University of Nevada
Reno

Geology and Mineralization of the Atlanta District
Lincoln County, Nevada

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Geology

by

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Very special thanks go to my wife Cindy for typing and the patience to endure the project.
ABSTRACT

The Atlanta District is in eastern Nevada at the north end of the Wilson Creek Range in Lincoln County. Rocks in the district consist of Paleozoic dolomite, shales, limestones, and quartzites which are overlain by Tertiary volcanic rocks and Quaternary alluvium.

Disseminated gold and silver mineralization occurs throughout the district in large jasperoid breccia zones which are developed primarily in carbonate host rocks. In addition, silver-gold mineralization is present as Manto type deposits in the Silver Park area. Gold and silver are thought to have been deposited in a near surface environment at the roots of a hot spring near or above the paleo water table.

Considerable exploration potential exists in the Atlanta District for small disseminated gold deposits of the Atlanta type.
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The Atlanta District is in southern south-central Nevada at the northern end of the Wilson Creek Range in Lincoln County (Fig. 2). The district is an unexplored land but by projecting adjacent survey lines the area appears to be approximately in the center of 770, 6686, S.R. Winnie Base Meridian. The entire area is covered by the northern one-half of the Atlanta, Nevada, 7.5 minute U.S.G.S. Topographic map. A 15 mile gravel road connects the district with U.S. Highway 95 at Pony Springs, a point 30 miles north of Winnie and 77 miles south of Ely, Nevada. Other gravel roads lead into Utah and in several directions to the north. All of these secondary roads are passable to two-wheel drive vehicles. The Silver Park District is approximately one mile west of the Atlanta Mine. A graded dirt road leads to Silver Park from a point which is approximately one-half mile south of Atlanta on the Pony Springs - Atlanta Road. Other parts of the area are usually accessible by use of a four-wheel drive vehicle on the many trails and unimproved roads.
INTRODUCTION

LOCATION AND ACCESSIBILITY

The Atlanta District is in eastern, south-central Nevada at the northern end of the Wilson Creek Range in Lincoln County (fig. 1). The district is on unsurveyed land but by projecting adjacent survey lines the area appears to be approximately in the center of T7N, R68E, Mt. Diablo Base Meridian. The entire area is covered by the northern one half of the Atlanta, Nevada, 7.5 minute U.S.G.S. Topographic Map. A 23 mile gravel road connects the district with U.S. Highway 93 at Pony Springs, a point 30 miles north of Pioche and 77 miles south of Ely, Nevada. Other gravel roads lead into Utah and in several directions to the north. All of the secondary roads are passable to two wheel drive vehicles. The Silver Park District is approximately one mile west of the Atlanta Mine. A graded dirt road leads to Silver Park from a point which is approximately one-half mile south of Atlanta on the Pony Springs - Atlanta Road. Other parts of the area are usually accessible by use of a four wheel drive vehicle along many trails and bull-dozed roads.
Elevations range from about 6,500 feet to 7,500 feet with approximately 400 to 500 feet of local relief common. The topography is a few higher, steeper basins (Fig. 2). The hills are sparsely covered by sage with occasional areas of pinon pine and juniper. A large snowfall in March has been observed in the area. There are several springs and many other small water sources. It appears that mining, exploration, or development has not adversely affected either flora or fauna.

PREVIOUS WORK

Published geologic work on the Atlanta area is very sparse. Meyers (1915) listed a few developments at the Atlanta Mine in The Engineering and Mining Journal, but said little about the geology. Hill (1916) gave a description of the area plus a sketch map of the geology in "Notes on Mining Districts in Eastern Nevada."

FIGURE 1. LOCATION OF ATLANTA DISTRICT
TOPOGRAPHY AND BIOLOGY

Elevations range from about 6,500 feet to 7,800 feet with approximately 400 to 800 feet of local relief common. The topography is one of low rounded hills with a few higher, steeper hills near the Atlanta Mine itself (fig. 2). The hills are generally completely covered by stands of pinon pine and juniper trees with the valleys mostly covered by sage with spotty juniper stands. Near springs aspen trees can be found. The climate is semi-arid with moderate snowfall in the winter. A variety of wildlife has been observed in the area. Mule deer, antelope, coyotes, wild horses, bobcats, rattlesnakes, jack and cottontail rabbits, and many other small mammals and birds have been observed. There are several springs in or near the area which furnish water for wildlife. It appears that mining has not, in any way, adversely affected either fauna or flora.

PREVIOUS WORK

Published geologic work on the Atlanta area is very sparse. Meyers (1915) listed a few developments at the Atlanta Mine in The Engineering and Mining Journal, but said little about the geology. Hill (1916) gave a description of the area plus a sketch map of the geology in "Notes on Mining Districts in Eastern Nevada."

Sharp and Myerson (1956) included a reconnaissance
FIGURE 2. Atlanta peak taken from Silver Park looking east. The Atlanta mine pit is just off the left skyline. Note vegetation of pinions and junipers.
geologic map of the Atlanta area in "Preliminary Report on a Uranium Occurrence in the Atlanta Area, Lincoln County, Nevada." Tschanz and Pampeyan (1970) published a brief description of the Atlanta District plus a 1:250,000 scale geologic map of Lincoln County, which includes the Atlanta District in "Geology and Mineral Deposits of Lincoln County." In addition to these few published reports, there have been several brief unpublished geologic reports on the area done by various company geologists.

PURPOSE AND METHOD OF INVESTIGATION

The Atlanta District was known to contain economic grade mineralization of both precious metals and uranium, but very little detailed information existed on the deposits. This study was undertaken to determine the type and possible extent of the ore deposits, as well as to understand the geology of the Atlanta District. Stratigraphic and structural features, which might control the localization of mineral deposits, were also sought. Geologic mapping of the Atlanta District at a scale of 1:12,000 was completed during the summer of 1977. The base map was a blow-up of the Atlanta, NV, 7.5 minute U.S.G.S. topographic map. Mapping concentrated on areas in and around mineralization in the Paleozoic rock sequence and, in general, was terminated in the Tertiary ignimbrites within a short distance from the contacts with underlying Paleozoic sediments. The area was revisited
several times during the fall and spring of 1977 and 1978 to confirm the geologic interpretations and to map both the Blue Bird Mine and the Atlanta Pit.

Laboratory studies include thin and polished section petrography in order to ascertain rock and ore mineralogy, textures and crystallization history as well as alteration; x-ray diffraction for mineral identification; and fire assay method of chemical analysis.

Field and laboratory information was synthesized to establish the geologic character of the mineral deposits in the district and, based on these characteristics, a model for their occurrence and development was constructed. This model was used in the identification of additional exploration areas in the district.

HISTORY AND PRODUCTION

It is not known exactly when the first mining activity in the district began. Information concerning the early mining history of the district is vague and sketchy.

C. E. Collins (1963) states that

...the area from Pony Springs to Hamlin Valley and Garrison was settled by early Mormon pioneers on small tracts of land. It appears water shortage made farming an uncertain living. Jesse Knight gave leases to the Mormon men on the Silver Park Mine, but no air drills or compressors were ever used or available. Two men, as partners, worked small sections of the surface of the property with hand drills and sorted high-grade silver ore. By spring, they endeavored to have a wagon
load of about six tons, which was then hauled by team and horses to the smelter at Golconda, Nevada.

The ore was said to have averaged 1,813 ounces silver per ton.

Tschanz and Pampeyan (1970) write that the ore deposits in the Silver Park District were discovered in 1869, with production being recorded from 1871 to 1878. Some very rich ore was supposedly hauled from Atlanta to Pioche for milling, but shipment stopped in 1878, because the ores were exhausted. Recorded production prior to 1878 was about $31,500 (Tschanz and Pampeyan, 1970). In October 1913, the Silver Park Mine was leased to Messrs. Devlin and Hoskins. They reportedly shipped a carload of ore that contained 100 ounces of silver per ton (Hill, 1916). After this, there was apparently little work done on the property until the late 1960's and early 1970's.

Boulders and large outcrops carrying free gold were discovered at Atlanta around 1906. The first shaft was sunk to a depth of about 60 feet by George M. Latimer. In June 1909, an option was taken on the property by Elmer M. Bray and Associates and in the latter part of 1911, they organized the Atlanta Consolidated Gold Mining Co. (Meyers, 1915). By October of 1913 the main shaft was 225 feet deep with about 350 feet of crosscuts and drifts on the 100 and 200 foot levels (Hill, 1916). A minor amount of ore was produced and shipped between 1906 and 1915.
In 1934, the Penobscot Mining Company was organized and started more extensive work on the Atlanta Mine. The Penobscot Mining Company ceased operations in 1938 because of a lack of sufficient funds. Very little ore had been produced during this time.

In 1948, C. E. Collins shipped 1,000.41 dry tons from the crosscuts underground to the smelter at McGill, Nevada (Collins, 1954). The ore ran .2075 ounces per ton gold and 1.35 ounces per ton silver. Between 1953 and 1955 approximately 16,000 tons of fluxing ore was shipped to the McGill smelter from a small open pit at the Atlanta Mine. The first 8,000 tons of this fluxing ore ran .3151 ounces per ton gold and 1.10 ounces per ton silver (Collins, 1954). The combined total of the 16,000 tons of ore shipped contained from $6 to $12 in gold per ton and about 0.05 percent U₃O₈. The total value of this fluxing ore was $181,200 (Tschanz and Pampeyeran, 1970).

Uranium was discovered at the Blue Bird Mine in 1954. Between 1954 and 1956 two carloads of ore were shipped which contained slightly more than 0.30 percent U₃O₈, about 1 ounce silver per ton and 0.03 ounce gold per ton. The total value of all silver, gold, and uranium produced in the district up to 1970 is estimated at $270,300 (Tschanz and Pampeyeran, 1970).

In 1966, open pit mining and milling operations commenced at the Atlanta Mine. Problems with the mill and
economics caused limited production up until 1975. In May of 1975, mining began with the operation run by the Standard Slag Company under a joint venture agreement with Bobcat Properties, Inc. The mill is currently processing 120,000 to 135,000 short tons of ore per year.
The Atlanta District area received nearly continuous marine deposition of limestone, dolomite, and quartzite for most of early to mid-Paleozoic time. Aggregate thickness of exposed Paleozoic strata in the Atlanta District is approximately 3,800 feet.

There are no known late Paleozoic or Mesozoic rocks in the Atlanta District. Tertiary volcanic rocks as old as middle Oligocene may rest on any Paleozoic formation in angular unconformity. Quaternary alluvium and fanglomerates rest in unconformity on either the Paleozoic formations or the Tertiary volcanics.

PALEOZOIC ROCKS

Paleozoic rocks in the study area are sediments which were deposited in the miogeosynclinal portion of the Cordilleran geosyncline. They range in age from Lower Ordovician to Lower Devonian. The exposed Paleozoic section consists of approximately 3,800 feet of shallow water marine carbonate, quartzites, and shales. The majority of the carbonate units were dolomitized contemporaneous with deposition or shortly thereafter. In general, fossils are not well preserved in the dolomites and few were found in the
area. The Tank Hill Limestone is the oldest unit followed by the Eureka Quartzite, the Ely Springs Dolomite, the Lake-town Dolomite and the Sevy Dolomite (fig. 3).

Tank Hill Limestone (Upper Pogonip Group)

The oldest exposed rocks in the Atlanta District are the limestones and shales of the upper portion of the Pogonip Group. These rocks are of Lower Mid-Ordovician Age. In Lincoln County the upper portion of the Pogonip Group is referred to as the Tank Hill Limestone (Westgate and Knopf, 1932). The Tank Hill Limestone is approximately equivalent to the Lehman Formation of Hintze (1951). In this paper, I have retained the use of the name Tank Hill Limestone as previous workers in the area have used the name and it appears to adequately cover the rocks in question.

The Tank Hill Limestone is a sequence of thin to thick bedded, dark grey to brown, argillaceous and silty limestone with some shaly interbeds. Fossils are locally abundant and consist of molds and casts of gastropods, brachiopods, and orthocones.

In the Atlanta District the Tank Hill Limestone section is believed to be approximately the upper 600 feet of the Pogonip section. Reconstruction of a stratigraphic column for the formation has been made almost impossible by extreme amounts of faulting and heavy rubble cover. The rubble indicates that there are many shaly layers interbedded
FIGURE 3. STRATIGRAPHIC COLUMN OF THE ATLANTA DISTRICT

<table>
<thead>
<tr>
<th>AGE</th>
<th>UNIT NAME</th>
<th>APPROXIMATE THICKNESS</th>
<th>NOTES</th>
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<tbody>
<tr>
<td>QUATERNARY</td>
<td>ALLUVIUM (Qa1)</td>
<td>0-100'</td>
<td>Qa1, MAY REST UNCONFORMABLY ON ANY UNIT</td>
</tr>
<tr>
<td>TERTIARY</td>
<td>NEEDLES RANGE FORMATION (Tv)</td>
<td>600'</td>
<td>Tv, MAY REST UNCONFORMABLY ON ANY OLDER UNIT</td>
</tr>
<tr>
<td>EARLY DEVONIAN</td>
<td>DEVY DOLOMITE (Dae)</td>
<td>1300'</td>
<td>LOWER CONTACT NOT EXPOSED</td>
</tr>
<tr>
<td>MIDDLE AND LATE SILURIAN</td>
<td>LAKETOWN DOLOMITE (Sl)</td>
<td>1000'</td>
<td>LOWER CONTACT DIFFICULT TO DETERMINE BECAUSE OF POOR EXPOSURE</td>
</tr>
<tr>
<td>LATE OROVICIAN</td>
<td>ELY SPRINGS DOLOMITE (Oes)</td>
<td>540-580'</td>
<td></td>
</tr>
<tr>
<td>MIDDLE OROVICIAN</td>
<td>ZUREKA QUATRIZITE (Oe)</td>
<td>450-480'</td>
<td>UPPER AND LOWER CONTACT OF Oe, SOMETIMES BRECCIATED</td>
</tr>
<tr>
<td>MIDDLE OROVICIAN</td>
<td>TANK HILL LIMESTONE (Op)</td>
<td>600'</td>
<td>LOWER CONTACT NOT EXPOSED</td>
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with the limestone. It is probable that the Kanosh Shale of Hintze (1951) may be exposed but no definite shale unit could be distinguished.

Eureka Quartzite

The Eureka Quartzite was named by Hague (1883) from a section in the Eureka District in Nevada. Kirk (1933) redefined the formation and designated outcrops at Eureka, Nevada as the type section. He described it as a dense vitreous white quartzite with dolomitic sandstone at the top and sandy dolomite and brown cross-bedded quartz sandstone at the base. The Eureka Quartzite is a widespread, uniform sheet of quartzite present over much of eastern Nevada, southeastern California, and western Utah.

In the Atlanta District the Eureka Quartzite is a relatively fine grained, practically pure orthoquartzite. It is white, pinkish white, to light grey in color and sometimes sugary in texture. Generally it is massive and bedding is not discernible. Where beds are observed they are from one inch to four or more feet thick and show some relict crossbedding. In many places red to purple iron staining is prominent especially along faults, joints, and brecciated contacts. In a few locations manganese oxides are present on joint surfaces. The thickness of the Eureka Quartzite is estimated at 450-480 feet in the Atlanta
FIGURE 4. TYPICAL TANK HILL LIMESTONE EXPOSURE

FIGURE 5. TYPICAL EUREKA QUARTZITE EXPOSURE
District. Because of faulting and large amounts or rubble a complete section can only be approximated from the western slopes of Atlanta peak.

The Eureka Quartzite is a very distinctive marker bed in the Atlanta District as well as elsewhere. The stratigraphic position and the lithology are sufficiently unique to correlate it with the Eureka Quartzite in other areas. No fossils were found in the Quartzite but its stratigraphic position indicates a Middle Ordovician age.

Deposition of the Eureka Quartzite may have taken place in a very large but shallow basin in which wave action and currents were very active and able to more or less evenly distribute the sand over the entire basin. The source of the sand is unknown but the complete absence of larger sized particles suggests that the sand may have been moved a considerable distance.

The contact between the white Eureka Quartzite and the underlying dark Tank Hill Limestone is very easily recognized and it appears to be conformable.

**Ely Springs Dolomite**

The Ely Springs Dolomite formation was first described and named by Westgate and Knopf (1932) from exposure in the Ely Springs Range in Nevada. The formation is a dark grey to black carbonate unit which has been described and mapped in central-southeastern California, eastern and southern Nevada, and western Utah. Its age has been determined as Late
Ordovician. Its most closely related lithologic equivalents are the Hanson Creek Dolomite in north-central Nevada and the Fish Haven Dolomite in north-western Utah and southern Idaho.

The Ely Springs Dolomite is generally described as a cliff-forming, dark grey to black, cherty, thick-bedded, massive dolomite with few well preserved fossils. Parts of the formation tend to be lighter in color, thinner-bedded, and more argillaceous. Chert nodules and strengers tend to occur as discontinuous masses concentrated along bedding planes.

In the Atlanta District the Ely Springs Dolomite appears to be approximately 540-580 feet thick. This measurement is hampered by the large amounts of faulting and minor folding which have taken place in the district. The formation is generally a black, medium-coarse grained, massive dolomite with large amounts of chert. No recognizable fossils were found except for several layers of algal balls and remains. These algal ball dolorudite beds are believed to represent an algal bank environment where wave and current action was sufficient to roll the algal colonies to produce a spherical form but not violent enough to produce a completely sparry cement (Chamberlin, 1975). In the mid to upper parts of the formation a few beds of lithoclastic breccia were found. These beds were probably formed by storm action which ripped up pieces of partially consolidated
and lithified sediments and then redeposited them.

According to Chamberlin (1975), the Ely Springs Dolomite contains little insoluble residue except for chert. What resident there is consists of predominantly black, very fine-grained organic material which was probably derived from the algae. This is what gives the formation its dark color.

In general, the Ely Springs Dolomite is a marine carbonate rock body which was deposited on a broad shallow shelf in dominantly subtidal to intertidal environments (Chamberlin, 1975). The bulk of the formation was dolomitized contemporaneously with deposition or shortly thereafter.

The lower contact of the dark Ely Springs Dolomite with the white Eureka Quartzite is very easily identified by the contrast in color between the two units. It appears to be a conformable and gradational contact although in the Atlanta District the rocks near the contact are often brecciated. There are several quartzite beds interbedded with light grey dolomite at the contact.

Laketown Dolomite

The Laketown Dolomite Formation was first described and named by Richardson (Richardson, 1913) from exposures in Laketown Canyon, Randolph County, Utah. The formation is a widespread light to dark grey carbonate unit distributed in
eastern Nevada, Utah, and southeastern California. Its age has been determined as Middle to Late Silurian. Its most closely related lithologic equivalents are the Roberts Mountain and Lone Mountain formations of central and southern Nevada.

The Laketown Dolomite is generally described as a light to dark grey, crystalline dolomite with cherty layers. The formation is generally divided into three parts with two dark, cherty dolomite sequences stratigraphically above and below a light grey, thick bedded dolomite.

In the Atlanta District the portion of the Laketown Dolomite exposed appears to be the lower 800 to 900 feet. The upper contact is not exposed but the section is believed to be approximately 1,000 feet thick. The lower portion of the Laketown is a dark grey to brownish, fine to medium grained, thin to medium bedded, cherty dolomite. The middle part and the bulk of the formation consists of a light grey, coarse grained massive bedded crystalline dolomite. The upper portion of the formation is a dark grey, fine grained, cherty crystalline dolomite. Fossils are poorly preserved and show very little original structure. No recognizable fossils were found in the area. In general, the Laketown Dolomite is a shallow water marine carbonate rock body which was dolomitized contemporaneously with deposition or shortly thereafter.
The basal contact of the Laketown Dolomite with the Ely Springs Dolomite appears conformable when observed. Beds above and below are parallel. In general, in the Atlanta District the contact is not easily recognized because of poor exposures of adjacent units. The contact has been placed at bedding planes which separate black, uniform, medium grained, thickly bedded Ely Springs dolomite below from grey, finely crystalline, thin to medium bedded impure dolomite of the Laketown Dolomite above. At a distance the color difference is usually readily apparent.

Sevy Dolomite

The Sevy Dolomite was first described and named by Nolan (1935) from exposures in the Deep Creek Mountains in west-central Utah. The formation is a widespread, tan to grey carbonate unit recognizable through an area of 100,000 square miles in California, Nevada, Utah, and Idaho. Its age is primarily Early Devonian although some of the lower beds of the unit are Late Silurian in age. Its most closely related lithologic equivalents are the lower portion of the Nevada formation and the Kings Canyon Dolomite.

The Sevy Dolomite is generally described as a fine crystalline to microcrystalline tan and grey dolomite which occurs in beds from a few inches to two feet thick (Osmond, 1962). In the Atlanta District the Sevy Dolomite appears to be approximately 1,300 feet thick. The basal contact
between the Sevy Dolomite and the Laketown Dolomite is not exposed in the area although it should be very near the surface at the southern end of the Sevy exposure (Plate 1). In the Atlanta area the formation is generally a very fine grained grey dolomite which weathers to a light grey surface. No fossils of any type were found in the formation. Beds of dolomite form stair-like slopes which make it easy to identify from a distance. Chert is rare but there are a few layers and stringers in some beds.

According to Osmond (1962), the Sevy Dolomite originated as a primary evaporitic dolomite with redeposited dolomite debris and was formed on extensive mud flats at or near sea-level. The flats were periodically flooded by streams from the east while marine invasions from the west were blocked by a barrier inherited from a Silurian barrier-reef trend in central Nevada.

TERTIARY ROCKS

Tertiary rocks in the Atlanta District are all of igneous origin. The rock units consist of a thick sequence of ignimbrites and a few highly altered dike-like intrusives. The term ignimbrite, as used here, is simply a rock unit term meaning a sheetlike deposit of relatively nonsorted and non-stratified pyroclastic material. The ignimbrites of the mapped area generally form low rounded hills with few outcrops. The rocks range in color from white through all
shades of pink, purple to brown. In general, the composition of the volcanic material is rhyolitic.

Extrusive Rocks

A detailed examination of the volcanic rocks surrounding the Atlanta District was not attempted. There may be several volcanic units within the area mapped but a very thorough and detailed microscopic study would be necessary to differentiate them. This was beyond the scope and intent of this thesis.

The volcanic rocks of the mapped area consist largely of crystal to crystal-vitric tuff which has been moderately to highly welded. The rocks range in color from greyish purple to a light pink. The aggregate thickness of volcanic rocks is approximately 600 feet in the mapped area and they lie unconformably on Paleozoic sedimentary rocks.

A thin section taken from rocks near the Atlanta mine consists of from 20 to 25 percent phenocrysts with the groundmass made of feldspar, quartz and glass. Examination of the phenocrysts shows over 50 percent of them are plagioclase, 20 percent are biotite, 10 percent are hornblende and 5 percent are quartz with a few fragments of altered volcanic rocks.

Using histograms from work done by Cook (1965) it appears that the Atlanta District sample correlates best with Cook's member number two of the Needles Range Formation.
This is probably the Minersville Tuff of Mackin (1960).

The Needles Range Formation was named by Mackin (1960) for exposures in the Needles Range of western Utah. The formation extends from western Utah into east central Nevada and covers an area of about 13,000 square miles (Cook, 1965). Needles Range Formation rocks are usually described as biotite-rich crystal to crystal-vitric tuffs of rhyolitic composition. The rocks are generally massive lithoidal rocks with a moderate compaction foliation imparted by parallel biotite flakes. Armstrong (1963) estimates the age of the formation of 28 to 29 million years using potassium-argon biotite dates.

**Intrusive Rocks**

The quartz porphyry found in the Atlanta mine pit is bright white in color with light grey quartz phenocrysts spread throughout. Alteration of the intrusive has been extensive. Alunization, argillization, and silification are so complete as to render a more precise identification difficult, hence the term quartz porphyry.

A thin section of the least altered rock shows that the rock contains approximately 40 percent medium grained phenocrysts. Examination of the phenocrysts shows that about 60 percent of them were probably plagioclase, 40 percent of them were quartz and a few grains were ferromagnesian minerals. All of the plagioclase and ferromagnesians have
now been extensively altered to alunite and kaolinitic clays. Some sericitic alteration is also present. The groundmass was composed of mostly feldspars now highly altered with about 20 percent fine grained quartz. There is also a trace of zircon in the groundmass. The intrusion was probably originally a quartz latite porphyry but because of the extensive alteration the field term, quartz porphyry, is used in this thesis.

Dikes found in the Blue Bird Mine are highly altered, siliceous and believed to have been generally rhyolitic in composition. The dike material consists of about 20 percent medium grained phenocrysts of feldspars, quartz and minor ferromagnesian minerals. The groundmass consists mainly of highly siliceous glass, fine-grained quartz and fine-grained opaque minerals. The rock has undergone argillic alteration and slight devitrification of the glass.

QUATERNARY ROCKS

The Quaternary deposits in the area consists of unconsolidated gravel and alluvium composed of rocks eroded from the nearby hills. These deposits are usually in the form of fanglomerate deposited along the slopes of the hills. The type of rubble depends on the composition of the slope above it. In areas of volcanic terrain the detritus is usually much finer grained than that derived from the Paleozoic sedimentary rocks. In a few of the stream beds there
deposits of alluvium which has been moved some distance but in general the quaternary deposits reflect the rock they overlie.

Structure in the district is locally complex due to large amounts of faulting. The Paleozoic sedimentary rocks of the district have a general strike of about 60° west and dip approximately 21° to the northeast. This general trend has caused many varied bedding attitudes within the Paleozoic rocks (Plate 3). The faulting has created, in a few locations, dips up to 40° in the Paleozoic rocks. The Tertiary volcanics rocks do not show recognizable bedding in most areas but in areas where compaction bedding is found the dips are generally very low angle. An exception to this is in some areas where the volcanics have been involved in the faulting. In these areas dips may be as high as 10° such as where volcanics are involved in faulting in the Atlanta pit (Plate 3). Using data by Cook (1966) it appears that the intermediate units in the Atlanta district are around 35 to 39 million years old. If these dates are correct the faulting is no older than 25 million years because it cuts the volcanics.

The geologic map and the root map diagram (Fig. 6) of the strike directions of faults in the district show three broad trends of fault strike directions. A visible group of major faults include the Atlanta and Cato.
Structure in the district is locally complex due to large amounts of faulting. The Paleozoic sedimentary rocks of the district have a general strike of north 60° west and dip approximately 25° to the northeast. This general trend has numerous local departures because normal faulting has caused many varied bedding attitudes within the Paleozoic rocks (Plate 1). The faulting has created, in a few locations, dips up to 60° in the Paleozoic rocks. The Tertiary volcanic rocks do not show recognizable bedding in most areas but in areas where compaction bedding is found the dips are generally very low angle. An exception to this is in some areas where the volcanics have been involved in the faulting. In these areas dips may be as high as 30° such as where volcanics are involved in faulting in the Atlanta pit (Plate 3). Using data by Cook (1965) it appears that the ignimbrite units in the Atlanta District are around 28 to 29 million years old. If these dates are correct the faulting is no older than 29 million years because it cuts the volcanics.

The geologic map and the rosette diagram (fig. 6) of the strike directions of faults in the district shows three broad trends in fault strike directions. A sizable group of major faults including the Atlanta and Mine fault
(Plate 1) strike between NS and N30°E. The next broad grouping consists of faults which strike between N60°E and EW. This group includes the Spring fault, Winding fault, Quartz fault and the fault between the Blue Bird mine and Silver Park (Plate 1). The third group consists of faults which strike between EW and N30°W. This last group of faults includes many smaller faults with no one prominent strike trend.

The major structural feature of the district is the north trending fault zone which I have called the Atlanta fault (Plate 1). This fault bisects the mapped area and can be traced for several miles to the south. The fault zone is mostly covered by alluvium but is indicated by the strong topographic expression shown by the valley which follows the inferred fault trace and by silicified breccia zones which crop out along the west side of the Tank Hill Limestone and Sevy Dolomite exposures. The Atlanta fault is apparently steeply dipping with the west side of the fault downthrown relative to the east side of the fault. The offset is probably as much as 600 to 800 feet in places as determined by the relative positions of stratigraphic units on both sides of the fault.

A fault parallel to the Atlanta fault occurs approximately 1,500 feet to the east in the northern portion of the mapped area. This fault runs through the Atlanta mine pit and thus I have called it the Mine fault (Plate 1).
FIGURE 6. ROSETTE DIAGRAM OF FAULT TRACES IN THE ATLANTA DISTRICT
This fault strikes approximately NS, dips 65 to 45 degrees to the west, and has the downthrown side to the west. Offset of the fault has not been accurately determined but it is believed to be between 300 and 500 feet as determined by limited drill hole information and stratigraphy.

The Gold fault to the east of the Mine fault (Plate 1) apparently originates near the Atlanta mine and strikes north 25° east. This fault has little or no evident offset but silicification and brecciation along this fault can be traced for over a mile to the northeast.

In the southeastern portion of the mapped area the Paleozoic rocks have been extensively faulted with many blocks being tilted and moved vertically. The Paleozoic outcrop area is bounded on the west by the Atlanta fault and to the south by the Spring fault. The Spring fault is inferred from topography and the apparent termination of many faults and silicified areas which are present to the north. This fault has its downthrown side to the south. The amount of offset cannot be known without geo-physical or drilling data. There are several faults which roughly parallel the Spring fault. The Winding fault 500 to 1,000 feet to the north parallels the Spring fault as does the Quartz fault 3,500 feet to the north. The Quartz fault separates Eureka Quartzite on the north from Ely Springs Dolomite on the south. The Winding fault appears to have had little offset while the Quartz fault apparently has from
150 to 300 feet of stratigraphic offset. A group of faults which strike north 30° west and separate Tank Hill Limestone on the southwest from Ely Springs Dolomite on the northeast is found in the center of the southern mapped area. This fault group is called the Bradshaw fault zone and apparently dips steeply to the northeast. It has virtually no offset at its northwest end and 500 feet or more of offset at its southeast end. A series of faults with small offsets roughly paralleling the Bradshaw fault zone are found throughout the southern mapped area where they appear to have localized silicification and brecciation.

It appears that there is a generally west trending fault which connects the Blue Bird mine area to the Silver Park area. This fault has unknown offset but the southern side of the fault is downthrown. The Silver Park area consists of a small horst like upthrown block with normal faults on either side to the north and south. The offset to the south is from 40 to 60 feet as shown by drill holes. It is probable that there is a series of parallel faults along the southern edge of the horst which increases the offset up to several hundred feet. The amount of downthrow at the north is not known.

The long low hill of Sevy Dolomite at the northern end of the mapped area is bounded on the west by the Atlanta fault and on the east by the Mine fault. This hill is cut
by several faults which strike between west and north 45° west. These faults have little or no offset but in some places rocks along the faults have been silicified and brecciated.

The structural features of the Atlanta District are thought to be caused by uplift resulting from an intrusion at depth under the district.

In the following sections of this paper the major mines and prospects of the Atlanta District will be described. Locations of these mines and prospects are shown on Figure 7. After these descriptions, sections on the genesis and classification of the deposits will be used to assess the exploration potential in the Atlanta District.

ATLANTA MINE (Au, Ag)

Work on the Atlanta mine dates back to 1954 and has continued intermittently up to the present time. Because of the generally low grade of the ore no operations at Atlanta were very successful until the advent of the present open pit run by Standard Blay Company. Profitability of the mine has been greatly facilitated by increases in the price of gold and silver in the past few years. The mine at Atlanta (Figure 8) is currently processing 125,000 to 125,000 short tons of ore per year (Nolde, 1974). The pit is approximately 700 feet long and 450 feet wide and lies on a west-facing hillside.
The Atlanta area has had a long history of small mining and exploration operations. For a variety of reasons, few, if any, of these operations were successful for anything but a very short time. It is evident from mapping the area that mineralization potential exists over much of the district. In the following sections of this paper the major mines and prospects of the Atlanta District will be described. Locations of these mines and prospects are shown on Figure 7. After these descriptions, sections on the genesis and classification of the deposits will be used to assess the exploration potential in the Atlanta District.

**ATLANTA MINE (Au, Ag)**

Work on the Atlanta mine dates back to 1906 and has continued intermittently up to the present time. Because of the generally low grade of the ore no operations at Atlanta were very successful until the advent of the present open pit run by Standard Slag Company. Profitability of the mine has been greatly facilitated by increases in the price of gold and silver in the past few years. The mill at Atlanta (Figure 8) is currently processing 120,000 to 125,000 short tons of ore per year (Hules, 1978). The pit is approximately 700 feet long and 400 feet wide and lies on a west facing hillside
(Figure 7). The stripping ratio of waste and low grade ore to mill ore is approximately 3.5 to 1. Some figures are maintained at 12 to 15 feet in ore and at 12 to 15 feet in waste (Smith, 1978). The average grade of ore is around 0.14 ounces gold per ton and 1.2 ounces silver per ton. The ore is ground to 95 percent minus 560 microns and is taken into a cyanide solution. Silver is recovered in the cyanide solution (above 90 percent) with silver cyanide (above 3 percent).

The only altered areas are the only silicified, brecciated, and altered areas; 100 to 200 feet wide and which trend parallel to the pit (Plate 10, Figure 16). These areas contain the ignimbrite, which is composed of fragments of all the other units present by caliche. Volcanic detritus is broadly mixed with sub-rounded fragments of silicified rocks up to 10 inches in diameter present.

The ignimbrite unit consists of Tertiary volcanics of rhyolitic composition. This unit is tentatively identified as the Deaver Range Formation member number two (Corey, 1966). Composition sheeting has caused within this unit and

FIGURE 7. LOCATION OF MINES AND PROSPECTS
(Figure 9). The stripping ratio of waste and low grade ore to milled ore is approximately 3.9 to 1. Bench heights are maintained at 12 to 15 feet in ore and at 22 to 25 feet in waste (Hulse, 1978). The average grade of ore is around .14 ounces gold per ton and 1.2 ounces silver per ton. The ore is ground to 90 percent minus 100-mesh and gold is taken into a cyanide solution. Reported gold recovery is high (above 90 percent) with silver recovery being from 30 to 80 percent.

The geology of the Atlanta mine is straightforward. The ore grade mineralization is found in a large, highly silicified, breccia zone which is approximately 150 feet wide and which has been exposed for 700 feet of length in the pit (Plate 3).

Rock units mapped in the pit consist of fanglomerate, ignimbrite, jumbled volcanic rocks, quartz porphyry, silicified breccia, footwall unit and Ely Springs Dolomite (Figure 10, Plate 3).

The fanglomerate (Figure 11) is Quaternary in age and composed of fragments of all the other units cemented by caliche. Volcanic detritus is usually small with sub-rounded fragments of silicified rocks up to 10 inches in diameter present.

The ignimbrite unit consists of Tertiary volcanics of rhyolitic composition. This unit is tentatively identified as the Needles Range Formation, member number two (Cook, 1965). Compaction bedding has formed within this unit and
FIGURE 8. ATLANTA MINE MILL AND THE TRAILER VILLAGE, 1977

FIGURE 9. ATLANTA MINE LOOKING EAST FROM JUST NORTH OF MILL AREA, 1977
FIGURE 10. ATLANTA MINE PIT IN DECEMBER, 1978. LOOKING TOWARDS THE NORTHEAST (SNOW COVERED PEAK IN LEFT BACKGROUND IS WHEELER PEAK.)
Qal = fanglomerate, Tv = ignimbrite, Tvj = jumbled volcanics, Tqp = quartz porphyry, Tb = silicified breccia, Oes = Ely Springs Dolomite.
A dip of 30° to the west is evidence (Figure 12) in some areas of the pit. Alteration of the unit has been extensive with little of the original mineralogy and texture still present. Most plagioclase has been completely altered to clay. Biotite has been partially replaced by quartz and that which remains is slightly discolored, bent, or fractured. Other ferrogmagnesian grains are represented now by faint outlines of iron oxides. In general, the entire rock has been extensively altered to clays, calcite, and fine-grained quartz.

The east contact of the Needles Range Formation in the Atlanta pit consists of several faults which bound an area of highly altered and jumbled volcanic material. This altered and jumbled volcanic material (Figure 13) is composed largely of subrounded blocks of ignimbrite which has been brecciated by fault movement and altered to clays. To the east of this fault bounded jumbled zone is a highly altered dike-like intrusion which is called by the field term quartz porphyry (Figure 14).

The quartz porphyry intrusion is very irregular following along and to the west of the silicified breccia zone. This unit is completely altered and appears bright white in color with light grey quartz phenocrysts spread throughout. Hand specimens are usually very friable except where the quartz porphyry has been highly silicified. The quartz porphyry is sometimes silicified and brecciated in areas along
FIGURE 11. FANGLOMERATE ON NORTH PIT WALL OF ATLANTA MINE. NOTE LARGE BLOCKS OF SILICIFIED BRECCIA SHOWN IN PHOTO BY Tb.

FIGURE 12. IGNIMBRITE (NEEDLES RANGE FORMATION) ON NORTH PIT WALL OF ATLANTA MINE. NOTE COMPACTION BEDDING.
FIGURE 13. JUMBLED VOLCANIC MATERIAL ON NORTH PIT WALL OF ATLANTA MINE.

FIGURE 14. QUARTZ PORPHYRY ON THE NORTH PIT WALL OF THE ATLANTA MINE.
the east contact with the silicified breccia. X-ray diffraction analysis shows that the altered quartz porphyry consists largely of alunite, kaolinitic clays and quartz. Occasionally minor gold values are found in areas of brecciated and silicified quartz porphyry.

Directly to the east of the quartz porphyry is the main ore rock zone. This is a zone of silicified breccia which consists of silicified fragments of carbonate rocks, quartzite, quartz porphyry, and volcanic material.

There are several forms that silicification takes in the Atlanta ore breccia zone. Hard, dense silicification which is usually grey or dark red in color is common (Figure 15). In this type of alteration, breccia fragments and infillings are equally silicified so as to make identification of the original breccia fragment rock type difficult. This very hard and pervasive silicification is usually in lenses or large lumps surrounded by more open silicification. The open areas contain silicified breccia fragments surrounding many open spaces and some drusy quartz (Figure 16.) The open spaces usually contain large amounts of limonite and occasionally Mn oxides.

The silicified breccia is mostly a reddish purple color but white, yellow, grey and pink colors are also present. Several periods of silicification and brecciation are indicated by breccia fragments found within fragments.
FIGURE 15. HARD DENSE CHERT LIKE SILICIFIED BRECCIA FROM MAIN ORE ZONE ON BOTTOM OF ATLANTA MINE PIT.

FIGURE 16. SILICIFIED BRECCIA ORE ON NORTH EAST WALL OF ATLANTA MINE PIT. NOTE OPEN SPACES AND LIMONITE.
In many areas along the footwall of the silicified breccia zone extensive masses of Mn and Fe oxides are present (Figure 17). The footwall material consists of kaolinitic clays mixed with large amounts of Mn oxide and limonite. This footwall material has been mapped as the footwall unit where it is present.

To the east of the footwall unit and the silicified breccia zone is the Ely Springs Dolomite which appears to dip to the north. The dolomite is bleached along fractures and bedding planes for at least 50 to 100 feet from the silicified breccia zone (Figure 18). Along fractures in the center of the bleached carbonate rocks irregular impregnations of silica are found. This silicification is very irregular and has sharp boundaries with the carbonate rock. Some very minor gold values are found along altered fractures within the dolomite but in general the dolomite can be considered to be not mineralized to any extent.

Faulting in the pit is reasonably simple. Most faults are normal and strike and dip roughly parallel with the silicified breccia zone (Plate 3). These faults are all part of a larger fault zone which on Plate 1 is called the Mine fault. The breccia zone strikes approximately north 5° east and dips from 40° to 70° to the west.

At the south end of the pit the Mine fault is apparently terminated by a fault zone which strikes north 45°
FIGURE 17. FOOTWALL ALTERATION ON EAST WALL OF ATLANTA MINE. WHITE MATERIAL IN UPPER LEFT CORNER IS SNOW.

FIGURE 18. ELY SPRINGS DOLOMITE IN EAST WALL OF ATLANTA MINE PIT. NOTE ALTERATION ALONG JOINT.
east and dips near vertical. This area is one of structural complexity with many small faults and joints (Plate 3). In this area the quartz porphyry breaks into many dike like masses surrounded by breccia. Sampling and drilling indicate that the present south end of the pit is probably the extent of the economically minable ore in this direction. At the northeast corner of the pit an area of faults and joints may indicate the beginning of the Gold fault as shown on Plate 1. Offset of the Mine fault zone as shown from the pit is at least 300 feet downthrown to the west.

Ore and Associated Minerals

Large amounts of colorful limonite and Mn oxides are present in the open spaces and along joint planes within the silicified breccia zone. No sulfide minerals have been found in the Atlanta pit, but the limonite is presumably formed from pyrite which was present before oxidation. Gold is evidently present as free microscopic or smaller size particles within the limonite, silica, and clay. No visible gold was found by this author in either microscopic sections or hand specimens. Silver is present in considerable amounts but no visible silver minerals have been detected. Geochemical assay results from the pit show several other elements to be anomalous. Samples from the Atlanta mine pit were run for Au, Ag, As, Sb, Hg and Mn (Beal, 1976). Partial results
are as follows:

Table 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Au oz./ton</th>
<th>Ag oz./ton</th>
<th>As ppm</th>
<th>Sb ppm</th>
<th>Hg ppb</th>
<th>Mn ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pb 3</td>
<td>.005</td>
<td>.062</td>
<td>1000+</td>
<td>200+</td>
<td>no info</td>
<td>200</td>
</tr>
<tr>
<td>Pb 4</td>
<td>.02</td>
<td>.34</td>
<td>200</td>
<td>100</td>
<td>8000</td>
<td>1000+</td>
</tr>
<tr>
<td>Pb 7</td>
<td>.01</td>
<td>.13</td>
<td>1000+</td>
<td>200+</td>
<td>no info</td>
<td>1000+</td>
</tr>
<tr>
<td>Pb 9</td>
<td>.06</td>
<td>4.1</td>
<td>800</td>
<td>no info</td>
<td>no info</td>
<td>1000+</td>
</tr>
<tr>
<td>Pb 10</td>
<td>.01</td>
<td>.23</td>
<td>1000+</td>
<td>200+</td>
<td>6000</td>
<td>1000+</td>
</tr>
</tbody>
</table>

Samples from Atlanta Pit, Larry Beal (1976)

Results shown in Table 1 illustrate the well known association of epithermal gold mineralization with high As, Sb, and Hg values. No antimony, mercury or arsenic minerals were detected in the pit but subhedral to euhedral barite crystals are common in some areas near the footwall of the silicified zone where they are clustered in open spaces along fractures (Figure 19). This author has no knowledge as to the method used for analysis of the samples in Table 1 or the exact locations from within the Atlanta pit they were collected.

BLUE BIRD MINE (U₃O₈, Au, Ag)

The Blue Bird mine, also known as the Hulse mine, is about 3,500 feet south of the Atlanta mine mill (Figure 7). It can be reached by a dirt road leading from the south end of the trailer village at the Atlanta mine.

The mine sits on a highly silicified and brecciated
FIGURE 19. BARITE CRYSTALS WITHIN SILICIFIED BRECCIA ORE ZONE ON NORTHEAST PIT WALL OF ATLANTA MINE.
outcrop which rises above the immediately surrounding terrain (Figure 20, Plate 1). Mine workings consist of an inclined shaft, wood headframe, and two levels of crosscuts. In all, about 275 feet of mine workings are present (Plate 4).

Mine workings are in a highly silicified breccia zone consisting of fragments of dolomite and volcanics which are completely silicified.

Open spaces in the breccia are common. Rocks on the upper levels of the mine are completely oxidized and are very similar in appearance to the Atlanta mine ore. On the lowest level of the mine considerable amounts of pyrite is disseminated in dark grey to black, highly silicified breccia. The silicified breccia zone has been intruded by many north 70° east striking, 15°-20° west dipping altered rhyolitic dikes (Plate 4).

Uranium mineralization appears to be confined to the silicified breccia between the dikes. Secondary uranium oxides have been reported in the mine (Garside, 1973) but none were located at the time of this examination. Assay samples of the mine ore are reported to contain up to 1.28 percent $U_3O_8$, .03 ounces per ton gold, and one ounce per ton silver (Tschanz and Pampeyan, 1970). A sample taken from the pyrite bearing area of the mine by this author contained .133% $U_3O_8$, .02 percent Cu, .12 percent Pb, no Au, and .41 oz./ton Ag.
FIGURE 20. BLUE BIRD MINE SHOWING SILICIFIED BRECCIA OUTCROP AND WOODEN HEAD FRAME. PICTURE TAKEN LOOKING TO THE NORTH WEST.
Samples of pyrite-bearing rock from the lower level of the mine were made into polished sections which were then examined by reflecting light microscope. Pyrite, marcasite, and pitchblende were identified. Small amounts of other minerals were tentatively identified as argentite and zircons. Detailed description of the minerals observed in the sections are as follows:

**Pyrite (FeS₂).** - Pyrite makes up from 50 to 90 percent of all opaque materials observed in the polished sections. Individual grains of pyrite range from .01mm to .5mm in diameter with large masses of pyrite up to 20mm across also present. The most abundant type of pyrite occurs in aggregates of euhedral to anhedral crystals interspersed with gangue. These aggregates showed a marked tendency to have a rim of massive pyrite forming a semi "atoll" type texture (Figure 21). The massive pyrite shows euhedral crystal faces at the outside edges of the pyrite mass. This massive rim pyrite is also some times seen as "atoll" like rims around breccia fragments as well as pyrite aggregates. Often marcasite is present as crusts on the outside edges of pyrite. The interior pyrite crystals in the aggregates often show several rims of growth zoning. Zoning in the core often has a pyrit ohedron habit, changing increasingly to a cubic habit in the outer zones. Ramdohr (Ramdhor, 1969) notes this to be common and probably
due to slight changes in chemical composition or the interruption of the growth process.

The second major type of pyrite has a highly corroded appearance (Figure 22). This texture is believed to be caused by changes in the chemistry of the mineralizing fluids which causes alternating pyrite deposition and solution.

In addition to these two major types there is a third type of pyrite which occurs as distinct euhedral to anhedral grains disseminates in gangue. This pyrite is found in the infillings between breccia fragments and within individual breccia fragments.

Marcasite \((\text{FeS}_2)\). - Marcasite is second in abundance to pyrite among opaque minerals and it makes up from 10 to 30 percent of the opaque minerals observed in the sections. Individual grains of marcasite range from .5mm to .05mm in width. Marcasite occurs in the polished sections as interlocked crystal aggregates which appear to have been precipitated as an incrustation upon pyrite. The outer crystals of marcasite show euhedral to subhedral crystal faces to the outside edges thus supporting the general open space filling character of the ore minerals. Marcasite is almost always twinned in the polished sections (Figure 23).

Pitchblende \((\text{UO}_2\text{O}_3)\). - Pitchblende, the massive variety of uraninite, is the third most abundant opaque mineral observed in the sections. It makes up from 1 to 10 percent
FIGURE 21. "ATOLL" LIKE RIM OF PYRITE AROUND AN AGGREGATE OF PYRITE CRYSTALS INTERSPERSED WITH GANGUE.

FIGURE 22. HIGHLY ERODED VEINLET FILLING PYRITE WITH SOME PITCHBLENDE SPHERULITES (pgb) ALONG UPPER EDGE OF PICTURE.
of all opaque minerals observed in the polished sections. Pitchblende occurs in spherulitic blebs from .1mm to 1.0mm in diameter, that are either isolated or in swarms forming in the interspaces between breccia fragments. Two distinct kinds of pitchblende designated types I and II have been reported by Ramdohr (1969).

Pitchblende I is a hard dense mineral which takes a good polish. In Pitchblende I $\text{UO}_2$ is greater than $\text{UO}_3$. Pitchblende I was not observed in the sections.

Pitchblende II is comparatively soft and under the microscope it seems to take a poor polish and appears to be finely porous. It is an alteration product of pitchblende I with $\text{UO}_2$ less than $\text{UO}_3$. Pitchblende II is present in the centers of most of the spherulites (Figure 24). Alteration rims and crusts of gummite surround the Pitchblende II in most cases. In some cases the pitchblende has been entirely replaced by gummite. Gummite is a fine-grained mixture of various secondary uranium minerals. The name can best be used in the same sense as limonite is used for the hydrated iron oxides, in denoting a variable fine-grained mixture of secondary uranium minerals (Heinrich, 1958).

According to Kidd and Haycock (1935), spherulitic forms of pitchblende in quartz are conclusive evidence of its colloidal deposition. The spherulites were probably formed while both the quartz and the pitchblende were in
FIGURE 23. MARCASITE CRUST (m) ON PYRITE AGGREGATE (p). CROSSED NICOLS.

FIGURE 24. TWO PITCHBLENDE SPHERULITES. SMALL AMOUNTS OF PITCHBLENDE II IN CENTERS WITH ALTERATION RIMS OF GUMMITE.
a gel state. The spherulitic forms would normally be ex¬pected to develop through nucleation and colloidal coagula¬tion when the solutions were becoming depleted in pitchblende molecules.

In a few of the polished sections there are indi¬

gual grains of a very hard, low reflectivity mineral with strong internal reflections. The mineral has tentatively been identified as zircon.

In one polished section a single grain of a low reflectivity, isotropic, soft, greyish mineral is present. It has a very eroded texture and cannot be positively identi¬

fied. It has been tentatively identified as argentite.

Assay reports from the Blue Bird mine show gold to be present but none was identified in the polished sections studied. It is possible that the minor gold values of Blue Bird mine ore may come from gold which is contained as a "mechanical" admixture of submicroscopic fineness within the pyrite.

SILVER PARK (Ag, Au)

The old Silver Park District, also known as the Jesse Knight property, is about 1.4 miles southwest of the Atlanta mine (Figure 7, Plate 1). It can be reached by a dirt road running west from the Blue Bird mine.

Old mine workings consist of many small irregular
shafts, drifts, adits and prospects pits. In addition, there are at least two shafts over 100 feet deep. The main and deepest shaft is at the bottom of a small gulch which separates two small hills of dolomite outcrop (Plate 1). Both shafts are inaccessible and in general, there is very little access to the underground workings in the Silver Park area. As a result underground information is essentially that from previous authors and limited drill hole coverage.

Silver Park is a dolomite outcrop area approximately 500 to 800 feet in north-south direction by 3,000 to 4,000 feet in an east-west direction (Plate 1). The dolomite, which strikes N60°E and dips 30° to the northwest, is believed to be the lower Laketown Dolomite. Tertiary volcanic rocks surround the dolomite outcrop on all sides in fault contact.

There are a few areas of silicified breccia similar to those found in the Atlanta mine area; notably those breccia areas at the south western corner and along the north central edge of the dolomite outcrop areas (Plate 1). These silicified breccia zones are mineralized but in general are not very large.

Mineralization in the area appears to be dominantly manto type replacement deposits which follow bedding planes and joints in dolomite. Both gold and silver are present but silver appears to be of major economic interest. In
addition very minor amounts of copper and lead are present. The parts of mineralized zones which can be inspected consist of altered dolomite with many solution cavities. Quartz, manganese oxides, limonite, barite, and calcite are the major constituents visible in the oxidized ore. Rock in surface exposures and shallow pits is oxidized and no unoxidized minerals were found. Manganese oxides and limonite form masses of boxwork type texture with quartz and calcite stringers running through the ore. Barite and quartz crystals are deposited on the surfaces of open cavities. No silver minerals were observed but in a few places small amounts of copper oxides were noted.

Hill (1916) appears to have gained access to some of the deeper workings. He describes the ore as follows:

The silver minerals are all of the oxidized type, and so far as known no original sulphides have been found. The yellow stains on the ore are argentiferous lead carbonate. Aggregates of minute green and blue crystals are silver-bearing copper carbonates, and thin purplish green stains seem to be a mixture of copper and lead carbonate. The richest ore is coated with irregular dirty brown films of soft waxy horn silver. Some of these scales of horn silver cover as much as a square inch, and are one-sixteenth inch thick. A thin section of a piece of rich ore shows horn silver scattered through the quartz as well as in the joints. A few specks of a blue-grey metallic mineral, which is semitranslucent and is decidedly red in reflected light, prove to be ruby silver.

There are many reports of high grade ore being mined from Silver Park. Values up to 2800 ounces of silver per ton
have been reported but it appears that an average figure for Silver Park ore would be 12 ounces silver per ton (Collins, 1963). Table 2 shows assay results of ten samples taken in the Silver Park area. This very limited sampling shows that ore grade mineralization does exist in Silver Park.

Table 2.

<table>
<thead>
<tr>
<th>No.</th>
<th>Ounces/Ton Au</th>
<th>Ounces/Ton Ag</th>
</tr>
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<tbody>
<tr>
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<tr>
<td>SWH - 10</td>
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<td>4.90</td>
</tr>
</tbody>
</table>

All samples taken from outcrops and old workings on hill southwest of main shaft. Results by fire assay, Standard Slag Company Lab.

In 1975 a large amount of shallow rotary drilling was initiated by Combined Enterprises, Inc. in the Silver Park area. A small zone of mineralization called the Loren ore body was located and a test pit mined. The project was dropped because it proved uneconomical. After examining limited drill hole information it appears that mineralization at Silver Park follows specific stratigraphic horizons which can be correlated between drill holes. There appears to be
at least five favorable horizons for mineralization but correlation between holes is hampered by the fact that most of the drill holes were less than 100 feet deep. Mineralized zones average about seven feet in thickness but there is no sharp edge to the mineralization.

BRADSHAW MINE (Au, Ag)

The Bradshaw mine is high on the southwest slopes of Atlanta peak (Figure 7). Access to the mine is by dirt road leading from the main Atlanta gravel road to the west. Mine workings consist of one adit with about 150 feet of workings which penetrate a large silicified outcrop on the Bradshaw fault zone. The workings form a cross with one drift perpendicular to the fault zone and two drifts parallel to the fault zone. They were evidently exploratory in nature because very little stoping was attempted.

The Bradshaw mine area consists of a large, highly silicified rock mass which crops out along the Bradshaw fault zone (Plate 1). The silicified rock appears to dip to the northeast at approximately 35° and is elongate in a northwest-southeast direction paralleling the strike of the Bradshaw fault zone. The rock appears very similar to the silicified breccia found in the Atlanta mine except that rock from Bradshaw has fewer open spaces. Breccia fragments appear to have been carbonate rocks but are now completely
silicified. The deepest portions of the mine working penetrate carbonate beds which have been silicified intact with only small amounts of brecciation. No sulfide minerals were found but limonite present in open spaces has probably been derived from the oxidation of pyrite. Sampling done by Standard Slag Company indicates widespread gold and silver mineralization to be present in the Bradshaw mine.

A heavy mineral fraction of Bradshaw rock examined by Wayne R. Kemp (1974) showed positive identification of native gold, geothite, quartz and manganese oxide. Kemp also believed he found argentite in small amounts occurring intergrown with goethite. The three grains of gold he observed ranges from 125µ to 50µ in size and were free and unattached to either quartz or oxide phases. In addition, Kemp noted the presence of one small grain of chalcopyrite. This mineral suite is very much like that found in most prospects and mines of the Atlanta district. No visible uranium minerals were found in the prospect area but a radiometric survey done by Laurence H. Beal (1978) indicates anomalous radioactivity on the dump of the Bradshaw mine.

SOLO JOKER (Au, Ag)

The Solo Joker prospects are on a small hill approximately three-fourths of a mile west of the Blue Bird mine (Figure 7). The prospects are at the eastern end of the
dolomite outcrop of Silver Park but are separated from any Silver Park workings far enough to be a distinct area. Two shallow shafts now completely inaccessible and a few prospect pits comprise the workings.

The geology is complex with faulting, silicification and brecciation present. The small hilltop containing the prospect consists of silicified breccia several hundred feet in length and of considerable width. A north 10° east striking, vertically dipping fault zone extends to the south for 200 feet from the main silicified zone. This fault zone is silicified over about a twenty foot width. To the east of this fault, dolomite crops out for about 100 feet before it is covered by volcanic material. This dolomite contains many calcite and quartz stringers. To the west of the fault is volcanic float.

<table>
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<tr>
<th>Sample #</th>
<th>Au oz./ton</th>
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Table 3, continued

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<th>Sample #</th>
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<tbody>
<tr>
<td>SJS - 13</td>
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<td>.82</td>
</tr>
<tr>
<td>Nevada Bureau of Mines</td>
<td>.05</td>
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</tr>
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</table>

All samples of silicified breccia on outcrops or old workings of Solo Joker Area. Results by fire assay, Standard Slag Company Lab.

Rock from the Solo Joker prospect is a highly silicified breccia with limonite and euhedral to subhedral crystals of barite in open spaces. The silicified breccia of the Solo Joker prospect looks almost identical to silicified breccia in the Atlanta mine pit. No visible ore minerals were found in the Solo Joker area but widespread gold and silver mineralization is present. Fifteen rock chip samples taken from silicified outcrops of the Solo Joker area (Table 3) contained an average of .05 ounces gold and .75 ounces silver per ton. Uranium mineralization may be present but no visible uranium minerals were observed and the samples were not assayed for uranium.

**DIRECT ORE DEPOSIT TYPES**

Examination of the major mines and prospects of the district shows that, except for Silver Park, all mines and prospects of the Atlanta District are closely related in
mineralogy and structural control. It also seems reasonable that they have had the same mode of formation.

The Atlanta mine exemplifies the main mineralization type in the district. This type is characterized by highly silicified zones consisting of microcrystalline to cryptocrystalline quartz which are almost always developed along high angle faults. The gross geometry of most of these zones is planar which reflects a structure such as a fault being the plumbing system for altering fluids. The planar geometry can also be the result of a permeable bed in carbonate host rock. Often an elongate pod of silicification forms at the intersection of two faults.

Silicified zones are usually extensively brecciated with individual breccia fragments so completely silicified that identification of the original rock type is difficult. When identification is possible the fragments consist largely of carbonate rock with some quartzite, volcanic rock, and intrusive fragments also present. The fragments are very angular and the breccia is chaotic looking. Often several periods of brecciation and silicification are indicated by fragments within fragments. In some cases the breccias are open with many open spaces filled with limonite, barite, manganese oxides, clay and drusy quartz. In other areas, often in the same large silicified zone, the rock is hard, dense and chertlike. Silicified zones sometimes contain
masses of unbrecciated but highly silicified carbonate rock. The silicified zones are usually reddish in color but may be colored from white through grey, yellow, brown, purple, to black. Jasperoid is an appropriate term to describe the silicified rock in most cases.

Oxidation of rock within the silicified zones has been intense in most areas of the Atlanta District and rarely are sulfides found in any mineralized area. Pyrite, now oxidized to geothite-limonite, was probably the most common sulfide present before oxidation. Marcasite, chalcopyrite, galena, and argentite have been noted in very minute quantities and because of the presence of base metals and silver in most deposits it is reasonable to assume that these sulfides were present in small quantities before oxidation. Gold, present in varying amounts in all of the mines and prospects, is microscopic or smaller in size and is in its free native state. It is probable that the vast majority of the gold was deposited along with silica and is present as free gold. In addition to gold, silver and minor base metals the jasperoid mineralized zones are usually anomalously enriched in arsenic, antimony, mercury, manganese, and barium. Psilomelane, other manganese oxides and barite are present in many of the prospects and mines. Minor uranium in most mines and prospects appears to be largely a result of secondary oxidation products derived from pitchblende. It appears that secondary
mobilization of uranium and silver has occurred in some deposits but in general the gold does not appear to be mobile.

Figure 25 provides a cross sectional schematic model of the generalized alteration pattern of Atlanta type deposits. Host rocks of the Atlanta type deposits are usually carbonates. In some cases a fault has offset carbonate rocks so that volcanic material is on one side with carbonate rock on the other. Alteration of carbonate material follows a typically zoned character with highly silicified often brecciated rock in the center giving way to highly bleached rock which is only silicified along joints and fractures. The bleached nature slowly lessens in intensity away from the silicified zone until relatively fresh carbonate rock is reached at the extreme limits of alteration (Figure 25). Where volcanic rocks are present on one side of the mineralized area the alteration goes from intense silicification through levels of kaolinitic argillization and alunitization. Argillic alteration gradually decreases and grades into unaltered volcanic rock. Economic grade mineralization appears to be primarily confined to the silicified zones with minor values in highly altered border zones.

The second type of deposit in the Atlanta District is found in the Silver Park area. These are manto-like deposits of silver, gold and base metals where mineralization appears
FIGURE 25. IDEALIZED EXAMPLE OF ALTERATION ZONING IN ATLANTA TYPE DEPOSITS.
to follow bedding planes and joints in carbonate rock. Siliconification, while present, is much less prominent than in Atlanta type deposits. Deep oxidation and a lack of underground information makes identification of mineralogy difficult. Large masses of goethite, psilomelane and other manganese oxides are present along with bleached carbonate rock in mineralized zones. Oxidized base metals are present in small amounts but primary economic importance is in silver and gold. In some areas very high silver grades are found but on average 10 ounces per ton silver in the better ore shoots is probably realistic. Away from mineralized zones the carbonate wall rocks appear virtually unaltered except for isolated quartz and calcite stringers. These manto-like deposits appear to be connected to high angle fault plumbing systems similar to those involved in Atlanta type deposits. It is possible that the Silver Park manto deposits are extensions of Atlanta type deposits and are the result of the same mineralization fluid pulses. It may also be the case that the two types of deposit are the result of different fluid pulses and are superimposed by virtue of using the same deep plumbing systems.

GENESIS OF ATLANTA MINE TYPE DEPOSITS

The general open space filling nature of the deposits indicates that Atlanta mine type deposits are formed from hydrothermal fluids which altered wall rocks and deposited
gold, silver, As, Sb and Hg in anomalous amounts in a near surface epithermal environment.

At the present time dilute hydrothermal solutions in the Broadlands geothermal field, New Zealand, are depositing volatile and precious metals which closely resemble the mineral suite of the Atlanta deposit (Ewers and Keays, 1977). The Broadlands fluids are nearly all slightly alkaline, dilute sodium chloride-bicarbonate solutions (Mahon and Finlayson, 1972).

Isotopic investigations indicate that the Broadlands fluids are predominantly meteoric in nature and the sulfur could have been leached from graywackes at depth (Giggenbach, 1971). Work by many authors has determined that most of the elements in solution may be derived from rock types commonly encountered in the Broadlands area through leaching by meteoric waters which have been heated by cooling magma at depth (Ewers and Keays, 1977). The same basic mechanism for obtaining elements in hydrothermal waters was suggested for the Carlin gold deposit in Nevada (Dickson, et al., 1979). Dickson, et al. suggested that Au, Hg, As and Sb were leached from Paleozoic sedimentary rocks below the deposit at temperatures above 300°C by mildly saline solutions which migrated as part of a circulating water system set into movement by a buried thermal source. This appears to have obtained their mineralizing elements. There is in
all probability at least 15,000 feet of sedimentary rocks of Lower Ordovician and Cambrian age beneath the Atlanta District. These rocks probably possess enough trace elements to be leached. It is also likely that magmatic components to the waters could have been introduced at depth by plutons.

Work by Sewart (1973) indicates that considerable quantities of gold may be transported in hydrothermal ore solutions as thio complexes, particularly in the near neutral pH region where the Au(HS)$_2^-$ complex predominates. This gold solubility maxima coincides with the pH range of the majority of hydrothermal solutions as reported by many authors. Figure 26 shows that any process which would shift the pH of solutions to either acid or more alkaline conditions would cause the precipitation of gold although a shift toward lower pH is quantitatively more effective. Deposition of gold would also be in response to lowering the temperature, changes in oxidation potential of the system and total sulphur concentration.

In near surface environments hydrogen sulfide, dissolved under pressure at depth, exsolves from thermal water as pressure decreases upward, and rises to the surface into an oxidizing environment. There soil bacteria such as members of the genus Thiobacillus catalyze the oxidation of H$_2$S and S to H$_2$SO$_4$ in their life processes (Schoen, et al., 1974). The H$_2$SO$_4$ combines with condensing water vapor and surface
water and percolates downward. This descending acid water increases the chaotic nature of the breccia through solution brecciation and also lowers the pH of the depositional environment so as to favor quantitative precipitation of gold.

Work by Schoen, et al. (1974) on alteration at Steamboat Springs, Nevada indicates that there is a definite pattern to alteration near the surface of hot spring systems. This pattern consists of silica at the top, kaolin-alunite below, conforming to the position of an ancient water table, underlain by illite-montmorillonite below the water table. This sequence indicates greatest alteration of the rock at the top and decreasing intensity of alteration downward and away from the site of formation of the $\text{H}_2\text{SO}_4$ altering agent. The presence of alunite in the Atlanta pit along with kaolinite and silica may indicate a near surface, near or above water table formational location for the Atlanta ore body.

Work done by Ewers and Keays (1977) on mineral zoning in the Broadlands geothermal field indicates that both arsenic and antimony closely resemble the depth-distribution profile of gold (Figure 27). This indicates that the solution complexes and depositional mechanisms for these three elements are closely related. For each of these elements decreasing temperatures are highly effective in bringing about deposition. This fact may help explain the close
FIGURE 27. DEPTH-DISTRIBUTION PROFILES FOR Au, As, and Sb IN DRILL HOLE BR 16 AT THE BROADLANDS GEOTHERMAL FIELD, NEW ZEALAND (EWERS AND KEAYS, 1977).
relationship between arsenic, antimony and gold in disseminated gold deposits.

Hausen (1967) writes that the nature of mineral surfaces for adsorption or nucleation of gold are of major importance in the deposition of gold at the Carlin mine. He states that gold has been adsorbed selectively or nucleated onto surfaces of illitic clays, carbonaceous matter, iron sulfides, and quartz.

This author believes that the present Atlanta ore body formed near or above the paleo water table under conditions of rapid and chaotic chemistry change of the hydrothermal fluids resulting from rising slightly alkaline to neutral fluids mixing with descending acidic solutions. Gold and other elements are deposited in the near surface environment primarily due to rapid reduction in temperature and shifting of the pH to acid. The gold might then have been adsorbed selectively or nucleated onto surfaces of iron sulfides, quartz, clays and possibly carbonaceous matter.

A hypothesized history of mineralization for the Atlanta deposit is as follows (Figure 28):

Uplift, presumably caused by a large intrusion at depth beneath the Atlanta District, caused large amounts of normal faulting in the overlying sedimentary and volcanic rocks. This faulting effected the 28 million year old Needles Range Formation volcanics so uplift is more recent.
than 28 million years. Either during faulting or shortly after the faulting ceased, small dike-like igneous bodies intruded up along certain of the faults. The combination of faulting and intrusion created large zones of tectonic breccia. These breccia zones were formed most extensively at fault intersections. The increased permeability formed by the faulting and brecciation, coupled with a cooling magma heat source at depth created a circulating water system. This hot water system, composed primarily of meteoric water but with a possible magmatic component, leached trace elements from rocks at depth beneath the Atlanta District at elevated temperatures and pressures. Solutions ascended some of the faults along the permeable breccia zones carrying minute quantities of base metals, gold, silver, iron manganese, antimony, arsenic, mercury, and barium in addition to silica.

As the near neutral pH ascending solutions neared the surface they began to boil releasing H\textsubscript{2}S gas. The H\textsubscript{2}S gas was converted to H\textsubscript{2}SO\textsubscript{4} near the surface and upon combining with water descends into the breccia zone. The highly acidic and siliceous solution further brecciates carbonate rocks forming a chaotic breccia. The most intense acid alteration occurs near surface and consists of extensive silicification forming a capping. Silicate minerals beneath and away from the massive silicification are converted to alunite and
Most intense acid alteration occurs near surface and consists of extensive silification forming a capping of jasperoid. Silicate minerals beneath and away from the massive silification are converted to alunite and kaolinite clays above the water table.

At or near the surface H$_2$S is converted to H$_2$SO$_4$ by biological action and combining with water descends. This acidic solution helps to further brecciate the carbonate rocks forming a chaotic breccia.

Below the water table illite and montmorillonite are major alteration clays.

Solutions begin to exfoliate gases such as H$_2$S.

H$_2$S

Near water table rising alkali waters meet descending acid waters and very chaotic solution chemistry exists. Gold is deposited due to lowering of the pH and temperature.

Not alkali solutions rising along structure are primarily meteoric in origin but a magmatic component may be present. Waters carry Ba, Mg, As, Sb, W, Hg, Ag, Pb, Cu, Zn, along with gold in varying amounts.

Major structure with tectonic breccia is used as fluid conduit for rising solutions.

FIGURE 28. DIAGRAMATIC CROSS SECTION OF ATLANTA DEPOSIT SHOWING METHOD OF DEPOSITION.
kaolinite clays.

Near the water table rising near neutral waters meet descending acid waters and a very chaotic solution chemistry exists. Gold is deposited from the thio complex \( \text{Au(HS)}_{\frac{1}{2}} \) as pH drops below neutral. The pH change also effects deposition of other trace elements. Gold and other trace elements are also deposited due to rapid reduction of temperature in the near surface environment.

**CLASSIFICATION OF EPITHERMAL DISSEMINATED GOLD DEPOSITS**

It is the belief of this author that most, if not all, epithermal disseminated gold deposits result from solutions which are similar in composition at depth. Meteoric waters set in motion by a thermal source at depth leach elements from rocks and carry them upward along plumbing systems which are usually high angle faults. Gold is carried in solution as the \( \text{Au(HS)}_{\frac{1}{2}} \) thio complex. It is only in the near surface environment that differences in chemistry and permeability cause different type ore deposits to form (Figure 29). The major basis for ore deposit differences is the permeability of the host rock. If the host rock is permeable or can be made permeable by solution alteration then the geometry of the ore body is much wider and variable in extent than a deposit formed in a relatively impermeable rock.

The Atlanta type deposits were formed in a relatively
impermeable dolomite host rock very near the surface immediately beneath a thermal spring. Because of this the geometry of the ore bodies are strictly structurally controlled and limited in lateral extent. Tectonic and solution brecciation was necessary for fluid spreading to take place. Silicification was extremely intense near the surface and along the structures which formed the major plumbing system. Gold was deposited primarily due to rapid decrease in temperature and pH. Simply stated, the gold bearing solutions migrated up along the fault breccias and then dumped their gold near the surface. The relatively impermeable dolomite did not allow them to spread laterally to any great extent.

Other disseminated gold deposits such as Cortez and Carlin were formed in a silty limestone which was easily decarbonized by hydrothermal fluids to form micro-permeable areas for gold deposition. Because of the host rocks permeability, solutions migrated laterally and formed large semi-strata-bound ore bodies. It is likely that Atlanta type deposits were formed near the surface above Carlin type deposits.

A third type of disseminated gold deposit is formed in permeable volcanics or volcanic sediments. In this type of deposit the ore body geometry appears as a funnel with the wider portions of the ore bodies near surface and narrowing with increasing depth until it becomes a vein type
deposit. The Bukchorn mine in Eureka County, Nevada is an example of this type of mineralization. Figure 29 shows the three basic disseminated gold deposit types. The classification system is very basic and undoubtedly could be expanded greatly with more detail.

**URANIUM MINERALIZATION**

Minor uranium values are present in most of the mineralized zones of the Atlanta District. The uranium mineralization appears to be very sporadic and pod-like in nature. There appear to be two possible modes for the origin of the uranium mineralization. Either the uranium was carried from below by the hydrothermal solutions or was leached from volcanic units near the surface.

It is possible that volcanic units which were at and near the surface during hydrothermal activity contained leachable uranium. The acidic waters which were being formed near the surface due to $\text{H}_2\text{SO}_4$ production could have begun leaching uranium. The uranium would then have been carried down to near the water table where the acidic solutions were neutralized by the alkaline rising solutions and dilution by groundwater. In these locations small amounts of pitchblende were deposited as spherulites within the breccia along with quartz, pyrite and marcasite. It is also probable that fluctuating fluid chemistry would enable uranium to be deposited in small
FIGURE 29. THREE BASIC DISSEMINATED GOLD DEPOSIT TYPES.
pockets well above the water table. Many of these small pockets of uranium were undoubtedly remobilized but some remain. A detailed study of the uranium contents of the volcanics near the Atlanta District would be necessary to help prove this method of implantation.

EXPLORATION POTENTIAL IN THE ATLANTA DISTRICT

Geologic work done in the Atlanta area indicates a potential for additional economic mineral development. Widespread silicification and gold mineralization in the district indicates that there was considerable hydrothermal activity with gold in the hydrothermal system. This, coupled with the lack of serious exploration attempts in the district, indicates that a great potential for disseminated gold deposits exists in the Atlanta District.

The most obvious exploration targets are the massive jasperoid zones which are spread throughout the district. Silicification has been shown to be of major importance in mineralized areas of the district and should be used as a guide to ore. A thorough geochemical sampling and detailed geologic mapping of these zones should produce many potential drill targets. Of particular interest is the Solo Joker area. In this area ore grade mineralization is present on the surface and large silicified zones correspond to intersecting faults.
Ore deposits located along structures in the dolomites are likely to be of the Atlanta type and large tonnages could be difficult to find due to the lack of lateral extent of the ore. There is a possibility, however, of finding a Carlin type disseminated gold deposit in the district. This type mineralization would most likely be in the Tank Hill limestone which from its lithology has a greater possibility to be altered to a micro-permeable host for gold deposition. A detailed stratigraphic study of the limestone might indicate favorable beds for gold deposition. Larger jasperoid zones in the Tank Hill exposures are mineralized and could possibly indicate Carlin type mineralization at depth. Exploration for Carlin type mineralization should concentrate on favorable Tank Hill beds which are up-dip from major faults and their silicified zones.

An additional possibility for gold exploration is to examine the volcanic terrains immediately surrounding the district. Zones of silicification and/or argillic alteration could indicate the presence of a Buckhorn type disseminated gold deposit at depth.

It is important that an exploration effort realize that in the Atlanta District in most cases you are very near the top of the system and gold values may be low and sporadic. Trace elements such as Hg, Sb, and As might give a better picture of anomalies than gold assays.
The Silver Park area contains several large jasperoid zones which are mineralized. This area has not been explored adequately at depth. Additional manto-like deposits may be found along with Atlanta type gold deposits. As precious metals prices increase it may become economically possible to mine the Silver Park area by open pit methods.

There is the possibility that additional small uranium deposits such as the Blue Bird mine could be found in the Atlanta District. These would probably be small and sporadic and would not constitute an interesting target unless uranium prices increase dramatically. There is the possibility, however, that a uranium recovery circuit could be profitable in a disseminated gold mine.


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