south of the Mineral Hill mine explore gossans and jasperoids. Analyzed samples from the area contain significant amounts of silver and gold. The workings lie along intersecting fault zones between the Silurian Roberts Mountains Formation and Ordovician Vinini Formation and Eureka Quartzite (NBMG Mining district file # 117, Mineral Hill district, unpub. report).

In April 1982, Amoco Production Co. completed a new field discovery oil well, the Blackburn No. 3, about 5 miles north-northwest of Mineral Hill on the east side of Pine Valley. Production through December 1982 was 14,228 barrels of oil with an API gravity ranging from 27°-29.9° (Garside, 1983). The new discovery is located less than 4 miles west of the well known Bruffey oil and gas seeps discovered by Mr. R.V. Bruffey in the 1920's. The oil seeps are associated with thermal springs and tufa deposits lying along the trace of a major Basin and Range, range front fault. (Foster, et al 1979).

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MODARELLI-FRENCHIE CREEK DISTRICT

The Modarelli-Frenchie Creek district is located in the north-central Cortez Mountains about 25 miles south-southwest of Carlin. The main mine in the district is the Modarelli iron mine located on the east side of the range in section 30, T29N, R51E. Lesser iron mines and prospects are located along the range crest above and south of the Modarelli mine and within Frenchie Creek canyon. A few small prospects south of the main district occupy Sheep Creek and Hand-me-down Creek. These prospects explore deposits of iron and sulfur, respectively. Also there are several minor occurrences of copper and barite in the mineralized areas.

The Modarelli iron mine, originally known as the Amarillo deposit, was discovered in 1903 (Shawe, et al, 1962). Mining of the deposit began in 1951 and continued sporadically through 1961. During this time, a total of 395,900 long tons of iron ore were produced (Muffler, 1964). The other iron deposits in the district are less extensive and were apparently never productive.

The geology of the Frenchie Creek 15' quadrangle was mapped by Muffler, 1962 and later published as USGS Bulletin 1179. Before his work in the area, the volcanic rocks in this part of the Cortez Range were considered to be Tertiary in age (Shawe, 1962). On the basis of field evidence, Muffler determined that the volcanic sequence is entirely Mesozoic, or more specifically, Jurassic (?) in age.

In Frenchie and Big Pole Creeks, the volcanic section may be as much as 10,000' thick (Muffler, 1964). The package of rocks are assigned to the Pony Trail Group which is subdivided into three members, the Big Pole Formation (volcanic wackes and flows), the Sod House Tuff (silicic tuffs, flows and water-lain material) and the Frenchie Creek Rhyolite (rhyolite and rhyodacite flows). "Iron mineralization and several types of associated hydrothermal alteration" has affected all three members of the Pony Trail Group, but the main iron ore replacement deposits are

localized "almost exclusively" in the Frenchie Creek Rhyolite, the youngest of the three members (Muffler, 1964).

In the Frenchie Creek area, the flows generally dip northwestward and are folded into an east-northeast trending anticline/syncline pair. Throughout the area, the rocks are kaolinized and near the mineralized sites some units are sericitized or silicified.

Surrounding the main district, the Pony Trail Group and Pennsylvanian and Permian sediments of the Brock Canyon Formation are intruded by a large, irregular shaped, multiple intrusive body, referred to as the Frenchie Creek intrusive complex. Muffler (1964) petrographically examined the various bodies in detail. Their compositions and textures are widely varying, but the most abundant intrusive type in the mapped area is granodiorite. Intrusion breccias are present and suggest a forceable mode of emplacement for the bodies. Radiometric age dates obtained from mafic phenocrysts separated from a diorite at Hand-me-down Creek and a quartz monzonite north of Sod House Creek ranged between 125-150 my, indicating a Cretaceous age for the complex (Schilling, 1965). The rocks are widely albitized through deuteric processes and show local kaolinitic overprints resulting from a latter stage of hydrothermal alteration (Muffler, 1964). In addition to the large intrusive bodies, there are numerous dikes and plugs of various compositions emplaced into the volcanic and plutonic section. A rhyolite plug which may have been a feeder for the Frenchie Creek Rhyolite is located near the mouth of Frenchie Creek canyon.

High-angle faults of various orientations cut the intrusive rocks and the volcanics. Some of the structures are silicified and mineralized and may have originated in response to deformation caused during the intrusive episode (Muffler, 1964).

The iron replacement body at the Modarelli mine is located at the intersection

of a N60E and east-west-striking high-angle fault. The triangular wedge formed between the fault zones is presently the location of a large terraced open pit. The walls of the pit expose a large mass of red and black iron ore; the oxidized portions of the original black magnetite ore are converted to red hematite. The most intense replacement of the host rock occurs in areas of high fracturing. Small stock piles of ore found near the crusher below the pit consist of specular hematite (martite ?) with some quartz, apatite and barite on fracture surfaces and in pods within the ore. Adjacent to the deposit the rhyodacitic flows are silicified or sericitized. Commonly, plagioclase phenocrysts in the rocks are replaced by clay minerals and iron-oxides. Away from the main deposit, the rocks contain abundant chlorite.

Less extensive iron ore bodies are located elsewhere in the district. These deposits lie along fault zones, and because of intense silicification, generally form resistant vein-shaped outcrops. The vein material is usually less oxidized and contains more original magnetite than the ore observed at the Modarelli Mine. In addition to massive black magnetite, the ore consists of hematite and has vug and cavity fillings of limonite, quartz and barite. The ore material is brecciated and cut by vitreous veinlets of quartz or apatite. Rose colored quartz occurs as vein material and as a gangue mineral in iron ore found as float near the Frenchie Creek prospect.

During our examination of the district in July, 1982, Amoco Minerals Co. was conducting exploration work within Frenchie Creek Canyon. Existing roads had been improved at the head of Frenchie Creek and along the ridgecrest area toward the Modarelli mine. Drill pads were constructed at scattered intervals along the roads. A rotary drill rig was actively drilling on the east side of the canyon floor in section 26, T29N, R50E. According to the Amoco geologist at the site,

the hole had reached a depth of 900'. Judging from the cuttings examined at the site, the drilled section was entirely in volcanics or tuffaceous sediments.

Behind (to the east) the drill area, the rocks form bold, jagged pinnacles which contrast markedly with the more easily eroded volcanics flanking the outcrop. At sample location 1545, located about 1 mile south of the drill area, there are similar jagged outcrops which, when examined more closely, were found to consist of a silicified and iron-rich volcanic breccia. The breccia is chaotic in appearance and contains bleached, silicified volcanic fragments of fine pebble to boulder size. The fragments are suspended in a matrix of hematite and silica. Hematite veins cross-cut some of the fragments. Internal, open-centered breccia zones cut the outcrop at high angles. The brecciated outcrop forms a rib which trends N80°E. Its discordant appearance suggests that it is a highly silicified fault zone or possibly an intrusive plug or dike. However, Muffler (1964) mapped this zone as the contact between the Sod House Tuff and overlying Frenchie Creek Rhyolite.

One and one-half miles east of the mouth of Frenchie Creek are numerous underground and surface workings which explore copper and silver-bearing, north-west-striking fault zones in rhyodacites of the Frenchie Creek Rhyolite. Although no recent activity was noted at the property, the extent of the workings indicate there may have been a small production of silver ore from the deposit. A sample collected from the mine (1546) consists of altered volcanic rock with pyrite, chalcopyrite and secondary coatings of copper oxides.

Sulfur is being deposited at warm springs located along a range front fault just southwest of Hand-me-down Creek (Muffler, 1964).

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MOUNTAIN CITY DISTRICT

The Mountain City district is located in extreme north-central Elko County, and includes the large area that lies generally north of the Independence Range and south of the Idaho border. The area is totally within the Humboldt National Forest and is bounded on the west by the Duck Valley Indian Reservation.

Included within the Mountain City district are the old districts of Cope, Murray, Sooner, Marseilles, and Van Duzer. Silver-gold lode deposits were discovered in 1869 in the Cope, Murray, and Sooner districts; those at Cope led to the founding of the town of Mountain City. Over one million dollars in silver was produced prior to 1881 from the mines around Mountain City. Gold placers were worked in the Van Duzer part of the district following their discovery in 1893 (Emmons, 1910). In 1931, the Rio Tinto copper deposit was discovered southwest of Mountain City. This deposit, which produced \$21 million before it closed in 1947, has far exceeded all others in total production within the Mountain City district. Small amounts of manganese, tungsten, and uranium have been produced from separate properties in various parts of the district during the years following World War II. During the late 1960's, a molybdenum occurrence was being explored in an area east of Mountain City (on what are shown as the Autunite claims, Mountain City 15' map). During the 1970's, attempts were made to reactivate the copper mine at Mountain City as well as to leach old dumps at the site for copper. During 1982, the only activity listed in the district was a small silver mining operation at the Silver King mine west

of Mountain City (in the old Marseilles part of the district) and a silver leach operation at the old Protection mine south of Mountain City (one of the old Cope district silver mines).

Rocks in the Mountain City district consist of a sequence of lower Paleozoic, western facies rocks, all now located within the upper plate of the Roberts Mountains thrust sheet. Several plutons of Cretaceous quartz monzonite intrude the Paleozoic formations and both quartz monzonite and the older rocks have been overlain by several sequences of Tertiary volcanic rocks (Coats and Stephens, 1968).

The orebody at the Rio Tinto mine occurred as lenses within a definite sequence of black shales in the lower portion of the oldest Paleozoic formation present in the district, the Ordovician Valmy Formation. The ore occurrence is interpreted as being genetically related to late Paleozoic mafic vulcanism (Coats and Stephens, 1968). The primary orebodies were lenticular in shape and were composed mainly of quartz, pyrite, and chalcopryrite. The principal orebody was completely leached to the 200 level, and supergene copper sulfide ore was found beneath an essentially barren gossan. Ore shipped from the property in the early production years ran as high as 37% copper; the overall grade of ore produced throughout the life of the mine was 9.7% copper (Coats and Stephens, 1968).

Gold and silver deposits of the Mountain City mining district, the original discoveries, are quartz veins which occur mainly in the Cretaceous quartz monzonite. Near the southern margin of the pluton, veins also cut

Paleozoic rocks. Tertiary rhyolitic rocks are hydrothermally altered near veins near the town of Mountain City, suggesting that the veins may be younger than 30 m.y. (the age of the rhyolites) (Coats and Stephens, 1968). The veins occupy faults which cut the older rocks; they strike in various directions but the most common direction is northwest. Ore shoots were as much as five feet wide. Primary ore in the veins consisted of pyrite, galena, sphalerite, tetrahedrite, arsenopyrite, chalcopyrite, argentite, and free gold. Most of the vein production, however, came from oxidized portions of the veins.

Tungsten has been reported from one mine in the Mountain City district, the Golden Ensign about one mile southeast of the town. The deposit produced mainly silver and gold, lead, and copper during the pre-1900 era of activity in the district. Scheelite and molybdenite are also reported present, but there is no recorded production of these metals (Stager, in preparation).

Uranium was discovered east of Mountain City in 1954, and small amounts of uranium ore were produced between 1959 and 1963. The deposits are in Tertiary conglomerates and tuffs in areas where these rocks overlie an eroded surface of the quartz monzonite. The deposits are localized along permeable layers, generally within the basal 30 feet of the host rock. The ore minerals, autunite, metatyuyamunite, uranophane, or torbernite, occur as fillings in cracks and pore spaces or they partly replace lignitized or opalized wood (Smith, 1976).

Gold placer operations have been carried on over the years since 1883 in the old Van Duzer portion of the district, and manganese was produced in 1943

from the Wicker mine on the west side of Merritt Mountain, east of Mountain City. Little is known of the manganese occurrence, but it is described as a vein type deposit in black shales (USBM field report, NBMG files). The molybdenum occurrence which caused a flurry of exploration activity in the 1960's is east of Mountain City in an area of more recent uranium exploration that extends across quartz monzonite outcrops on the north edge of the Huber Hills. This area is described as a stockworks zone in quartz monzonite near a contact with granite (Sparks Tribune, August 7, 1969). The activity described in the 1969 news article was apparently not successful, as there is no activity in the area at this time.

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NORTH BATTLE MOUNTAIN AREA

The North Battle Mountain area, sometimes referred to as the Stony Point district, is located along the southwest flank of the southern Sheep Creek range about six miles northeast of Battle Mountain. Most of the mines and prospects in this district are in Lander County in the eastern portion of T33N, R45E.

According to Stager, 1977, silver-lead ore was discovered in the area in 1906, but mainly prospecting and little mining took place in the district for the next several years. A carload of ore was shipped in 1910, and in 1927-28, exploration and development began at the Snowstorm mine. The Snowstorm, the only metal mine of consequence in the area, produced about 200 tons of ore during this early period. Work was done in the area over the years, but no major activity took place until barite was discovered in steep slopes of the range above the Snowstorm mine in the mid-1970's. Barite claims were staked in 1977, and production of barite from at least one mine, the Rimrock, was reported in 1982.

During the early 1960's, as part of the Heavy Metals Program, the U.S. Geological Survey did a considerable amount of geologic mapping and geochemical sampling in this part of southern Sheep Creek range. The results of this work, published as U.S.G.S. Circular 595, outlined areas of interesting heavy metal anomalies around the Snowstorm mine. Some exploration interest was generated at the time the Circular was released, but, as far as is known, no metallic deposits were found.

Rocks exposed along the flanks of the Sheep Creek range consist of a narrow northwest-trending band of western-facies Paleozoic rocks which is

capped by Miocene volcanic rocks to the northeast (Stewart and McKee, 1977). The Sheep Creek range has the topographic expression of an elongate mesa with volcanic flows forming the top and Paleozoic rocks forming outcrops along the steep sides. The Paleozoic section shows complicated thrust relationships, with imbricate thrust fault slices containing rocks of Ordovician through Devonian age.

The silver-lead deposits in the vicinity of the Snowstorm mine are described as occurring along narrow, discontinuous quartz veins that strike $N55^{\circ}-65^{\circ}E$ and dip about $45^{\circ}S$ and the ore minerals are given as argentiferous cerussite with some azurite, malachite and galena (Stager, 1977). Mining at the Snowstorm itself was done along a $N20^{\circ}W$, flat-dipping shear zone which roughly follows bedding in the Paleozoic chert and some workings along the ridge southwest of the Snowstorm are along E-W shear structures. The entire area surrounding the old silver prospects is vividly colored by iron oxides and possibly by oxides of antimony and arsenic. Rock breccia was noted with barite cementing fragments. Quartz cementing material is also present.

Lenses of barite, up to 30 feet in thickness, occur in the Paleozoic section, generally up-slope to the northeast of the old silver prospects. According to Papke (in preparation), the barite occurs in the Devonian Slaven Chert. Two deposits have been mined and the area is still an active barite producer. It is interesting that Papke notes (see property descriptions, Rimrock and Cutler mines) that the barite formations and the enclosing rocks display much more iron staining than is normal for barite occurrences in this area. It is very likely that the colorful iron staining, the heavy metal anomalies and the presence of the small silver-lead occurrences are all related to a period of metallic mineralization that post-dates the thrust faulting.

The suite of heavy metals outlined here by the 1986 U.S.G.S. work is similar to the heavy metal associations known to occur around and with the "Carlin-type" disseminated gold deposits. It is possible that exploration potential for this type of deposit still remains in the Sheep Creek Range.

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RAILROAD DISTRICT

The Railroad or Bullion district is located in the northern Pinon Range about 15 miles south-southeast of Carlin. The old mining camp of Bullion lies on the east side of the range at the entrance to the mine area. The mine area contains numerous adits, some of great extent, which occupy the steep upper slopes of the highest ridge (8,710') of the Pinon Range, known collectively as Bunker Hill and Ravens Nest. The adits occur in tight clusters on the north and west slopes of the peak.

The district was organized in 1869 a short time after the discovery of mineralized deposits at Mineral Hill located approximately 25 miles to the south. Smelters were in operation throughout the 70's and 80's at Bullion (Emmons, 1910), marking the beginning of a long and productive history of mining activity. Production figures are not complete, but an estimated 4.7 million dollars worth of Pb, Cu, Ag, Au and Zn were mined between 1869 and 1968 (Smith, 1976). Some production of barite has also occurred from the Pine Mountain Barite mine located on the west slope of Pine Mountain (Papke, in preparation).

The geology of the district was mapped at a scale of 1:12,000 by Ketner and Smith, 1963. The high peak area of Bunker Hill is underlain by generally massive to thickly bedded limestones, dolomites and minor quartzites and siltstones of the Silurian Lone Mountain Dolomite and the Devonian Devils Gate Limestone and Nevada Formation. Together the carbonates comprise a section about 2,300' thick. The main hosts for mineralization are the carbonates of the Nevada Formation and the Devils Gate Limestone. Older Paleozoic clastic rocks and dolomites are exposed within a narrow horst northeast of Bunker Hill. West of the district, the carbonate section is overlain by Mississippian argillites and quartzites. To the east they are unconformably overlain by Tertiary quartz latite tuffs and black vitrophyres (Ketner and Smith, 1963).

The sediments of the Railroad district are folded into a north-trending,

overturned anticline named the Pinon Range anticline. The axis is located just west of Bunker Hill. The central portion of the anticline is intruded by a stock and several dikes and is also the site of several high-angle reverse and normal faults. The most notable faults are the northeast-striking Bunker Hill Fault and the east-west-striking Bald Mountain Fault. Both faults have reverse movement, lie adjacent to mineralized areas and were later intruded by rhyolite porphyry dikes. The Bald Mountain Fault is post-intrusive as it truncates the north end of the stock, but other more minor faults in the district are likely related to deformation caused by the forcible intrusion of the stock. The faults and folds in the district do not seem to be the major control of ore deposition (Ketner and Smith, 1963).

The intrusive rocks in the district, as subdivided by Ketner and Smith, 1963, consist of two types; a medium crystalline granite which grades into quartz diorite and rhyolite porphyry. The outer shell of the stock is composed of the granite and the central core is intruded by a roughly circular body of rhyolite porphyry. The numerous dikes in the district also consist of rhyolite porphyry. Some of the intrusive dikes near the mineralized areas are sericitically altered.

Chemical analyses of the intrusive rocks from the district showed "more than average amounts" of Cu, W, Co, Ag, Pb, Sn or Mo in several different samples (Ketner and Smith, 1963). Minute crystals of pyrite, chalcopyrite, sphalerite, pyrrhotite, ruby silver and galena were observed in polished sections of the rhyolite porphyry core. Also samples of the Bunker Hill dike were found to contain more barite and sulfides than the main stock (Ketner and Smith, 1963). A biotite separate from a quartz monzonitic portion of the stock yielded a K-Ar age of 33 m. y. (Schilling, 1965).

The richest ore bodies in the district are replacement deposits located along the intersection of fractures or joints in the limestones and the rhyolite porphyry dikes. These deposits contain lead, silver and copper and usually form vertical

chimneys which have been mined to depths of 500' (Emmons, 1910). Thus far, a zone of secondary enrichment has not been reached. The entire deposit to this depth is oxidized. Ore minerals reported from the deposits are cerussite, horn silver, pyromorphite, malachite, azurite, chrysocholla, cuprite, pyrite, chalcopyrite, argentiferous galena, bornite, chalcocite, sphalerite, tetrahedrite, duftite (Pb Cu (As₅ O₄) (OH)), and suprite (Emmons, 1910, Granger, 1957). The gangue minerals are quartz and calcite and everywhere the ore is stained by abundant iron and manganese oxides. The dumps from these deposits contain abundant gossans. Anomalous concentrations of Zn, Pb, Ag, Mo, Be, Y and La were found in mine dump samples collected from the central district (Ketner and Smith, 1963).

The location of the replacement deposits is marked by irregular zones of iron-rich gossan within bleached and **marbelized** limestones. Marbelization of the limestone wallrock is a characteristic alteration observed throughout the entire district.

Tactite bodies developed locally and were mined primarily for copper (mainly chalcopyrite, bornite, chalcocite). They also contain galena, sphalerite and resultant oxidation products. Some of the ore mined from these deposits carried 3.8% copper and good values in silver (Granger, et al, 1957). The largest tactite bodies lie along the granite limestone contact but similar deposits are found southwest of Bunker Hill near the Grey Eagle mine where only one small intrusive dike crops out (Smith and Ketner, 1978). However, a magnetic anomaly centered at Lee Canyon just west of the Grey Eagle Mine is interpreted to overlie a "large igneous body at shallow depth" (Smith and Ketner, 1976).

The tactites near the Grey Eagle mine are vein shaped occurrences which strike east-west and contain scheelite, in addition to copper. Their narrow, vertical form is suggestive that the deposits follow fissures or fractures in the limestone host rocks.

Although there is no recorded production of tungsten from the district, narrow (2-3' wide) scheelite-bearing tactites are exposed within the Davis Tunnel 3,000' beyond the portal. (Stager, in press). The tactite assayed 0.3 to 4.3% WO_3 . The occurrence of scheelite in the district may be more common than previously thought. Dense, iron-stained tactite from dumps near the Grey Eagle and Standing Elk mines (sample 173 and 1533) contain some disseminated scheelite in addition to copper, lead and iron sulfide minerals.

Gold-bearing quartz veins crosscut the granite stock at the Delmas mine. However, the grade of the vein ore was too low to work profitably in the early years of mining.

Fluorite reportedly occurs in the ore at the Standing Elk mine (Papke, 1979). Although none was observed at this locality, a minor amount of fluorite was noted in a sample of turquoise-bearing clay gouge collected near the Bald Mountain Chief mine (sample 1683).

Near the Sun mine in the SE/4 of section 33, T31N, R53E, several small discontinuous replacement deposits of hematite occur in limestone near the granite contact (Shawe, 1962). Also, molybdenite occurs in core retrieved from the rhyolite porphyry. The molybdenum content reportedly increases with depth (Smith, 1976).

Many of the mines in the central district are patented. The old workings are generally inactive but the mineralized areas on Bunker Hill have been the site of extensive exploratory drilling in the last few years.

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ROBINSON MOUNTAIN DISTRICT

The Robinson Mountain mining district encompasses a relatively large area in the southern Pinon Range but contains only a few small prospects located on the west and east flanks of the range. The district is named after a conspicuous 8,114' peak located on the lower east flank of the range.

The main activity in the district is related to exploration for barite. Three areas of barite mineralization were examined during the course of this project but many other areas of shallow surface exploration were noted on barite claims throughout the district. The only known production from the entire district is for a small amount of vein barite (1-1,000 tons) obtained from the Snow White claims located in the south half of Section 2, T29N,R53E (Papke, in preparation). Vein samples collected by USBM engineers contained as much as 90-93% BaSO₄.

Newmont Exploration Ltd. holds claims near the ridgecrest in the northern and southern portions of the district. During the summers of 1981 and 1982, they conducted exploration work, including drilling, in both of these areas. The southern area, named the Jak claims, extends in a north-south direction in an area with no previous history of mining activity. The northern area, named the Irene claims, contains old prospects and exploration cuts for barite.

The rocks in this part of the Pinon Range mainly consist of siliceous, clastic and carbonate sediments of Ordovician through Permian age. The older sediments form the upper and lower plates of the Roberts Mountains thrust and the younger sediments are part of the overlap series. The most abundant rock types in the area are Mississippian and Permian clastic rocks which include conglomerates, sandstones (quartzites), shales and siltstones. Bedding attitudes are variable since the rocks are folded and deformed by thrusting and high-angle faulting. Mafic to silicic volcanic flows and rhyolitic to dacitic ash-flow tuffs overlie the sediments on the east flank of the range.

Two small rhyolitic stocks outcrop in the heart of the Jak claims in sections 26, 27 and 34, T29N, R53E. The stocks intrude limestones and siltstones of the Pennsylvanian and Permian Moleen Formation and undivided rocks (Smith and Ketner, 1978). If the stocks were emplaced during the same intrusive episode as the Railroad stock located 14 miles to the north (see Railroad district), they are probably Oligocene in age. A few dikes intrude rocks of the upper and lower plates in addition to rocks of the overlap assemblage. Although dikes are present throughout the district, they are especially prominent in areas of known barite mineralization.

At the Jak claims we examined outcrops of grey rhyolite porphyry of the southern intrusive body. The exposed rhyolite contains disseminated crystals of oxidized pyrite and in places, is sheared, silicified, bleached and iron-stained. Bedded limestones and calcareous siltstones directly east of the rhyolite appear iron-stained and slightly recrystallized but, in general, little altered. However, north of sample sites 161 and 1510, there is a resistant ridge composed of silicified siltstone and quartzite breccia. The outcrop contains pods and veinlets of quartz, barite and iron-oxides. The ridge is most likely a surface expression of N20W high-angle fault structure. Although not much evidence of mineralization was observed at the Jak claims, the presence of pyritized and altered intrusive rocks and favorable sedimentary host rocks make this area a logical exploration target for possible disseminated precious metals.

An asphaltite prospect is located in the western foothills of the range "at the mouth of a tributary to Smith Creek, about 1½ miles east of Indian Campground" (Hamilton, 1956). Solid bituminous material of the variety impsomite is reportedly found as lenses, stringers and sheets in a fracture zone about 3' wide in Mississippian sandstones and shales (Fulton and Smith, 1932). The deposit also contains concentrations of vanadium and uranium (Smith, 1976; Garside, 1973).

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Also see general reference list for Pinon Range.

ROCK CREEK DISTRICT

The Rock Creek district is located due west of Tuscarora along the lower northwest flank of the Tuscarora Mountains. The mines in the district lie along the Rock Creek and Dry Creek drainages. The Falcon mine, which is patented, and the Rock Creek "prospect" are the major workings. However, there are several other mines in the district not shown on the Mt. Blitzen 15' topographic quadrangle. (For locations of minesites, see Mt. Blitzen 15' map accompanying this report). The undeveloped areas between the minesites are covered by unpatented claims. Some large claim blocks surround the Rock Creek prospect area. Although we observed no active exploration in the district at the time of our visit, all of the properties showed evidence of recent (1-5 years ago) development or activity.

Quartz veins containing ruby silver were first mined in 1876 at the Falcon mine. Between 1879 and 1928, a small amount of silver (4,685 oz.) and gold (14 oz.) were produced, mostly from the Falcon mine. The production total includes ore derived from the nearby Divide mine, which, in this report, is treated as a separate district (see Divide district).

In 1944, Bailey and Phoenix stated that the district contained two "little developed quicksilver prospects," named the Rock Creek and Teapot prospects. By the 1960's, Lawrence, 1963, reported there had been additional and continued prospecting for mercury. Since then, surface exploration for mercury and possibly associated precious metal deposits has continued in previously mined and unmined areas. Cordero Mining Co. drilled an area near the Teapot property in 1964. Cinnabar was found within 100' of the surface in

about one-third of the 116 holes drilled (Smith, 1976). Today, the Rock Creek "prospect" is one of the best developed properties in the district. Several adits, inclined shafts and trenches cover the east facing slope at the minesite. Roads to the mines are recently graded, possibly in preparation for future drilling or other exploration work. A double barrel retort lies below the underground workings.

The oldest rocks exposed in the Rock Creek area are siliceous Paleozoic sediments of the western facies group. However, the majority of the area is covered by Tertiary volcanics ranging in age from Eocene (?) to Miocene (?) (Hope and Coats, 1976). The oldest volcanic units are flows and ash-flow tuffs of andesitic to rhyolitic composition. These rocks are overlain by flows, welded tuffs and tuffaceous or clastic sediments which are similar in composition to the older extrusives. The best exposures of the older volcanics are in drainages and basins. The younger volcanics are preserved in remnants at higher elevations. Throughout the district, the volcanics are disturbed by numerous high-angle faults. Many of the more extensive faults are north or northeast-striking.

"Basement" exposures of western facies sediments exist in windows and faulted wedges within the predominately volcanic terrain. Interbedded cherts and quartzites are exposed along a roadcut one mile south of the Falcon mine. In the western portion of the district, the volcanics overlie sandstones and siltstones of the Permian Horse Creek Formation. Presently, all of the ore deposits in the district are hosted by the Tertiary rocks. As yet, none are located in the Paleozoic sediments.

The Mount Neva Pluton intrudes western facies rocks and older andesites and rhyolites approximately 2.5 miles southeast of the Falcon Mine. The intrusive is a hornblende-biotite granodiorite that displays both porphyritic and

granophyric textures. A few small stocks, probably related to the main pluton, are present north and south of the district. A K-Ar age determination obtained from biotite dates the pluton at 38.4 m.y. (Coats and McKee, 1972). Some andesitic dikes or shallow-intrusive bodies may occur in the district (Lawrence, 1963), but none were observed at the minesites we visited.

The ore minerals in the Rock Creek district are deposited in the north-striking fissure veins and shear zones which generally cut the older Tertiary andesitic or rhyolitic flows and tuffs. Siliceous breccias and quartz veins are found on the dumps of most minesites. The breccias usually contain bleached, argillized and silicified volcanic rock fragments. The fragments are cross-cut by vitreous grey quartz veinlets and generally contain sulfides (mostly pyrite). The matrix of the breccias consist of sugary white quartz or banded chalcedony. A few samples display evidence of multiple veining and silicification. The quartz in the breccias usually contains pyrite, cinnabar, metacinnabar (?), and a low proportion of fine grey sulfides not identified. The quartz veins in the district consist of finely banded or swirled opaline or chalcedony. Pyrite is ubiquitous and cinnabar, specularite(?), and Feoxs are common. Some vuggy quartz occupies fault zones, having been deposited along open fractures or cracks. These veins may predate the formation of the more massive chalcedonic veins and veinlets.

The banded chalcedonic veins observed at the Silver V claims average about 1' in width. The veins were emplaced along a north-striking shear zone. The host andesites are bleached white and argillized or silicified along the fault zone. The rocks at the minesites are sheared and iron-stained.

At the Rock Creek "prospect", lenses and veinlets of opaline silica replace a dacite(?) tuff along a highly silicified, steeply inclined,

north-striking fault zone. Dark red to black mercury minerals were observed in the opaline material deposited on fracture surfaces and in replacement pods in the host rock. A sample of banded opalite with fossil reed impressions and scattered sprays of cinnabar was collected from "float" near the adits. The source of the opalite was not found in outcrop exposures at the minesites.

Although stibnite was not observed in any of the vein samples collected from the district, Lawrence, 1963, reports the presence of antimony at five locations, including the Falcon Mine, Fisher (Silver V) prospect, Red Cow prospect, Rock Creek prospect and an occurrence in section 10, T40W, R49E. The most common antimony mineral is stibnite which occurs in vuggy quartz veins or quartz filled fractures within the silicified fault zones. Some white and yellow antimony oxides also occur. At the Falcon Mine, antimony occurs as pyrargyrite in vuggy quartz, chalcedony and in the silicified andesite host.

Current and continued interest in the district is prompted by several factors. The district is relatively little known and lies close to the rich silver-gold deposits of Tuscarora. Also, there are extensive areas of altered volcanics cut by shallow-level, hydrothermal vein and breccia deposits. The district contains a Tertiary intrusive body and is cut by numerous, high-angle structures. Mercury and antimony are known to occur, in addition to silver and some gold. These factors are useful indicators in the prospecting of bulk mineable precious metal deposits.

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RUBY VALLEY DISTRICT

The Ruby Valley or Battle Creek Mining district is located opposite the north end of Franklin Lake on the east side of the Ruby Mountains. The largest mines in the district lie on the ridge between Battle and Myers Creeks at elevations above 7,400'. A few smaller mines and prospects are located just north of Battle Creek and south of Myers Creek.

Between 1908 and 1967, small amounts of lead, zinc, silver, copper and gold were produced from the district (Stager, in preparation). Although the first claims in the district were staked in 1903, tungsten was not discovered until 1943. Intermittent mining from 1944 through 1977 resulted in the production of 5,000 units of WO_3 (Stager, in preparation). The ore produced from the district between 1944-45 averaged about 1.5% WO_3 (Stager, in preparation). Sulfide ore shipped from the Battle Creek group since 1949 contained maximum yearly average grades of 55% lead and 14.2% zinc (Smith, 1976).

From north to south, the district is underlain by Cambrian marbles, dolomites and quartzites. At Myers Creek, the sediments are intruded by Jurassic and Cretaceous granites. The Battle Creek Tungsten mine, the largest working in the district, is located along the undulatory, east-west, limestone-igneous contact.

At the Battle Creek Tungsten mine (sam 1609), a benched slope explores an alternating sequence of marble, quartz monzonite and tactite. The most abundant rock type in the mine area is coarsely crystalline white marble. The intrusive rocks appear to be dikes or fingers off of the main intrusive body which have general north trends. Some pegmatite dikes and quartz veins are also exposed. Lenses of dark green tactite have formed directly adjacent to the intrusives. The tactite is composed of calcite, quartz, pale green tremolite and finely crystalline diopside. It typically contains irregular clots and lenses of sphalerite, pyrite,

galena, chalcopyrite and scheelite. The lead-zinc sulfide minerals also occur in clear to vitreous grey quartz gangue. Vertical fissures within the sulfide-bearing tactite zones are filled with gossan and quartz vein material, both of which contain abundant fine crystals of scheelite. Bleaching and marbelization of the country rocks extends beyond the mineralized areas. According to Stager (in preparation), the main scheelite deposits at the Battle Creek mine occur in several east-west trending lenses of chlorite schist surrounded by granite and pegmatite. The largest lense is 100' long and attains a maximum thickness of 10'.

During our examination of the district in August 1982, the Battle Creek Tungsten mine was actively being worked by Knight Roundy Mining Inc. The recent work consisted of road improvement and extensive trenching of some of the minesites. At that time, it appeared as though preparations for small-scale tungsten production were underway.

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SAFFORD DISTRICT

The main mines in the Safford district occupy Palisade and Safford Canyons located about 13 miles southwest of Carlin at the north end of the Cortez Mountains. A few minor prospects included in the district are scattered throughout the low mountains north and south of Barth, a railroad siding in Palisade Canyon about 4 miles southwest of the old townsite of Palisade.

The major mine in the district is the Barth, or West, iron mine which lies at Barth siding on the junction between Safford and Palisade Canyons. Discovery of the outcropping ore body apparently preceeded 1869 (Roberts, et al, 1967), but the first major production occurred between 1903-1918 when almost 550,000 tons of iron ore were recovered by the American Smelting and Refining Co. (Couch and Carpenter, 1943). The mine was inactive until drilling of a magnetic anomaly indicated the presence of an extended ore body. Problems with flooding curtailed mining until 1960 when flood waters were averted by the construction of a new channel for the Humboldt River (Roberts, et al, 1967). From 1961 through 1964, almost 600,000 tons of ore with an iron content between 63-64% were shipped from the mine. Mining of the deposit continued fairly regularly until operations ceased in February 1980 when the open pit intersected the water table 300' below the surface (person. comm., M.R. Healy). At the time of our June, 1982 visit, stockpile ore was being shipped to Provo, UT and other destinations 3-4 times a week. Crushing and screening occurs on a weekly basis. The mine is operated by Nevada Barth Corp. on land owned by Southern Pacific Railroad Co.

Prior to 1910, more than \$ 200,000 worth of silver ore was produced from two principal mine sites in Safford Canyon, the Onondaga and Zenoli mines (Emmons, 1910). Little is known about the history of activity since that time, but recent exploration activity in Safford Canyon indicates a revived interest in the area. Several of the mines within Safford Canyon are patented.

Most of the Safford district is underlain by Jurassic andesite flows of the Frenchie Creek Rhyolite (Smith and Ketner, 1976). These rocks are host to the iron and silver mineralization in Palisade and Safford Canyons. The host rock at the Barth iron mine is described as an "olivine-bearing hypersthene andesite flow" (Shawe, et al, 1962). The flows dip shallowly westward and are intruded just north of Palisade Canyon and to the east by several small "quartz monzonite, diorite and syenite" igneous bodies of post Jurassic, probable Tertiary age (Stewart and Carlson, 1976).

The iron ore from the Barth Mine consists mainly of red hematite, with minor remnant magnetite and some specularite (Emmons, 1910). The ore occurs in a massive replacement deposit of possible contact metamorphic origin. The deposit varies in form and dimension with depth but generally dips about 40° to the northeast. Networks of hematite extend into the fractured footwall rocks and veinlets of apatite cut the ore zone. The ore is generally high quality and uniform in grade but it contains "undesirably large amounts of phosphorous" (Shawe, et al, 1962). In 1954, a pyrite and pyrrhotite sulfide zone was intersected in a drill hole located southeast of the main ore body (Shawe, 1962).

The silver mineralization in Safford Canyon occurs in north or northwest-striking fissure veins or fault zones cutting altered Jurassic andesites. The veins are described as narrow and non-persistent (Roberts, et al, 1967). The sulfide ore contains tetrahedrite, sphalerite, grey copper, chalcopyrite, pyrite, galena and stibnite (?) in a gangue of quartz, calcite, barite, and manganocalcite. Iron-oxides, copper carbonates and horn silver are present in the upper portions of the vein. Although stibnite is reported from the Zenoli mine, Lawrence, 1963, was unable to locate any during his examination of the area.

The Onondaga mine was visited during our examination of Safford Canyon. One

of several workings at the mine site is a N20W trending adit which explores a N25W striking, 75SW dipping sheeted shear zone in propylitized and silicified andesites. The shear zone extends for about 100' north of the adit. The andesites exposed at the portal are altered to clays, iron-oxides and calcite. Silicified andesite breccia from the dump (sample 167) is cemented by quartz, calcite, barite and iron and manganese oxides. The altered fragments and breccia cement contain unoxidized clots of galena, pyrite and sphalerite (?). Below the portal, exposed along a new exploration road, the andesites are propylitized, fractured and cut by calcite veins. Throughout the exposed roadcut, the rocks contain abundant fine-grained pyrite and are coated by minor copper oxides. Further up the canyon, at the Safford Canyon mine, two barite veins are exposed in bleached, altered quartz latitic volcanic rocks (Papke, in preparation). The width of the veins range from 6" to 4' and their strike lengths are about 130' and 150'. Exploration work has been done in Safford Canyon during the past few years. Several drill areas are located within the canyon and there has been extensive chip sampling of altered rock exposed along new roadcuts near the mines.

Shallow shafts and prospects located within Palisade Canyon and in the low mountains north and south of Barth explore copper-bearing fractures or faults in andesites and basaltic andesites. The main minerals are malachite, azurite and pyrite, but bornite, chalcopyrite and chalcocite were also observed. The host rocks are generally fractured and silicified adjacent to the mineralized areas. The workings are of minor extent and no recent activity was noted in these areas.

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SCRAPER SPRINGS AREA

The Scrapper Springs area is located about 10 miles northeast of the Midas district and is roughly halfway between Midas and the Burner Hills in portions of Sections 2, 3, 4, 5, 8, 9, 10, 15, 16, and 17, T40N, R47E. Until recently, the only mineral activity in the area was centered around an occurrence of zunyite which was found on the summit north of Scrapper Springs. The zunyite, discovered by Coats of the U.S.G.S. while mapping in the area in 1979, was investigated in 1980 by the U.S.B.M. as a potential source of refractory material. The presence of zunyite, a complex hydroxy-fluoro-chloro aluminum silicate mineral indicative of advanced argillic alteration, later caused some interest to be generated in the area for precious metals exploration.

Rocks in the Scrapper Springs area consist of a sequence of andesites, rhyodacites, and tuffs which have been, in some areas, pervasively propylitized and, locally, silicified. Coats (1979) believes that these rocks may be correlative with similar rocks which form hosts for the silver ore bodies at the Cornucopia mining district.

At the zunyite locality, zunyite occurs in a hydrothermally altered breccia in andesite and tuff. The breccia zone is well exposed along a ridge for 900 feet and is traceable for an additional 1200 feet along strike. Thicknesses ranging from 12 to 62 feet have been reported (McMahan and Pierce, 1981). Drilling in late 1981 by the U.S.B.M. on the zunyite occurrence did not confirm the presence of sufficient refractory material to be commercially

important. Some pyrite was, however, encountered in the drilling but not specifically analyzed for metallic elements. Other zones of hydrothermal alteration were outlined by the U.S.B.M. both north and south of the original zunyite discovery area. To the north, hydrothermally altered andesite breccia containing alunite was found along a N45°E structure. To the south, in the southwest quarter of Section 15, T40N,R47E, another hydrothermally altered zone is described along a N25°E structure in andesite breccia. Also to the south of the zunyite location, about one mile along the road leading to the northwest from the old corral at Scraper Springs, an old prospect exposes brecciated, iron-stained rhyolite along a fairly strong east-west structure. Hairline quartz veinlets lace the rock, and trace amounts of an unidentified blue-black metallic mineral are present. Stibnite has been reported in a quartz vein near this location, and it is possible that the fine-grained mineral is also stibnite.

At the time this area was examined in August 1982, U.S. Steel Company had recently staked a large block of claims covering the area from Scraper Springs to the north toward the zunyite.

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SNOWSTORM MOUNTAINS AREA

The Snowstorm Mountains area is located on the north slope of the northern Snowstorm Mountains along the Elko-Humboldt County line in the extreme western portion of the Elko Resource Area. The area lies in generally remote country northwest of the town of Midas, west of the south fork of the Little Humboldt River. The only known prospects are along the drainages of First Creek and Snowstorm Creek, both northeast draining creeks which are tributary to the Little Humboldt.

The geology of this area is very poorly described. On the open-file geologic map of the area by Hope and Coats, 1976, the area is shown to be underlain by rhyolitic to dacitic flows and domes of Miocene age. Regional faults trending northeast and northwest cross the area.

The Snowstorm Range has the general appearance of a tilted block with a steeper southwest face and a more gently dipping northeast slope. The northwest-trending faults appear to be concentrated along the southwest face of the range and along the drainage of the Little Humboldt to the northeast. Snowstorm Creek, First Creek, and other small creeks on the eastern slope of the Snowstorms parallel the northeast trending faults.

The rocks exposed in the First Creek-Snowstorm creek area are a series of rhyolites and rhyolite flow breccias which now dip gently to the northeast. Individual flow units form spectacular columnar outcrops along cliffs or breaks, many of them marked by aspen groves and springs.

The small prospects visited at First Creek expose a vertical fracture zone which cuts a moderately kaolinized ash layer. Iron oxides and some calcite occur along a narrow breccia zone following the N70°E fracture system. No sign of recent activity was seen in this area.

The Snow claims, on Snowstorm Creek, cover an area of brecciation, iron staining, and moderate alteration in an outcrop of rhyolite flow or possibly welded tuff. The area of brecciation appears to include most of the area of a small, round hill located between two forks of Snowstorm Creek. This could mark the outcrop of a dome or plug which cuts the flow units. Rocks on the dumps of the prospects here are composed of fractured, moderately kaolinized breccia cemented with vein quartz. Some quartz veins are three to four inches thick, some have open centers, and some show quartz after calcite pseudomorphs.

The prospects here are fairly old, probably dating to the 1920's or 1930's. The area was staked in 1980, but no signs of recent exploration work were in evidence when the property was visited in August, 1982.

Both periods of prospecting activity here were, no doubt, for gold. The Midas district is located a little over ten miles to the southeast in similar rocks and the largely unexplored ground extending from Midas to the Snowstorm area could host other gold ore bodies.

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SWALES MOUNTAIN DISTRICT

The Swales Mountain district is located in the southern Independence Mountains about 15 miles north of Carlin. Most of the mines are located on the east slope of Swales Mountain, the southernmost peak of the Independence Mountains. Three barite mines located on the west flank of the range lie 3 to 4 miles west of the main district.

The mineralized zones at Swales Mountain are small and according to Smith, 1976, were never productive. However, judging from the size of the workings at the High Top claims, there may have been some minor production of gold or silver in the past. In 1973, two men were mining turquoise from cherts at the Edgar Turquoise mine (Mineral resource inventory of Elko Planning Units, Elko BLM report, NE9-4, 1976?). The mine is located about two miles southwest of the main district. During our examination of the district in August, 1982, little activity was noted other than recent staking and sampling.

The geology of the Swales Mountain area was mapped by the USGS in 1967 as part of a program to study the mineral potential of the area. The results of the study were later published by Evans and Ketner, 1971 and Ketner, et al, 1968. The geology is summarized as follows:

"At Swales Mountain these two diverse rock assemblages (siliceous western facies and carbonate eastern facies) have been juxtaposed by a thrust that postdates Early Mississippian limestone of the miogeosynclinal facies. The carbonate assemblage is exposed in a window through the thrust fault on the east side of Swales Mountain. The lowest strata exposed in the lower plate are tentatively assigned to the Silurian Roberts Mountains Formation. Along a secondary thrust fault, Devonian limestone has been thrust over the Silurian and Mississippian limestones. The upper plate of the main thrust consists of Ordovician chert and shale of the Vinini Formation. The Paleozoic sedimentary rocks and the thrust

faults have been folded and faulted and intruded by Tertiary monzonite porphyry and quartz porphyry. Tertiary latite flows, sandstone, and vitric tuff lie above the older rocks of the quadrangle. (Evans and Ketner, 1971)."

The main part of the Swales Mountain district is located in a lower plate window composed of dark-colored, silty limestones and minor sandy and shaley interbeds. The limestone units have been correlated with rocks exposed at the Carlin Gold mine, namely the Silurian Roberts Mountains Formation and the Devonian-Mississippian Popovich limestone (Ketner, et al, 1968). However, at Swales Mountain the Roberts Mountains Formation is more thickly bedded and does not display its characteristic fissility.

Intrusive rocks are abundant in the Swales Mountain area. The intrusives are composite bodies consisting of stocks, dikes, sills and shallow-level flows. Radiometric age dates from potassic minerals separated from the bodies range from 37-41 my, indicating they are of mid (?) -Tertiary age. Field relationships show that monzonite porphyry is the youngest rock type and intrudes bodies of quartz porphyry. The monzonite also cross-cuts thrust faults and high-angle faults in the area. Both the monzonite and quartz porphyries intrude lower and upper plate rocks.

At the minesites, the intrusive stocks form resistant, jointed, blocky outcrops. Near sample locations 1550 and 1570, quartz monzonite porphyry is weakly propylitized and contains clots and lenses of chlorite and epidote. In other areas, the monzonite is kaolinized or silicified and bleached. Feldspar phenocrysts are usually altered to clays and the matrix is generally iron-stained. Also, dikes of various composition are present at the minesites and may be directly related to the mineralization. At the High Top claims, a light-green colored, monzonite porphyry dike contains abundant fine-grained pyrite. The dike strikes N50W, is about 3' in exposed width and is directly adjacent to the mineralized zone. There is good

evidence that some of the dikes were intruded along pre-existing fault structures (Evans and Ketner, 1971).

The workings in the main district consist of clusters of small shafts, adits and prospects which are developed in limestone adjacent to the eastern and southern margin of a north-south elongate, monzonite porphyry stock. The ore deposits are typically vein-shaped skarn or gossan (replacement) zones which strike north or northwest and dip moderately to steeply to the west or southwest. The "veins" are several feet in width and generally conform with the bedding of the enclosing sediments. Most of the deposits occur within wider zones of silicated limestone. Some of the mineralized zones have sharp upper and lower contacts with unaltered or recrystallized, calcite veined limestone and therefore have a vein-shaped appearance. Well defined contacts between the veins and unaltered wallrock may be an indication that these deposits are structurally controlled by either bedding, fracturing, faulting or even host rock composition or porosity. Brecciated, copper-stained quartz vein from Gold Prospect # 1 indicates this deposit is fault related.

All of the ore zones contain clay gouge and abundant iron, manganese and copper oxides. Post-ore faults and fissures cut the mineralized zones at high angles.

The skarn at the minesites is composed of yellow-green garnet, pyroxene minerals, epidote and quartz. The samples are dense and often fractured. In some areas the skarn displays a sugary or marly appearance possibly inherited from a silty host rock. Chalcopyrite, pyrite and copper carbonates occur in clots, lenses and veinlets of all the skarn samples collected from the district. In addition to these minerals, the skarn contains minor scheelite (at the Gold Prospect # 1), bornite and specular hematite (at sample locations 1550 and 1570).

Gossan is abundant on most of the dumps. It generally is vuggy, siliceous and displays boxworks. Some of the gossan samples contain remnant pods of sulfides

and vugs lined with hemimorphite.

Mineralized rock from the Swales Mountain area was sampled and analyzed by the USGS. The results from the study are published in USGS Circular 588. Their findings are as follows:

"A few samples from these areas contain as much as several tens of parts per million of gold, several hundred parts per million of silver, more than 100 parts per million of molybdenum, and thousands of parts per million of lead, zinc, and copper, but most samples are leaner (Ketner, et al, 1968)."

Core from three drill holes was analyzed for metals at regular intervals. The core rock showed some slightly anomalous horizons of gold (0.02-0.1 ppm), mercury, molybdenum and barium but in general their metal contents "are too low to be of any immediate significance" (Ketner, et al, 1968). Two of the holes were drilled in lower plate rocks and one began in the upper plate, intercepted the thrust zone and bottomed out in lower plate limestone.

Several small prospects and adits are located 1-2 miles southwest of the main district in upper plate rocks which are intruded by stocks and north-south dikes of quartz and monzonite porphyry. Alteration of the siliceous host rocks includes bleaching, fracturing, recrystallization and iron-staining. At the Bad Apple claims (section 6, T35N, R53E), altered mudstones of the Ordovician Vinini Formation contain small veinlets of malachite and fracture surfaces coated by copper and iron oxides. The porphyry at the minesite is altered, bleached and cut by random veinlets of "punky" iron and manganese oxides. The alteration of the intrusive rock ranges from kaolinitic to silicic. Below the workings there are several quartz porphyry dikes which form resistant, iron-stained outcrops. The USGS collected samples from this area which contain more than 10 ppm Mo, 70 ppm Ag and 1 ppm Au in addition to some Hg, Cu, Pb and minor Zn. (Ketner, et al, 1968).

The barite mines located west of the main district are developed in mudstones,

cherts and minor limestones of the Ordovician Vinini Formation. The barite is bedded and occurs in units approximately 10-20' in width. The units are usually conformable with the bedding of the host rocks. Dikes and jasperoid are present locally. The most productive deposit is the Longshot mine (section 28, T35N, R52E) which showed renewed activity during a visit to the property in 1980 (Papke, in preparation).

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TUSCARORA DISTRICT

The Tuscarora mining district lies at the foot of Mount Blitzen on the east side of the northern Tuscarora Mountains about 52 miles northwest of Elko. The district historically includes placer deposits on McCann Creek below Beard Hill, and lode prospects and mines in the area generally extending from McCann Creek to the east and northeast around to the present location of the town of Tuscarora. The mining areas are concentrated in the southern half of T40N, R52E, and the northern tier of sections in T39N, R51E.

Placer gold deposits were discovered in the early summer of 1867 along McCann Creek, and mining activity was concentrated in the area around Beard Hill up until 1871 when high-grade silver veins were discovered to the east near the site of present day Tuscarora. Silver production from these veins extended from that time through about 1895, with 1878-79 being the banner production years. In 1890, the Dexter gold deposit, located along the south edge of the town, came under development and provided the bulk of Tuscarora's production through 1905. Only minor production has been reported from the Tuscarora district since the Dexter declined in 1905.

Beginning in the mid-1930's and continuing to the present time, Tuscarora has been the site of numerous exploration ventures, most of them concerned with developing large tonnages of lower grade gold-silver ore which would be minable by bulk methods. In 1979-80, a dump leaching operation began, and many of the large dumps remaining from the pre-1900 operations were removed to the leach site just southwest of town for treatment. In 1982 when the district was visited, this operation was inactive.

Most of the Tuscarora district is underlain by bedded andesite breccias and tuffs with interbedded andesite flows. These rocks are intruded in many places within the district by irregular bodies of dark green andesite. To the north, on the edge of the mineralized area, a small block of Ordovician quartzite and chert crops out, and a large stock intrudes the section northwest of the district.

The bedded andesites are regionally tilted 15° - 50° E or SE, are steeply domed around the intrusive plug, and are cut by shear zones which trend east or northeast and dip steeply (Smith, 1976).

The intrusive andesite bodies which cut the bedded series are as much as half a mile wide and a mile long. The best documented contact between the bedded series and the intrusive andesites is along the Dexter structure on the south edge of the district. Here, the contact dips to the north at about 30° . The intrusive andesites are cut by steep north-south and east-west structures (Smith, 1976). Four different kinds of ore bodies have been mined over the years within the Tuscarora district. Earliest mining took place on placer gold deposits which had formed in Quarternary gravels that blanket the flanks of the range below the lode outcrops. Silver-rich vein occurrences were mined from the steep structures which cut the intrusive andesite body in the central part of the district, and gold-bearing stockworks were mined along the bedded andesite-intrusive andesite contact (the Dexter zone). In 1940, mercury deposits were discovered in the Berry Creek area and north of Tuscarora at the Red Bird property. Mercury mineralization occurs in altered, brecciated andesite along shear zones.

Both bedded rocks and the intrusive andesite bodies that cut them are extensively propylitized. Silicification is localized near the ore occurrences,

and adularia is found near the centers of mineralization. Adularia from one of the east-west striking silver veins along the north side of the district (the DeFrees vein) has been dated at 38 m.y. (McKee and Coats, 1975). This is described as being the oldest Tertiary epithermal vein mineral deposit in northern or central Nevada (McKee and Coats, 1975). For a district with as long a production history as Tuscarora, the detailed geology of the ore occurrences has not been well described. The contact relationships of the bedded series and the intrusive bodies are obviously important, yet a detailed map of the district geology is not available. In the central part of the district, the major ore occurrences are concentrated generally along two major shear zones which trend east-west and coincide with the north and south margins of one of the intrusive andesite bodies. North-south fissures which cut this body are also mineralized, and ore chutes appear to occur in the north-south structures at or near their intersections with one of the major east-west structures. The Navajo silver lode occurred along the west side of the district along a north trending structure near its intersection with the east-west Dexter contact-shear zone. The Dexter itself occurred along the east-west contact-shear zone. To the north, the Belle Isle, North Belle Isle, Commonwealth, and North Commonwealth were mined near the point their north-trending veins approached an intersection with the east-west structures which pass through the Grand Prize, Argenta, Independence, and DeFrees mines. Ore bodies in the Grand Prize, Argenta, Independence, and DeFrees were along the east-west fissures, but are reported (Smith, 1976) to have pitched northward along the structural intersections. There are areas in the district where potentially important intrusive contact-shear zone intersections may occur but are obscured by gravel cover. A detailed mapping program in the Tuscarora district could be rewarding.

There are also placer occurrences remaining in the district which could be of future importance. Several placer exploration ventures have examined gravels located along the mouth of McCann Creek from the area of the Quarter Circle S ranch to the Owyhee River. The gravels contain gold and, although are in an environmentally sensitive area, could someday constitute a minable resource.

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UNION DISTRICT

The Union district is located around the south end of Union Mountain, an eastern ridge of the Sulphur Springs range about 45 miles north of Eureka. The district is along the Elko County-Eureka County line; the original mining area is in Eureka County but there are numerous prospects in both counties.

According to Vanderburg (1938), the first discovery in the district was in 1886, a small smelter was built in 1887, and several hundred tons of silver-lead ore were treated. Union Mines Co. operated in the district between 1915 and 1918, mining and shipping 7088 tons of ore. Minor silver-lead production is credited to the Union Mines property in 1951 and again in 1955.

Barite has been known in the district, occurring both as replacements in Devonian rocks and as a gangue mineral with metallic occurrences. The Bear mine produced barite in 1948-49 (Horton, 1963), and small tonnages have been produced at the Brown Sugar and Jeanne Marie properties (Papke, in preparation).

The Union district is underlain by chert and shale of the Vinini Formation which have been thrust upon Devonian limestone (Roberts et al., 1967). The geologic relationships within the district and the surrounding area are complicated by numerous northwest-trending faults which cut the section in the general area between the main Sulphur Springs range and Union Mountain. Mineralization at the Union (Bell) mine is reported to have occurred along north and northeast-trending fracture zones, and barite veining at the Jeanne Marie prospect is also reported to follow a northeast trend. The relationship of the two structural trends is not known.

At the Bell mine, the old Union Mines property, mineralization occurred as replacement ores in dolomite; the mines are along a brecciated thrust contact. The ores were mainly oxidized, and cerussite and barite were noted on the dumps. Wallrocks are silicified dolomite and limestone which are highly stained with iron and manganese oxides. Some jasperoid breccia cemented with calcite was noted.

The barite prospects in the district are of two general types, replacement deposits in dolomites of the Devonian Nevada Formation, and vein barite deposits. The vein deposits are also described as being replacements of Devonian dolomite, but the occurrences cross-cut the enclosing rock (Papke, in preparation). Of special interest is the Jeanne Marie deposit (see property description files) where a thick barite vein occurs in an area of barite veining, brecciated jasperoid, and gossanous material. Geochemical results of sampling at this deposit show anomalous arsenic values to be present. A sample taken at the Bell mine also showed high arsenic values as well as high values in lead, zinc, and antimony.

Rocks mapped as Mississippian age, possibly including the Chainman Formation, are shown to be present in this district (Stewart and Carlson, 1976). The presence of these rocks, known to be favorable host rocks for disseminated gold, coupled with scattered samples with anomalous metal content, point to the Union district and the adjacent portions of the Sulphur Springs range as favorable gold prospecting areas.

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GENERAL REFERENCE LIST FOR ELKO RESOURCE AREA

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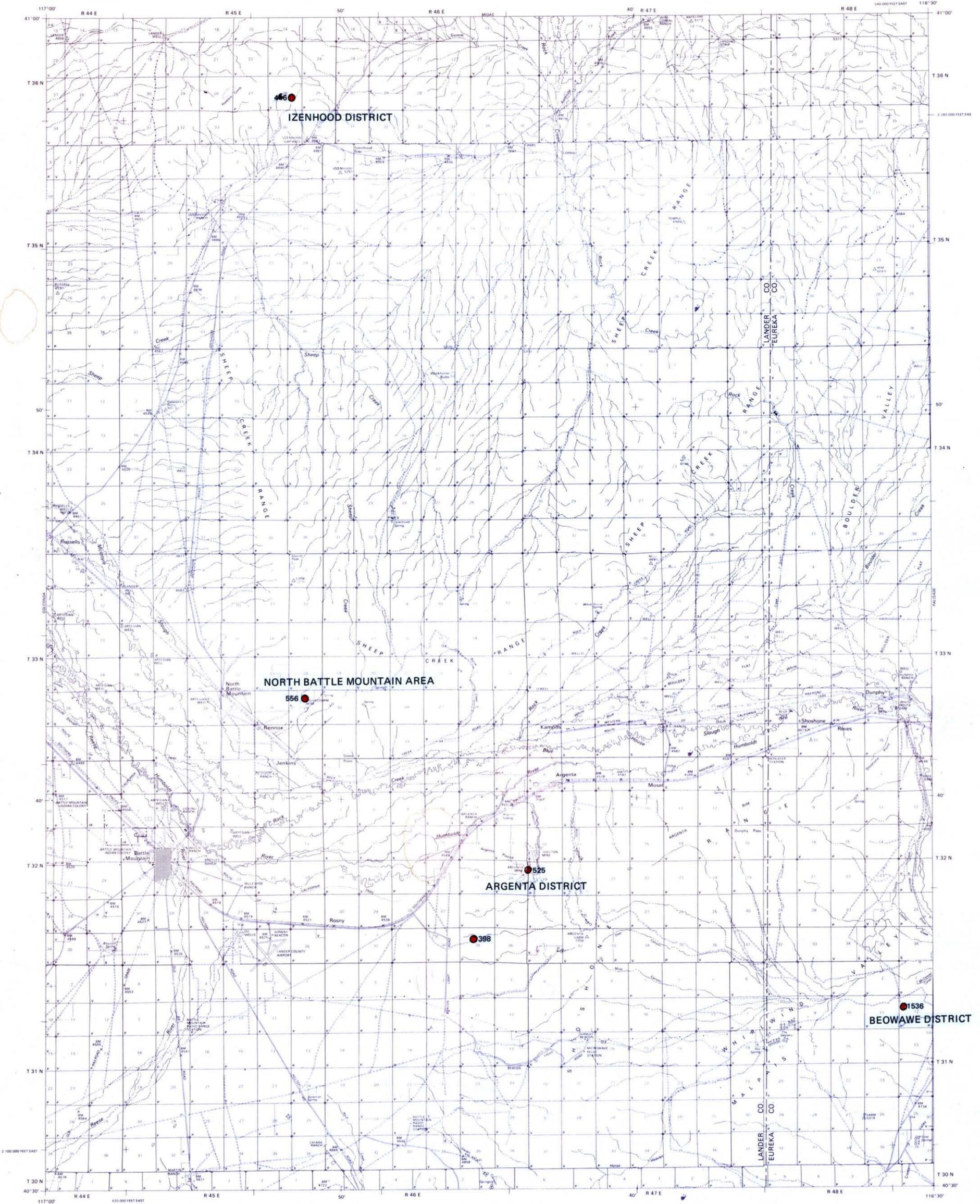
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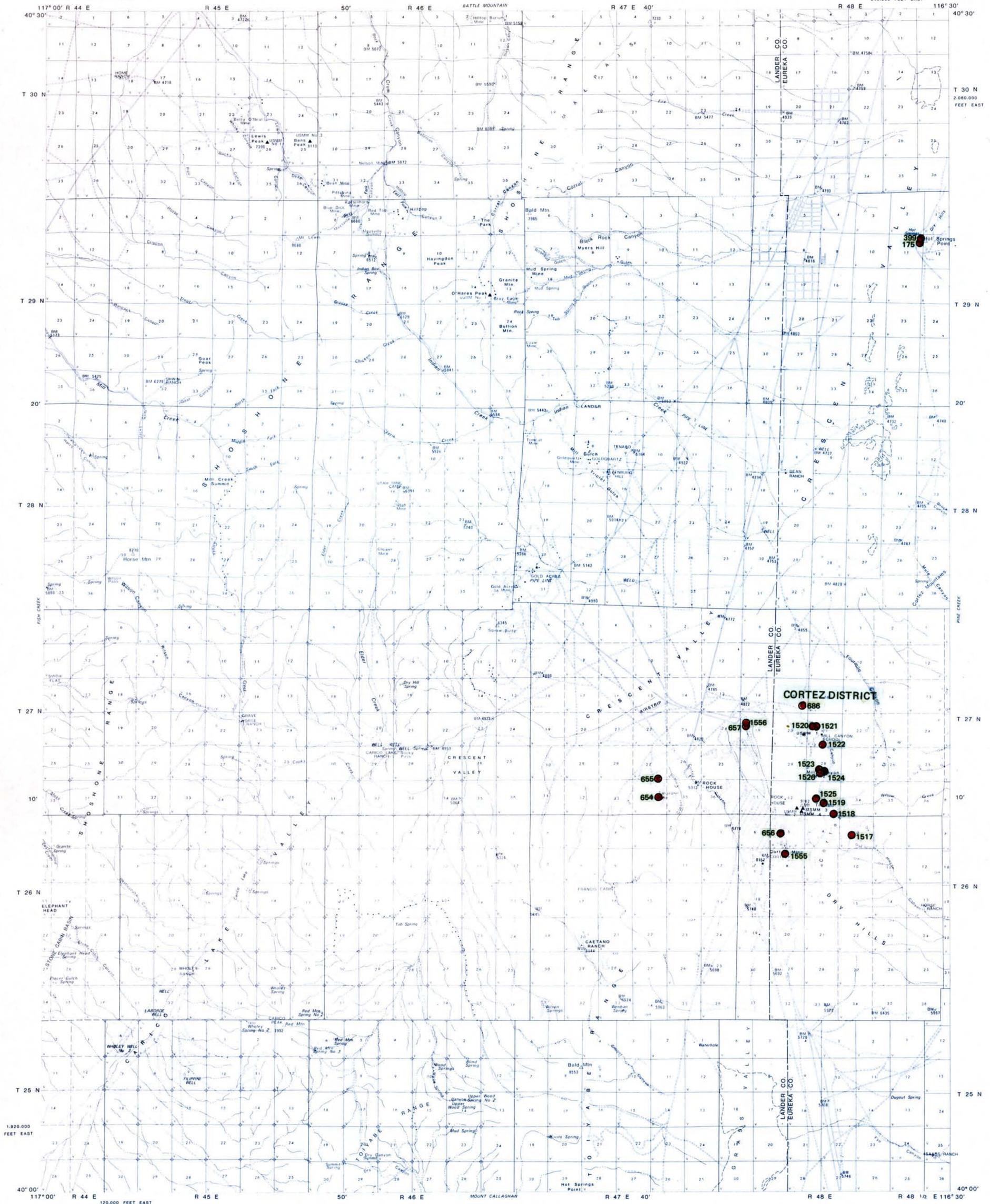
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SOURCE MATERIAL DATA
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A A (C) B. L. M. Compilation
A A (D) State Highway Maps



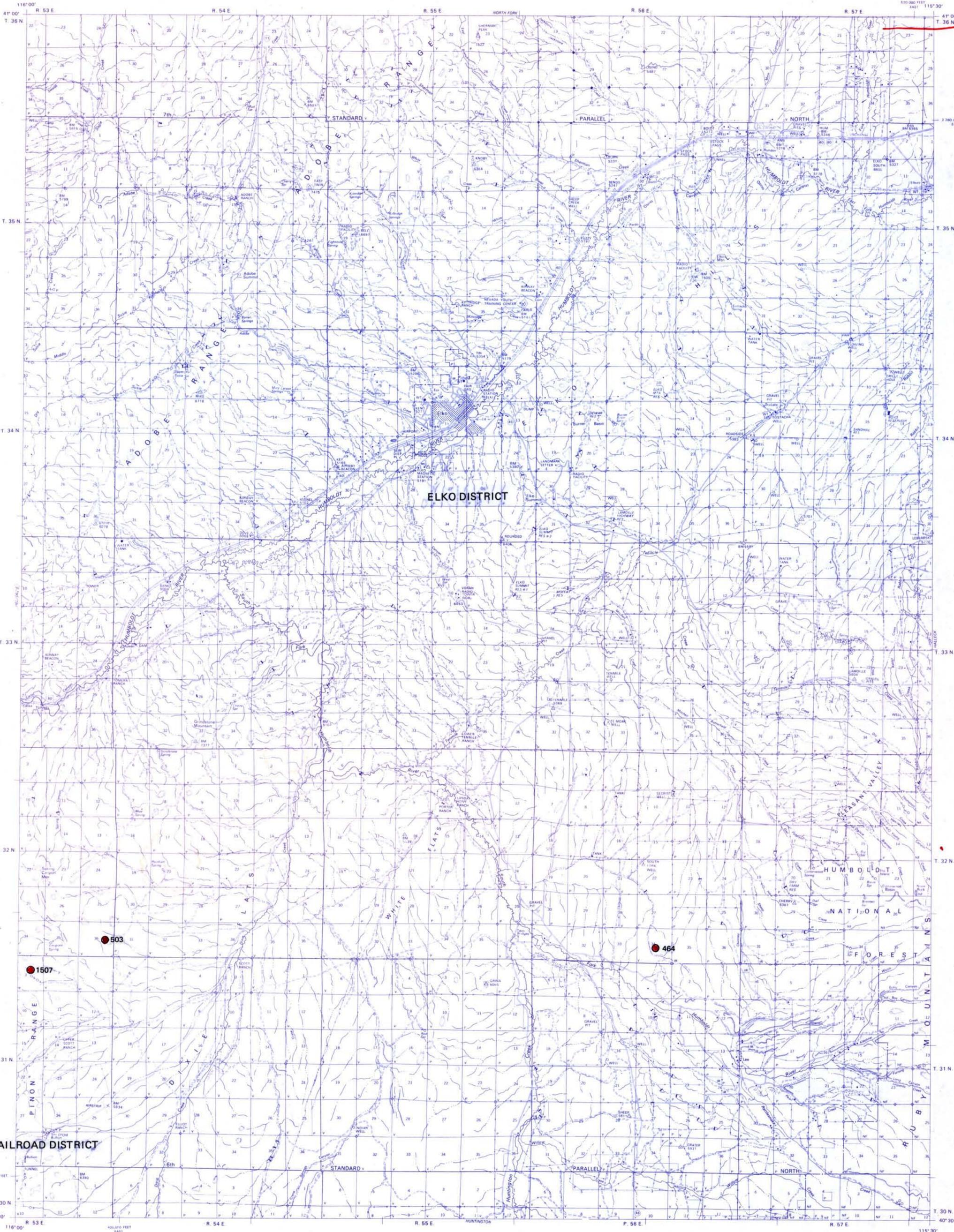
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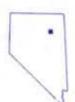


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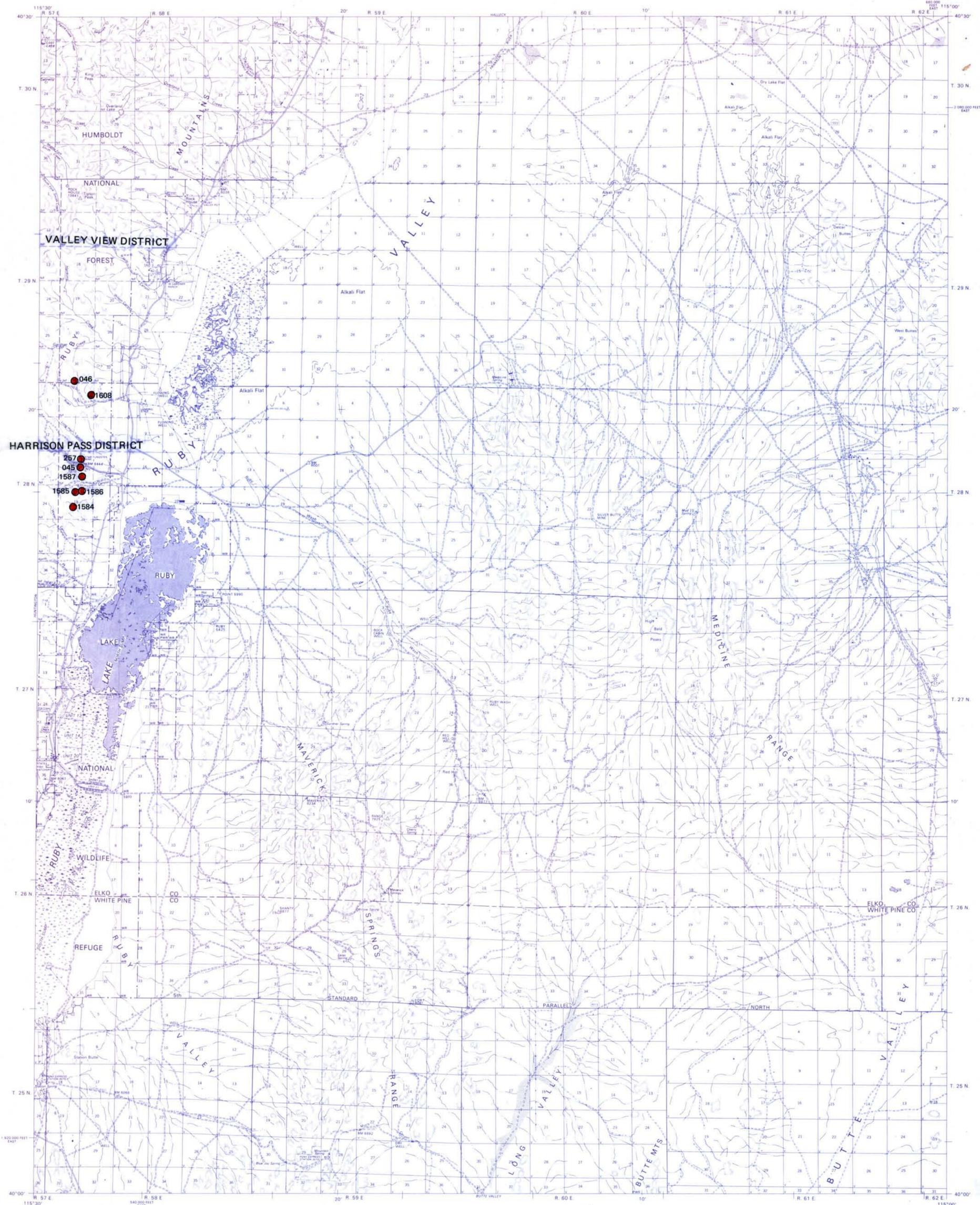


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NBMG 83-9+10B



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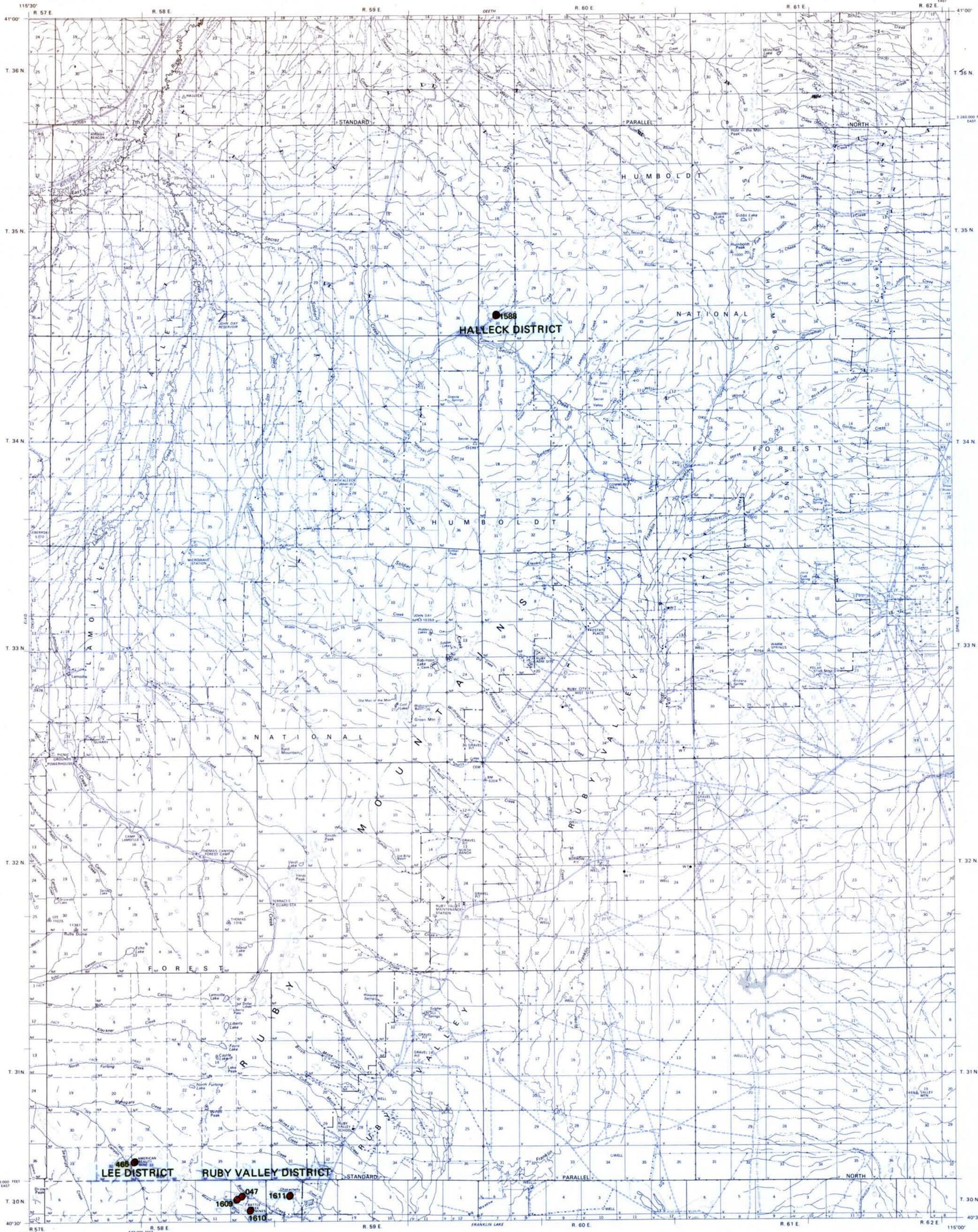


LEGEND

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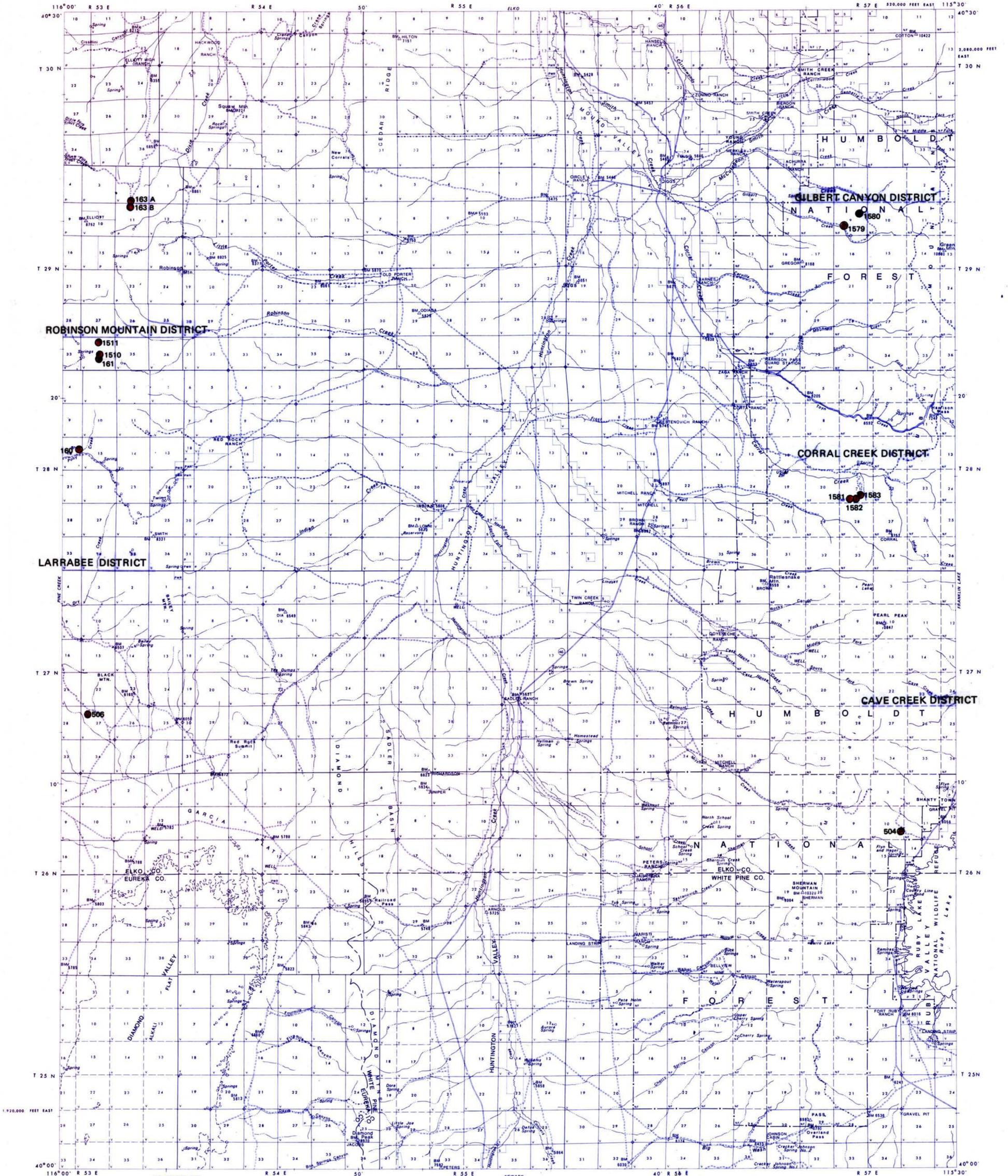


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HALLECK, NEVADA
40-115-1
1970

NBMG 83-940
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SOURCE MATERIAL DATA

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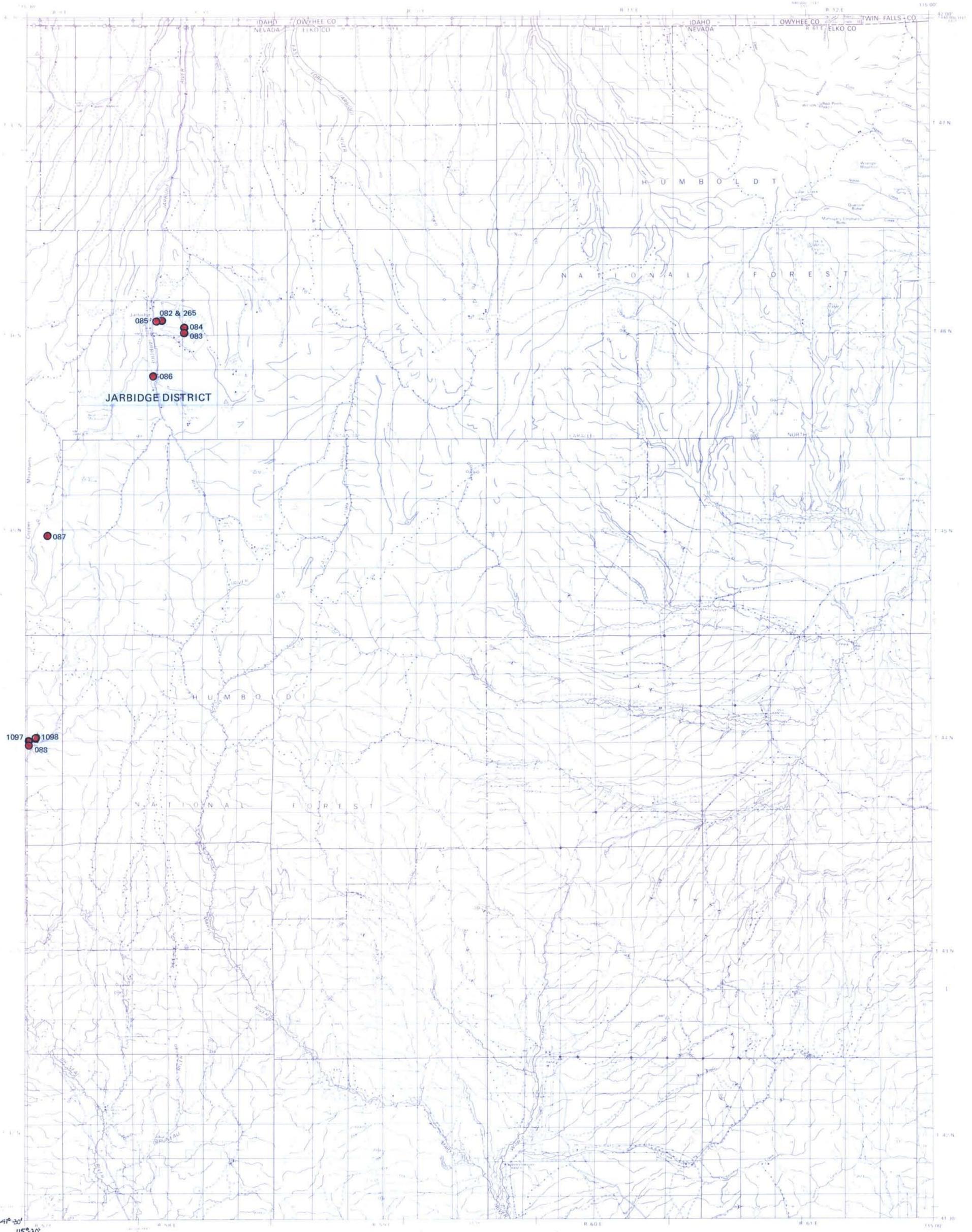
REVISIONS

REVISION	DATE

ROAD TYPES

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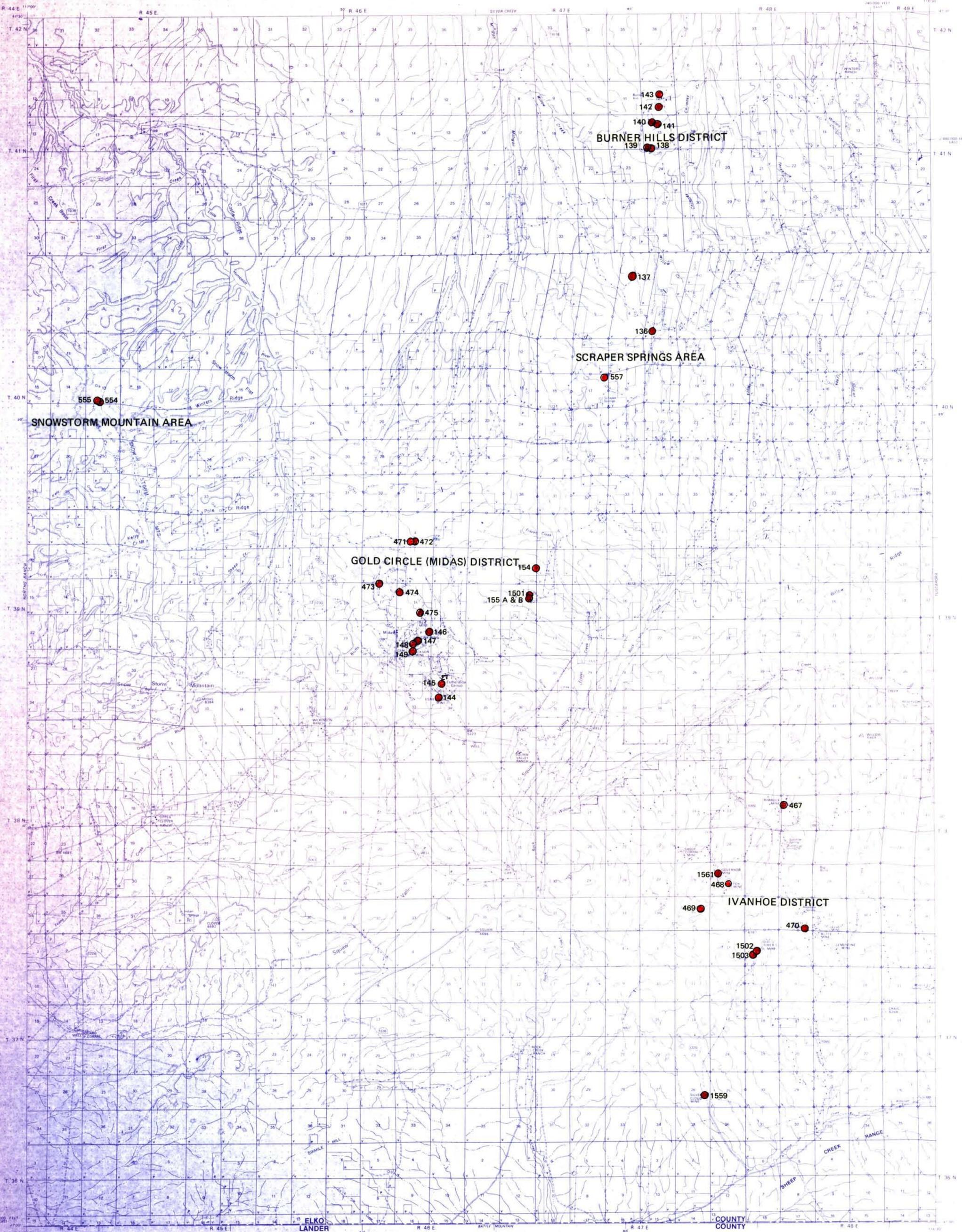
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JARBIDGE, NEVADA

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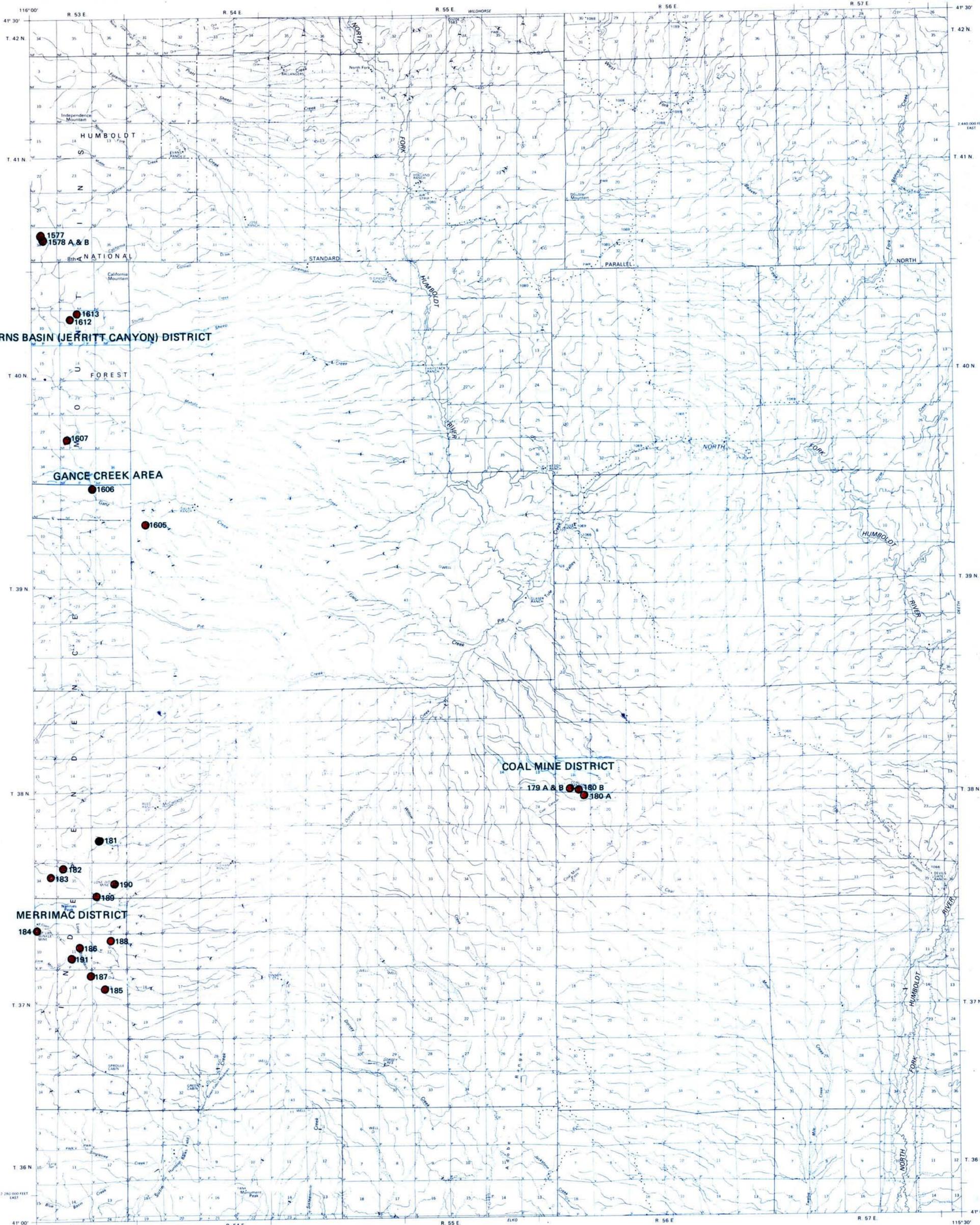


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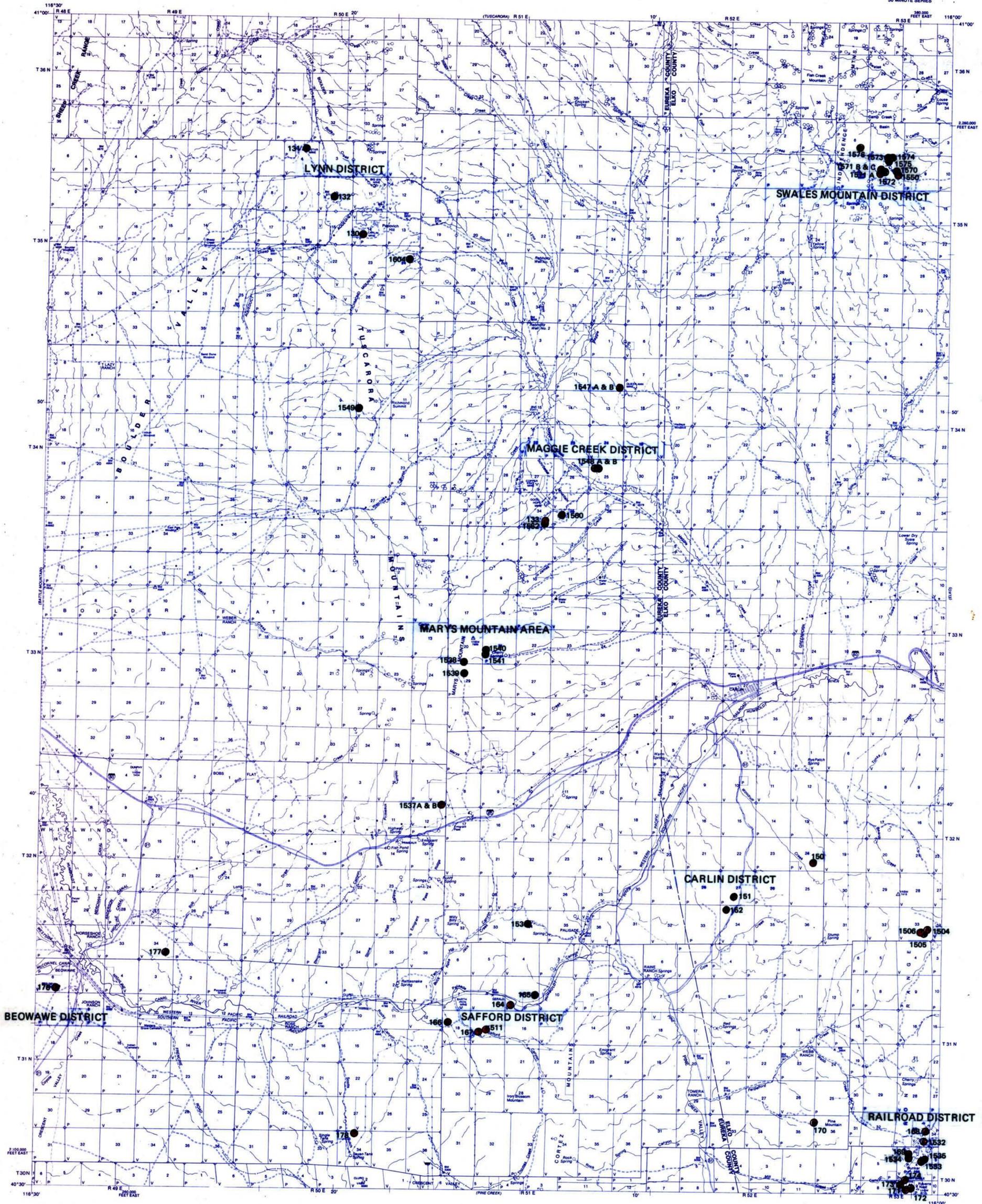


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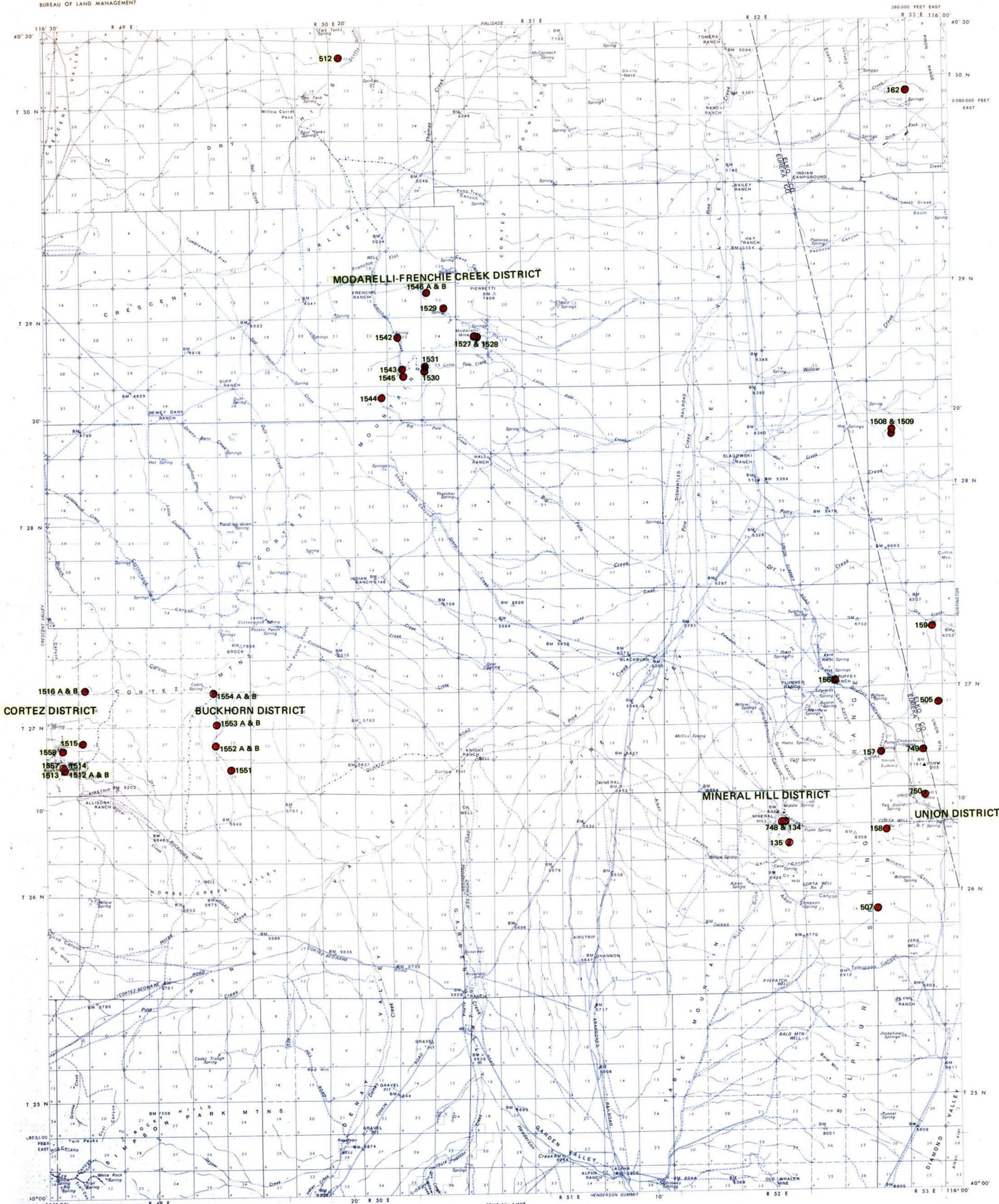


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NBMG 83-910I



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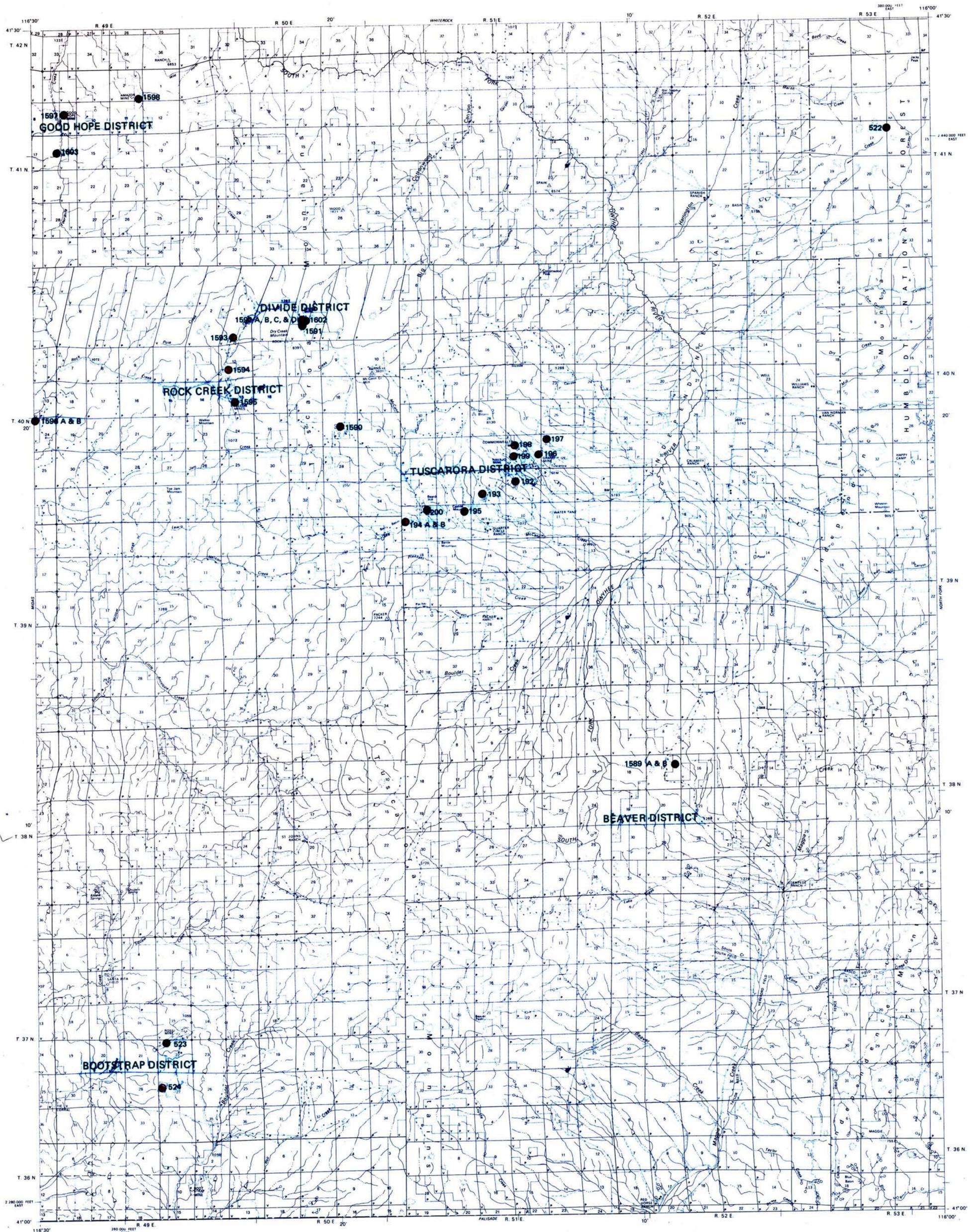
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D	A	(D) State Highway Maps

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REVISIONS	
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ALL WEATHER ROAD PERMITS ROAD
SEASONAL ROAD TRAIL

NBMG 93-9410J



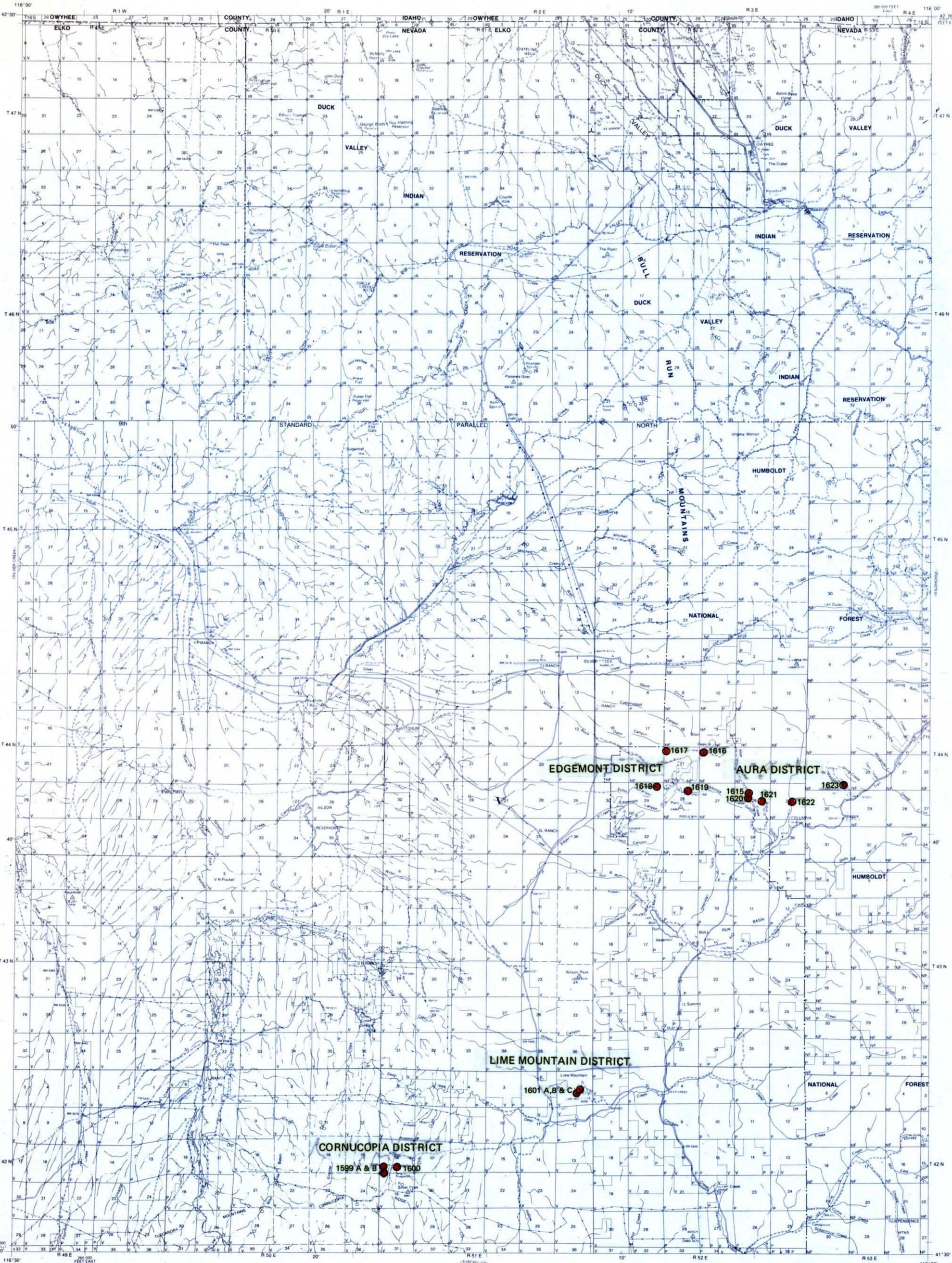
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TUSCARORA, NEVADA
41-116-2
1977

NBMG 83-9+10K



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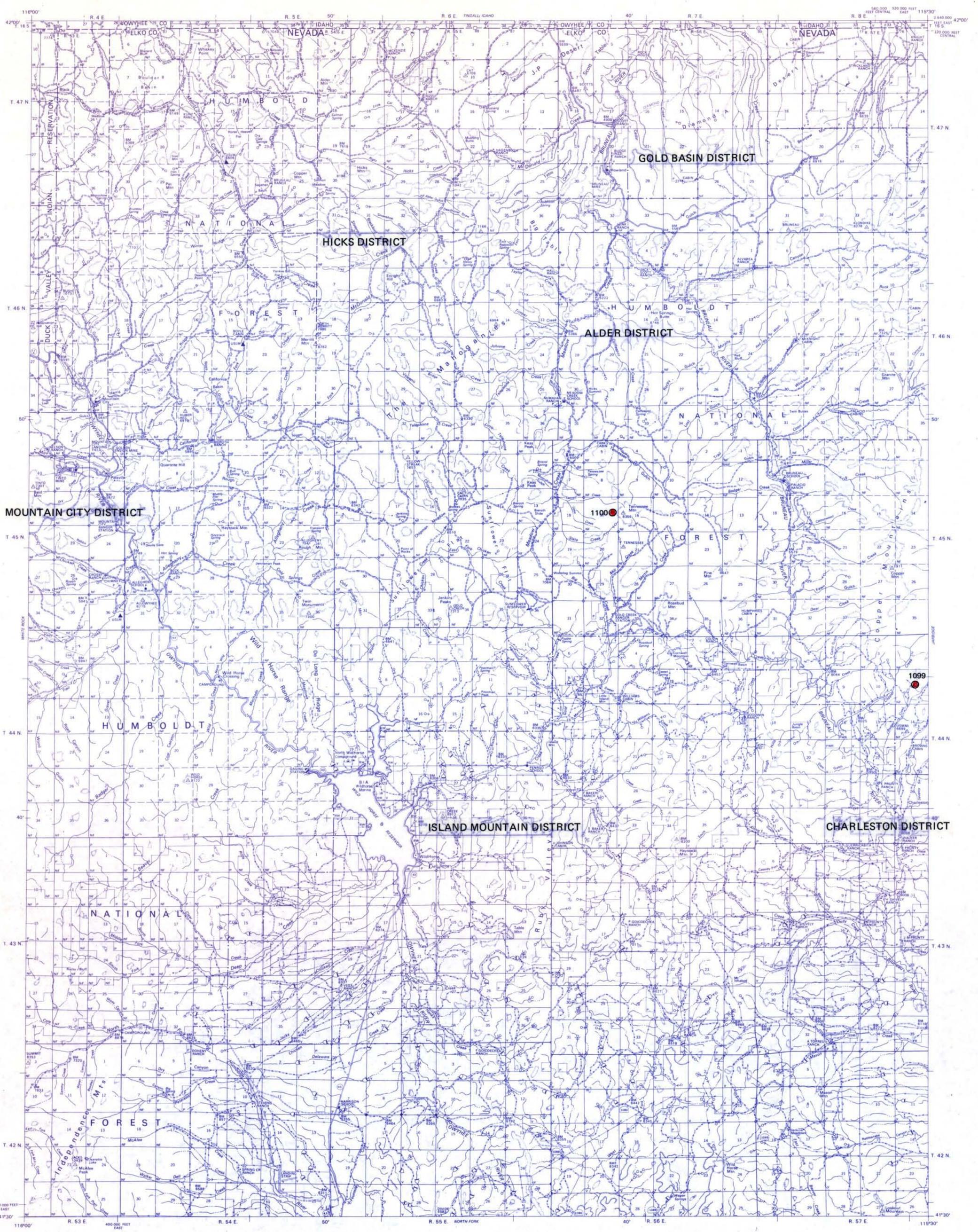
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1978

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- A A (C) B.L.M. Compilation
- A A (D) State Highway Maps

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NBMG 83-9+10L



SOURCE MATERIAL DATA
(A) U.S.G.S. Quad Maps
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Source Material Updated With Photography 1987



WILD HORSE, NEVADA
41-115-4
1970 S/2
1972 N/2

NBMG 83-9410 M