MINES AND PROSPECTS IN AND AROUND THE FARMINGTON CANYON COMPLEX, NORTHERN UTAH

by

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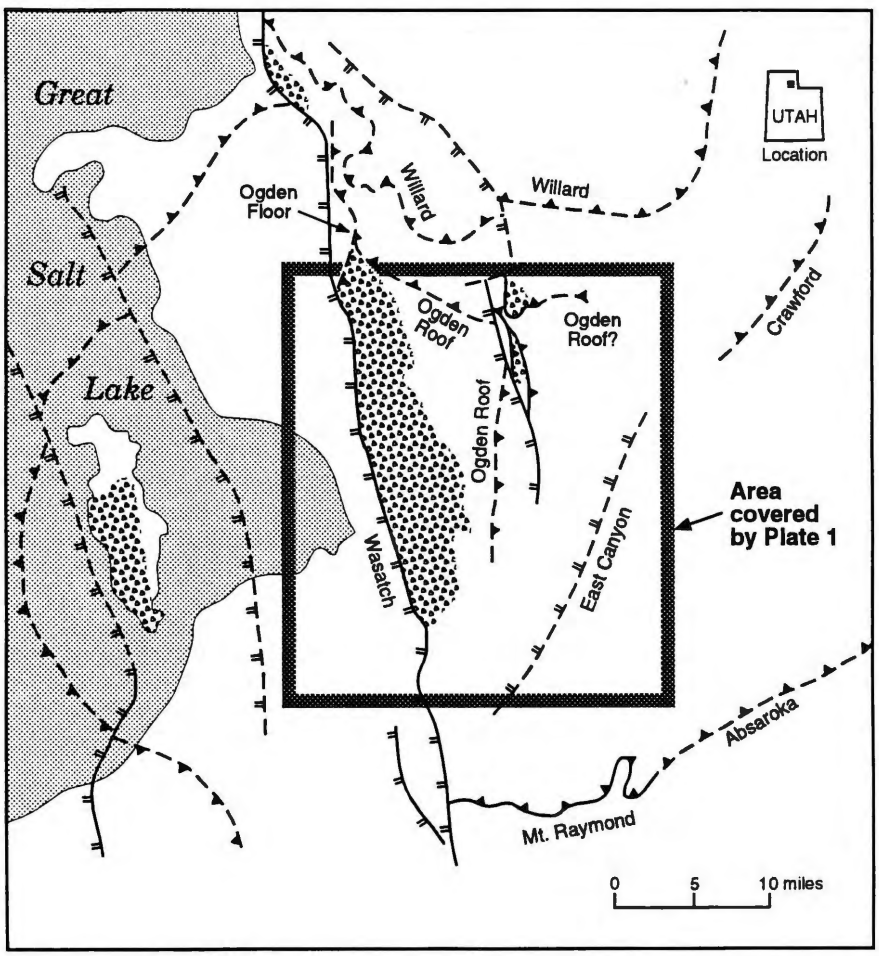

OPEN FILE REPORT 325 June 1995

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ABSTRACT

Forty-three mines and prospects were examined in the northern Wasatch Mountains of north-central Utah. Areas sampled include the Argenta, Morgan, Farmington, and Hot Springs(City Creek) districts and the Mountain Green area. One-hundred and twenty three samples were collected and assayed for 17 elements including base- and precious-metals and a broad suite of associated elements. Four ore types were found. From oldest to youngest, the types include: (1) stratabound-copper mineralization in Triassic sandstones and shales, (2) quartz-chalcopyrite veins, usually in chloritic shear zones, in the Precambrian Farmington Canyon Complex, (3) disseminated pyrite and chalcopyrite in quartzo-feldspathic gneiss and granite gneiss in the Precambrian Farmington Canyon Complex, and (4) lead-zinc-silver vein or replacement deposits in lower to middle Paleozoic rocks. Types 2 and 3 may be the same age with the difference only due to the amount of structural preparation. Although some of the mines and prospects contained ore-grade mineralization, most are small with very limited tonnage potential. We think it unlikely that sufficient ore-grade tonnage could be developed at any of the prospects examined to justify a reasonable-sized operation.

INTRODUCTION

In mid-1991, the Utah Geological Survey was approached by Union Pacific Resources to enter a cooperative program to study the mines and prospects in and around the Farmington Canyon Complex in the northern Wasatch Mountains of Utah. The purpose was to examine and sample mines and prospects in the area, classify the deposits as to deposit type and possible age, and to evaluate the potential of the mines and prospects. Of particular interest was the gold potential of the area. The study was particularly appropriate because most mines and prospects had either not been described or were inadequately described and there was almost no analytical information for any of the occurrences.

A total of forty-three prospects were examined during the study within the following mining districts or areas: Argenta district, Mountain Green area, Morgan district, Farmington district, and Hot Springs district. Many prospects consisted of multiple workings but overal most were small. Only a few mines had any reported production and most of these were in the Argenta district. A total of 123 samples were collected including five samples from Antelope Island. The samples were assayed for 17 elements including precious and base metals (gold, silver, copper, lead, and zinc) and a broad suite of associated elements.

Most field work was completed during the summer and fall of 1992, but several prospects were re-visited in late 1994 and additional samples collected.

LOCATION AND ACCESS

The study area is located in the northern Wasatch Mountains and extends for a distance of approximately 25 miles (40 km) from just north of Emigration Canyon to just north of Weber Canyon (figure 1). Access is generally poor. A paved road in Weber Canyon crosses the northern part of the area and a paved road in Emigration Canyon crosses the southern part of the area. In the central portion a paved and gravel road extends up Farmington Canyon, loops around the crest of the of the range and returns down to Bountiful. Several roads extend several miles up some of the canyons on the west side of the range but do not reach the higher elevations. A number of dirt and gravel roads are present on the east side of the range and in the Durst Mountain area in Morgan county but most are chained or locked preventing access.

GENERAL GEOLOGY

The general geology of the area is shown on plate 1. The area contains of two basement-cored antiforms of Precambrian to Cretaceous units which are unconformably overlain by a series of more gently-dipping Cretaceous to Tertiary units. The two antiforms are located along the crest of the Wasatch Mountains between Emigration Canyon and Odgen Canyon and in the Durst Mountain area.

The basement cores are Precambrian meta-igneous and meta-sedimentary rocks of the Farmington Canyon Complex. These rocks are mostly layered quartzo-feldspathic gneiss, granitic gneiss and schist of various lithologies. The rocks have been subjected to several episodes of metamorphism, locally up to granulite grade, and deformation during the early Proterozoic. Syn-metamorphic(?) intrusions of quartz monzonite gneiss were mapped by Bryant (1988a) in the northern part of the area (Byrant, 1988a, 1988b; Barnett,Bowman and Smith, 1993). Syn- and post-metamorphic pegmatites are common.

The basement rocks are unconformably overlain by Cambrian to Upper Cretaceous sedimentary rocks with an aggregate thickness of over 20,000 feet (6,100 m) (Hintze, 1988). These units generally strike north to northeast with moderate to steep dips to the east or southeast but are locally overturned. The sedimentary rocks consist of:

(1) Cambrian limestone, quartzite, shale, and siltstone;

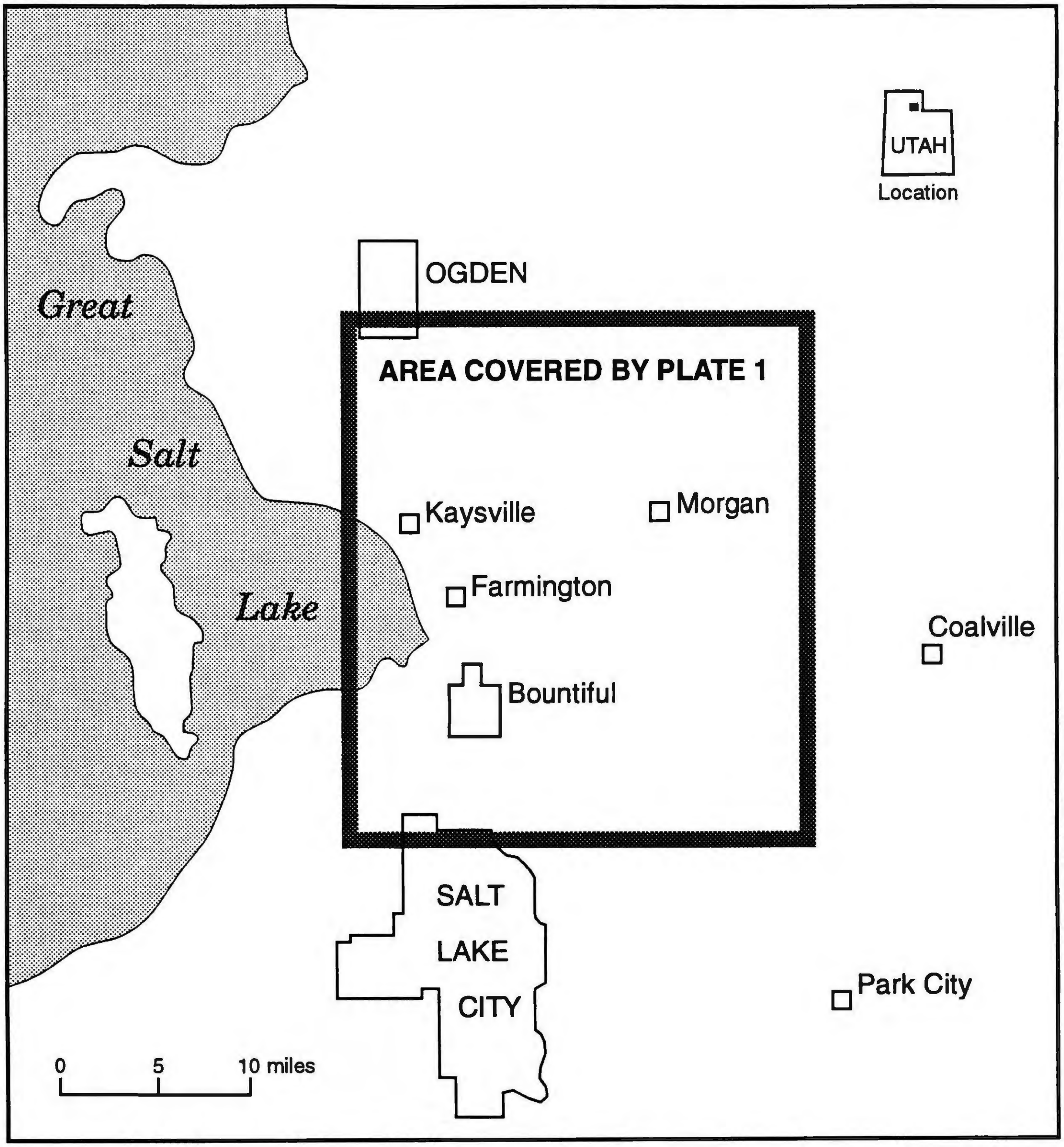


Figure 1- Location Map.

(2) Devonian to lower Pennsylvanian limestone and dolomite with lesser interbedded shale and siltstone, and minor quartzitic sandstone;
(3) middle Pennsylvanian to Lower Triassic sandstone, siltstone, and limestone,
(4) Lower Triassic to Middle Jurassic marine sandstone, shale and limestone and non-marine sandstone and siltstone;
(5) Lower Cretaceous non-marine sandstone, siltstone and conglomerate; and
(6) Upper Cretaceous, mostly marine, fine-grained sandstone and shale with lesser non-marine conglomerate and coal.

Upper Cambrian through Middle Devonian units are only locally present having been largely removed by pre-Middle Devonian erosion in most areas.

The basement rocks and the overlying Cambrian to Upper Cretaceous sedimentary rocks are unconformably overlain by a series of Upper Cretaceous to Oligocene conglomerate, sandstone, shale and volcanoclastic rocks that usually dip less than 20 degrees. The sandstone and conglomerate of Upper Cretaceous to Eocene age were mostly derived the highlands that formed during folding and thrusting of the Precambrian to Lower Cretaceous units during the Sevier orogeny. Numerous erosional and angular unconformities within the Upper Cretaceous to Eocene rocks reflect successive orogenic pulses.

All of the preceeding units are locally unconformably overlain by a variety of Quarternary deposits.

The area is located in the southern part of the Idaho-Utah-Wyoming sector of the Cordilleran fold and thrust belt. The area is structurally complex area and contains several stacked thrust sheets cut by large-displacement normal faults. Most of the folding and faulting occured during the Cretaceous to Eocene compressional Sevier orogeny with later normal faulting during Miocene through Holocene basin and range extension. Structural features formed during the Sevier orogeny include:

(1) ductile deformation zones (DDZs) in the Precambrian basement rocks;
(2) a number of successive thrust sheets; and
(3) broad folds in Precambrain to Cretaceous rocks above ramps in the thrust sheets (ramp anticlines).

Structural features developed during basin and range extension include mostly north- to northeast-trending, moderately to steeply dipping, normal faults forming elongate ranges and sediment-filled valleys. Episodic uplift accompanied both the Sevier-age thrusting and folding and the later normal faulting.

A anastomising network of Sevier-age ductile deformation zones developed in the Precambrian basement rocks in the Wasatch Range (Yonkee, 1992). These zones of highly sheared rock contain abundant chloritic and sericitic phyllonite and mylonite. The phyllonite and mylonite are compositional different from the adjacent wall-rock precusors indicating significant alteration and metasomatism. Zones vary from a one-inch to over 150-feet (3 centimeters to over 50 meters) wide. On the west side of the Wasatch Range, these zones dip gently to the east with top to the east movement while on the east side of the range they dip moderately to the west with top to the west movement. Sericite within these zones is between 110 and 140 Ma based on argon-argon dating. Formation of the ductile deformation zones largely preceeded most of the thrusting, broad-scale folding and uplift associated with the Sevier orogeny (Yonkee, 1992). The DDZs initially developed at high angles and were later rotated, in some cases almost 90 degrees, to their current orientation by later thrusting, broad folding, and normal faulting.

A number of eastward-directed thrust faults developed contemporaeous and subsequent to the formation of the ductile deformation zones. Four major thrust sheets are recognized in the northern Wasatch Mountains (figure 2). From oldest to youngest they are: (1) Willard thrust, (2) Ogden thrust, (3) Crawford thrust and (4) Absaroka-Mt Raymond thrust.

The Willard thrust is exposed north of the area of plate 1. Movement on the Willard thrust begun about 120 Ma.(Yonkee, 1992). It juztaposed Proterozoic and Paleozoic rocks over Paleozoic to Mesozoic rocks.

The Ogden thrust system consists of a floor thrust and a roof thrust. The two thrusts are exposed north of the area of plate 1 in Ogden and Taylor Canyons. In this area the Ogden floor thrust juxtaposes Precambrian and Lower Cambrian units over Lower to Upper Cambrian units and the Ogden roof thrust juxtaposes Lower to Middle Cambrian units over Middle to Upper Cambrian units. To the south in the area covered by plate 1, the Ogden floor thrust is not exposed on the surface but is thought to be present beneath the Wasatch range 15,000 to 20,000 feet (4,600 to 6,100 m) below the present surface where it juxtaposes Precambrian Farmington Canyon Complex over Precambrian Farmington Canyon Complex. In this same area the Ogden roof thrust rises above the crest of the Wasatch Mountains and has been eroded. Yonkee (1992) shows the position of the roof thrust as 6,000 to 8,000 feet (1,800 to 2,400 m) above the crest of the range. Both the roof and floor thrusts dip moderately to steeply to the east and the roof thrust is thought to be present in Morgan Valley beneath Tertiary cover. Most movement on the Ogden thrust was between 110 and 80 Ma. (Yonkee, 1992).

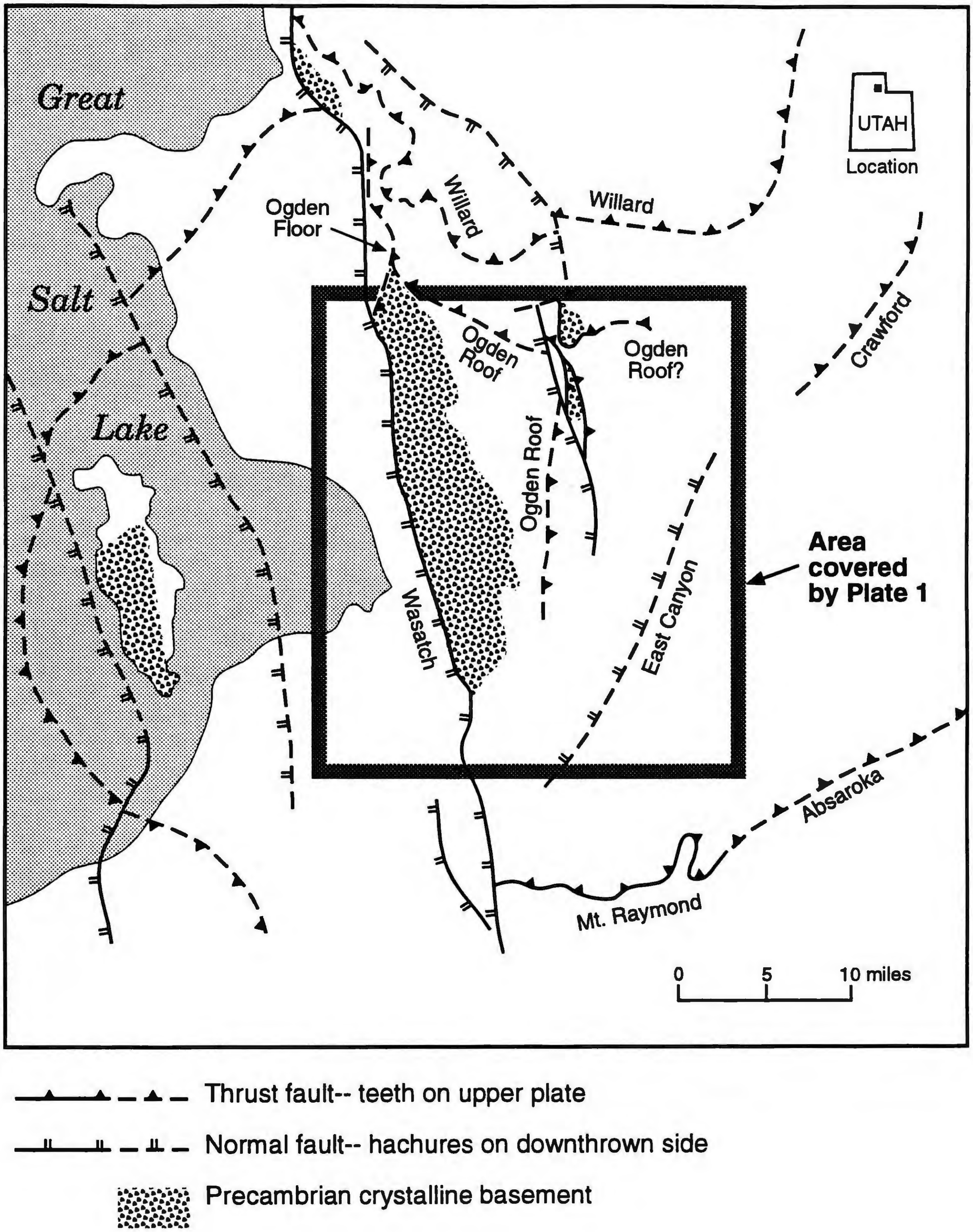


Figure 2. Generalized structure map showing major thrust and normal faults and Precambrian crystalline basement. Modified from Schirrier (1985), and Yonkee (1992).

Several thrust faults have been mapped in the Durst Mountain area east of Morgan Valley and one may be an uplifted portion of the Ogden roof thrust. The postulated Ogden roof thrust is exposed along Cottonwood Canyon where Precambrian basement and Cambrian to Mississippian rocks are juxtaposed over Cambrian to Pennsylvanian rocks. The thrust fault dips moderately to steeply to the east and the southern edge may be a lateral ramp. The eastern edge is covered. A monocline or possibly half an anticline is developed above the thrust. Another thrust trace is exposed on the west side of Durst Mountain where Precambrian basement and Cambrian rocks overlie Cambrian to Devonian rocks. Several anticlines have been mapped above this thrust. The eastern edge of this thrust fault is covered.

The Crawford thrust is exposed in the Crawford Mountains east of area of plate 1 where Cambrian rocks overlie Mississippian rocks. Most movement on the Crawford thrust was between 85 to 80 Ma (Wiltschko and Dorr, 1983). The Crawford thrust may be the leading edge of the Ogden thrust or it may represent a slightly younger thrust system developed from the Ogden footwall decollement. The East Canyon normal fault on the east side of the area of plate 1 may be a Crawford thrust ramp along which later normal movement occurred during basin and range extension (Schirmer, 1985).

The youngest exposed thrust in northern Utah is the Absaroka-Mt Raymond thrust system. This thrust system is exposed south of Parleys Canyon where Mississippian to Permian rocks overlie Mississippian to Jurassic units. The area is extremely complex with several northeast-trending anticlines and synclines in the upper plate, probably developed during the thrusting. Most movement along this thrust system was between 60 to 80 Ma (Wiltschkko and Dorr, 1983). Some blind thrusts or reactivation of older thrusts may be present in the area and some of the observed folding may be related to ramps in the older thrusts (Schirmer, 1985). Absaroka-Mt Raymond thrusting rotated and folded the older thrust sheets and rotated the DDZs (Yonkee, 1992).

The area of plate 1 is cut by several generally north-trending normal faults and related graben including Ogden and Morgan Valleys. These faults cut Precambrian to Holocene units and are due to basin and range extension. Major faults include the Wasatch fault, the fault on the west side of Morgan Valley, the fault on the east side of Morgan Valley and the East Canyon fault. Cross sections show the dip on the major west-dipping faults to be between 25 to 45 degrees (Yonkee, 1992). Many of the west-dipping normal faults may have developed along older thrust ramps with attendent reversal of movement.

MINERALIZATION

Three or possibly four types of mineralization were found in the area. From oldest to youngest, the types include (1) stratabound-copper mineralization in Triassic sandstones and shales, (2) quartz-chalcopyrite veins, usually in chloritic shear zones, in the Farmington Canyon Complex, (3) disseminated pyrite-chalcopyrite in quartzo-feldspathic gneiss and granitic gneiss of the Farmington Canyon Complex and (4) lead-zinc-silver replacements in lower to middle Paleozoic carbonate rocks. Types 2 and 3 may the same age with the difference only due to the amount of structural preparation.

Stratabound Copper Mineralization:

Three sedimentary-hosted copper prospects were examined. The prospects are all very similar and all occur at the same stratigraphic position in the upper part of the Mahogany Member of the Triassic Anakareh Formation. The prospects are found over a distance of 4 miles and it is likely that additional occurrences are present along strike and down dip in the same favorable horizon. The mineralization is very similar to that described by Gale(1910) for occurrences near Montpelier in Idaho.

The copper mineralization consists of blue-black copper sulfides (chalcocite?, digenite?) and secondary copper carbonates (malachite and azurite). The copper sulfides occur as disseminations, replacements of carbonaceous material, and as rinds around shale or claystone clasts. The larger plant fragments and twigs are only partially replaced with the copper sulfides preferentially replacing the rims and lumens of the plant cell structure. Both the copper sulfides and copper carbonates are concentrated along the siltier partings and bedding planes of the host unit.

The host rock is greenish-gray to brownish-gray, thinly-bedded to laminated, micaceous, fine-grained sandstone and siltstone within a sequence of red-brown, more massive, fine-grained sandstone. The copper sulfides are restricted to the "reduced" green-gray parts, but the secondary copper carbonates while mostly in the reduced parts, are also found in the red-brown "oxidized" parts. The contact between the "reduced" and "oxidized" parts is usually gradational and locally crosses depositional boundaries. Several of the green-gray units change along strike into red or red-brown units indicating either very local reduced zones in an overall oxidizing depositional environment or later oxidation of a more extensive "primary" reduced zone. There is no apparent concentration of copper at the oxidized-reduced contact.

One to three "ore horizons" were found at the prospects examined. The "ore horizons" are from two to about six-feet (0.6 to 2.0 m) thick and are commonly separated from each other by three to six feet (1 to 2 m) of red-brown massive sandstone. The "middle ore horizon" consisting of thinly-bedded to laminated sandstone and siltstone is the most persistent. This horizon is from four- to six-feet thick (1.3 to 2.0 m). The copper minerals are not uniformly distributed throughout the "ore horizons" but are concentrated on bedding planes and partings in the siltier horizons and around twigs and plant fragments in the fine-grained sandstone.

The copper mineralization is generally low-grade. Samples of the "ore horizons" assayed from 0.25 to 2.29 percent copper and 0.4 to 67 ppm silver, but the higher-grade samples were all select grab samples. A four-foot-thick chip sample across the "middle ore horizon" contained 0.4 percent copper which is probably more representative of the average grade. Samples from the northern prospect contained higher copper and silver and a significantly higher silver/copper ratio. The carbonaceous material at this location is much finer-grained, more macerated and more concentrated in discrete bands which could explain the higher values. The explanation for the higher silver/copper ratio is unknown. Although samples were not assayed for organic carbon, there is a strong correlation between visible carbon trash and copper content.

The potential of these prospects is low. The "ore horizons" are thin, low grade, and dip moderately to steeply into the hillside. The lateral extent of the horizons, at least at the prospects examined, is also limited. Even though select "high-graded" ore has been mined and shipped, it is unlikely that a sufficient tonnage of pittable, ore-grade material could be developed.

The age of the mineralization is not well constrained. Several lines of evidence, however, suggest that the copper mineralization was early, probably during diagenesis; (1) partially replaced twig fragments are not flattened, (2) the copper sulfides in the wood fragment lumens filled open spaces rather than replacing earlier filling material and (3) rare disseminated, diagenetic (?) pyrite, now altered to limonite, is not replaced by copper sulfides.

A possibly related style of mineralization is found at the Phil Shop Hollow prospect (Devils Slide 005). Malachite occurs along the upper contact and along fractures within a 2-foot (0.6 m)-thick, massive to crudely-bedded, vuggy limestone. The minealization is stratabound and traceable for at least 60 feet (20 m) before being covered by colluvium. No sulfides were observed and the nature of the sulfide mineralization, if any, is unknown. The deposit might be related to copper-bearing fluids from the overlying Ankareh Formation or possibly even the Woodside Formation migrating down fractures until they hit a favorable porous host unit in the underlying Dinwoody Formation.

Quartz-Chalcopyrite Veins:

Sixteen quartz-chalcopyrite-vein prospects were examined. The prospects are found over a distance of 18 miles (29 km) from Weber Canyon southeast of Ogden to Mill Creek Canyon east of Bountiful, and over a width of 4 miles (6.5 km). Most of the prospects are in the Farmington district, but the Strawberry mine is in the Mountain Green area. Less than half of the prospects examined had exposures adequate to determine vein width, orientation, and structural relationship. For the remaining prospects, the nature of the mineralization was inferred from the distribution of workings and materials remaining on the mine dumps.

The quartz-chalcopyrite-vein style of mineralization consists of white to gray quartz veins and stringers containing veinlets and blebs, up to 1-inch (2 to 3 cm) long of chalcopyrite and pyrite. Secondary mineral are common and include chalcocite, bornite, "copper pitch", cuprite, tenorite, azurite, malachite chalcanthite, brochantite, and possibly anterlite. Malachite and "copper pitch" are most common secondary copper minerals.

Individual quartz veins are less than 1-inch to nearly 4-feet (3 to 120 cm) wide, but most of the prospected veins are 10- to 24-inches (25 to 60 cm) wide. The veins form discontinuous, single to multiple veins or pods and sheeted to anastomosing vein systems. The sheeted and anastomising vein systems may be up to 10-feet (3 m) wide with individual veins 0.25- to 6-inches (0.8 to 15 cm) wide. The quartz is usually white to dark gray, vitreous to glassy, and vuggy in part. It is usually moderately to strongly limonite-stained and commonly fractured.

The vein and vein systems are commonly, but not invariably, developed in quartz-chlorite phyllonitic shear zones (DDZs) that cross-cut the gneissic foliation. These quartz-chlorite phyllonite zones are from 10- to nearly 80-feet (3 to 24 m) wide and generally trend east-west± 20 degrees. The foliation within these zones strikes parallel to the zone trend and dips moderately (35-70 degrees) to both the north and south. The quartz veins are generally quasi-parallel to the phyllonite foliation but in detail slightly cross-cut the phyllonite foliation. In the few prospects where exposure was good, the quartz veins are seen to be emplaced along brittle fault and fracture zones that diverge from the foliation in the phyllonite by as much as 20 degrees. These fault and fracture zones have clay gouge selvedges up to 2- to 3-inches (5 to 8 cm) wide, and the quartz veins are margined by gouge on one or both sides. Not all the fault and fracture zones within the phyllonite contain quartz veins. The distribution of much of the secondary copper is controlled in part by the brittle fault and fracture zones even when they do not contain quartz veins.

Similar vein and vein systems are developed in amphibolite, quartzo-feldspathic gneiss, biotite-quartz-feldspar gneiss, granitic gneiss, and pegmatite. The veins generally cross-cut the foliation or banding of the host unit, but "pegmatite-hosted" veins usually follow the pegmatite contact. Vein emplacement in these host units is also controlled by late brittle faults and fractures.

Wall-rock alteration is minor. For the gneiss- and pegmatite-hosted veins the adjacent host units are weakly chloritized and locally sericitized. The width of the alteration envelope is narrow, usually less than 2 to 3 feet(0.6 to 1.0 m). For the phyllonite-hosted veins, alteration is probably similar but is difficult to distinquish from the alteration accompaning the formation of the quartz-chlorite phyllonites. However in one case, a thin 2-inch (5 cm)-wide sericite selvedge was found adjacent to a quartz vein cutting phyllonite and is probably related to the veining. Gray silicified rock is also found on the dumps of several phyllonite-hosted vein prospects but was not observed in place and the relationship of the silicified rock to the veining is unknown. Narrow zones of disseminated sulfide mineralization are found adjacent to many of the veins in both the phyllonite- and gneiss-hosted deposits. These zones consist of disseminated fine-grained pyrite and chalcopyrite and contain up to 5 percent total disseminated sulfides. The pyrite/chalcopyrite ratio for these zones appears to be slightly higher than for the quartz veins proper. The disseminated mineralization rarely extends more than 1- to 2-feet (0.3 to 0.6 m) from the veins.

Samples of the quartz-chalcopyrite veins contain from 0.08 to 7.7 percent copper with most samples in the range of 1 to 2 percent. The veins are also locally anomalous in gold (100-7,350 ppb), silver (1-11 ppm), and weakly anomalous in lead (100-400 ppm) and zinc (150-600 ppm). The higher gold values are concentrated in the central part of the area near the Utah-Pioche mine and Mud Creek prospect suggesting a crude zoning. Lead, zinc, molybdenum, and bismuth values and lead/zinc ratios, however, show no consistent zoning pattern.

The quartz-chalcopyrite veins have little potential for development. Although select samples show ore grade values, the mineralization is narrow, discontinuous and of small lateral extent. It is unlikely that a sufficient tonnage of ore could be developed to justify an operation.

The quartz-chalcopyrite veins are younger than the quartz-chlorite phyllonites which were dated by Yonkee (1992) as between 110 and 140 Ma using 40Ar/39Ar ages for sericite. The true age is probably significantly younger since the veins are in brittle faults and fractures which would form only after uplift of the dated ductile-deformation-zone phyllonites. The vuggy nature of the quartz also supports the conclusion that the veins were formed under lower effective pressure conditions. A "best guess" estimate for the age of the quartz chalcopyrite veins is between 65 to 85 Ma during the later stages of the Sevier orogeny.

The origin of the mineralization is unknown. The wide-spread distribution of the prospects, the relatively uniform nature of the mineralization, and the apparent lack of zoning suggest a large system as might be developed by basin-wide circulation. Unanswered questions include (1) the source of the metals, (2) the mechanism to separate copper from other presumed disolved base metal constituents, (3) the focusing mechanism to confine fluids a few specific zones, and (4) why the veins are confined exclusively to the crystalline rocks of the Farmington Canyon complex.

Disseminated Pyrite-Chalcopyrite:

Non-vein margin disseminated pyrite-chalcopyrite mineralization was found at six prospects in the Farmington district. These prospects are present over a distanct of 9 miles (14.5 km) in the southern part of the district. Most occurrences were found in adits driven to intersect quartz-chalcopyrite veins and could easily be missed on surface exposures since the rocks are only weakly altered and iron-stained.

The mineralization consists of 2-5 percent fine-grained, disseminated pyrite and chalcopyrite in weakly argillitized and possibly sericitized quartzo-feldspathic gneiss, granite gneiss and occassionly quartz-chlorite phyllonite. The host rocks are strongly fractured and usually cut by thin hairline to 1-inch (1 to 25 mm)-wide quartz stringers. The quartz stringers develop in and along clay-lined fractures. Sparse sulfides are associated with the quartz, but most of the sulfides are disseminated in the wall rock. Disseminated sulfides extend over a width of at least 70 feet in the Miller Creek prospect (Bountiful Peak 002), but other occurences are narrower and more discontinuous.

Samples of the disseminated-style mineralization assayed from 0.0l to 0.8 percent copper and from 6 to 65 ppb gold. Samples were not anomalous in silver, lead, or zinc.

The potential for development of this disseminated style of mineralization is uncertain, but probably low. Although grab samples show values that would be ore to sub-ore grade for a large pittable operation, insufficient work has been done to determine the extent and average grade of the mineralization. It is probable that additional zones of disseminated mineralization are present in the area and could concievably be larger or higher grade.

Because of the general similarity between the pyrite-chalcopyrite-disseminated mineralization and the quartz-chalcopyrite veins, the age and origin are thought to be similar. A nearly continuous range is found between the disseminated style with narrow quartz stringers and wider zones of disseminated mineralization and the vein style with thicker quartz veins and narrower zones of disseminated mineralization. The main difference between the two styles is probably due to structural preparation. Faults and fractures developed in the strongly anisotropic phyllonites are larger and show a preferred orientation subparallel to the phyllonite foliation whereas faults and fractures developed in the more homogeneous granitic gneiss and quartzo-feldspathic gneiss are smaller and with more diverse orientations. The time difference, if any, between the two styles of mineralization is unknown.

Lead-Zinc-Silver Replacements:

Lead-zinc-silver replacement deposits are found in the Argenta, Morgan and Hot Springs districts. They are usually restricted to lower to middle Paleozoic limestones and dolomites. One prospect in the southern Farmington district contains lead and zinc in quartz veins hosted by the Farmington Canyon Complex and may represent a more distal part of the Hot Springs district system. Workings at most of the lead-zinc-silver prospects are caved and the ore on the dump, if present, is mostly oxidized to a porous or siliceous limonite gossan. It is nearly impossible to determine ore controls or estimate the size of the ore shoots because of poor surface exposure and very limited underground access. In addition, many of the prospects were driven in barren carbonate units presumably to intersect gossans found upslope on the surface. Most of these cross-cuts did not intersect mineralization at depth since no ore was found on their dumps.

The Argenta district is located on both sides of Cottonwood Creek in northern Morgan County and covers an area of approximately 12 square miles (3,100 ha). Seven prospects were examined in this area. In the Morgan district, lead-zinc-silver replacement deposits are restricted to several small deposits located approximately 2 miles (3 km) north of Morgan. Two prospects were examined in this area. The Hot Springs district is located north of City Creek just east of Salt Lake City and covers an area of approximately 8 square miles (2,100 ha). Six prospects were examined in this area.

The lead- zinc-silver mineralization consists of massive to semi-massive replacements of limestone. Most of the ore observed is highly oxidized and consists of porous to siliceous limonite gossan with secondary lead and zinc minerals and rare remnant galena. The observed secondary ore minerals consist of smithsonite, cerrusite, anglesite and, at one prospect, malachite. Jarosite, plumbojarosite and hemimorphite have also been reported (Heyl, 1963). In most cases, however, the secondary minerals are masked by the abundant limonite and not usuallly identifable in hand samples. The primary mineralization in the Argenta district consists of "steel galena, pyrite, dark-brown sphalerite, platy barite, calcite, and much jasperoid" (Heyl, 1963). The abundance of limonite and the relatively low values for lead and zinc in the oxidized gossans suggest that the primary ore was rich in pyrite, particularly in the Argenta district.

The ore occurs as linear to tabular replacement bodies along cross-cutting faults and breccia zones, as tabular replacement bodies along bedding, and as highly irregular replacement bodies cross-cutting bedding. Most ore zones are small, usually only 2- to 4-feet (0.6 to 1.3 m) wide (or thick for bedding replacement deposits) and from less than 20- to possibly 40-feet long (6 to 12 m). Down-dip dimensions are estimated to be less than 60 feet (20 m) Several surface stopes at the Carbonate Gem mine measured 5 feet by 8 to 12 feet by 6 to 8 feet (1.6 x 2.4 to 4 x 2 to 3 m), but there is no information on the size of the underground stopes. Several of the tabular and irregular replacement bodies developed adjacent to faults. In some cases the faults acted as feeders, but in others the faults were younger and displaced the mineralization.

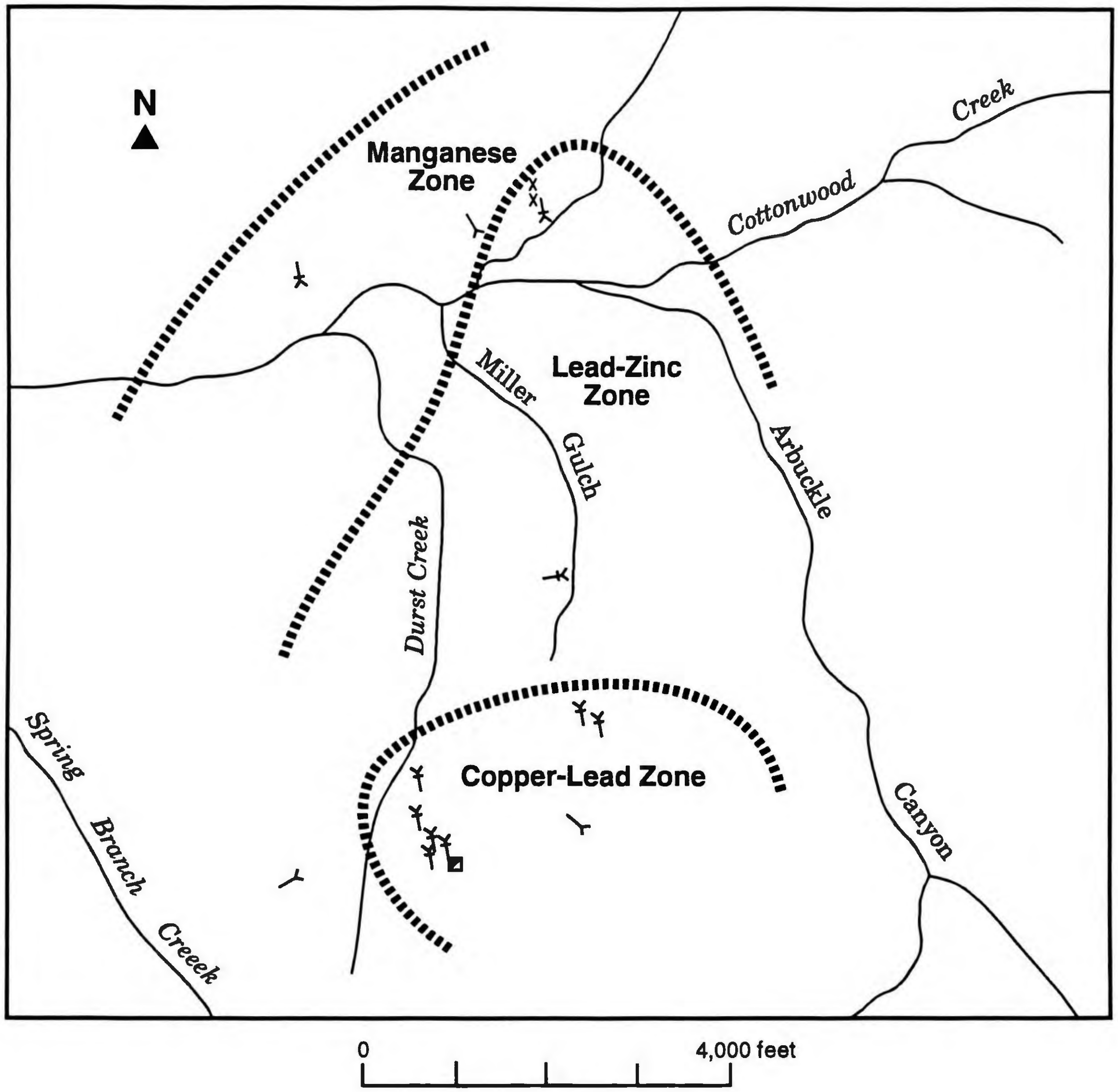
The host rocks are medium to dark gray, usually massive, limestones and dolomites. In the Argenta district, the main host rock is the Cambrian Maxfield Limestone which hosts the larger deposits. A small deposit was also found in the Mississippian Gardison Limestone. Several prospects explored the Devonian Hyrum Dolomite, but little or no ore was found on the dumps of these prospects. In the Morgan district, the single, small deposit examined was in massive, fine-grained dolomite of the Devonian Hyrum Dolomite. In the Hot Springs district, host units include the Cambrian Maxfield Limestone, the Devonian Stansbury Formation, the Devonian Pinyon Peak Formation, the Mississippian Humburg Formation and the Mississippian Donut Formation. The larger workings are in the Maxfield Limestone, and the Mississippian Donut Formation. In all of the districts the best host is massive to thick-bedded, light- to dark-gray limestone irrespective of the age or formation.

Little or no wall-rock alteration is associated with the lead-zinc-silver deposits and contacts between ore and host are usually sharp. Bleaching and recrystallization of the dark- to medium-gray limestone adjacent to the ore was observed at several prospects but rarely extends more than 6 to 12 inches (15 to 30 cm) from the edge of the replacement body. In addition, the more massive gossan pods are often surrounded by a halo of moderately to strongly fractured limestone with abundant limonite veins and stringers up to 3- to 4-inches (8 to 10 cm) wide and scattered gossan pods. The fractured and limonite-veined limestone rarely extend more than 3 to 5 feet (1 to 2 m) from the more massive replacements. At the Cottonwood Creek prospect (Durst Mountain 006) barite is concentrated in this halo zone, but it is not known if the barite at other prospects occupies this same position.

Samples of gossan and gossan-veined limestone from the Argenta district contained 300 to 20,110 ppm lead, 780 to 25,349 ppm (2.5 percent) zinc, 22 to 151 ppm copper and 1.0 to 103 ppm silver. These samples are highly leached since the ore shipped before 1918 contained an average of 16.9 percent lead and 2.7 ounces silver per ton (Heyl, 1963). Samples of gossan from the lead-zinc-silver prospects in the Morgan district contained 330 to 560 ppm lead, 110 to 480 ppm zinc, 50 to 80 ppm copper and 0.3 to 0.5 ppm silver. Samples of gossan and gossan-veined limestone from the Hot Springs district contained 230 to 98,750 ppm (9.8 percent) lead, 300 to 186,800 ppm (18.6 percent) zinc, 65 to 8,000 ppm copper and 1.3 to 204 ppm silver. These much higher values suggest that the gossans in the Hot Springs district were not as strongly leached as in the Argenta district possible due to a lower pyrite content in the hypogene ore.

A crude base-metal zoning pattern is found in both the Argenta and Hot Springs districts (figure 3 and 4). This tenative zoning pattern is not well constrained because of the limited number of samples and the differential effects of leaching on the mobility of the various base metals. The effect of leaching is particularly apparent in the lead/zinc ratios where the ratio in the gossans may have little relationship to the ratio of the primary ore.

In the Argenta district the southern prospects contain higher copper (150 to 700 ppm vs 60 to 140 ppm), higher lead (12,800 to 20,000 ppm vs 600 to 3,500 ppm), and lower manganese (80 to 270 ppm vs 350 to 3,560 ppm) than the northern prospects. Lead/zinc ratios also increase to the south. The northern prospects have lead/zinc ratios of 0.18 to 0.76 compared to the southen prospects with lead/zinc ratios of 0.8 to 2.0. The zoning pattern is somewhat similar to that in the Tintic district and suggests that the center of the system was in the south near the Morgan Argentite mine. Molybdenum, tungsten, and bismuth values were plotted to check for intrusive-related zoning but showed no consistent patterns and all values were low. The lead-zinc-silver replacement deposit in the Morgan district to the south does not appear to be part of this system. In the Hot Springs district the base metal zonation consists of a western zone of high copper (3,000 to 8,000 ppm), moderate lead (400 to

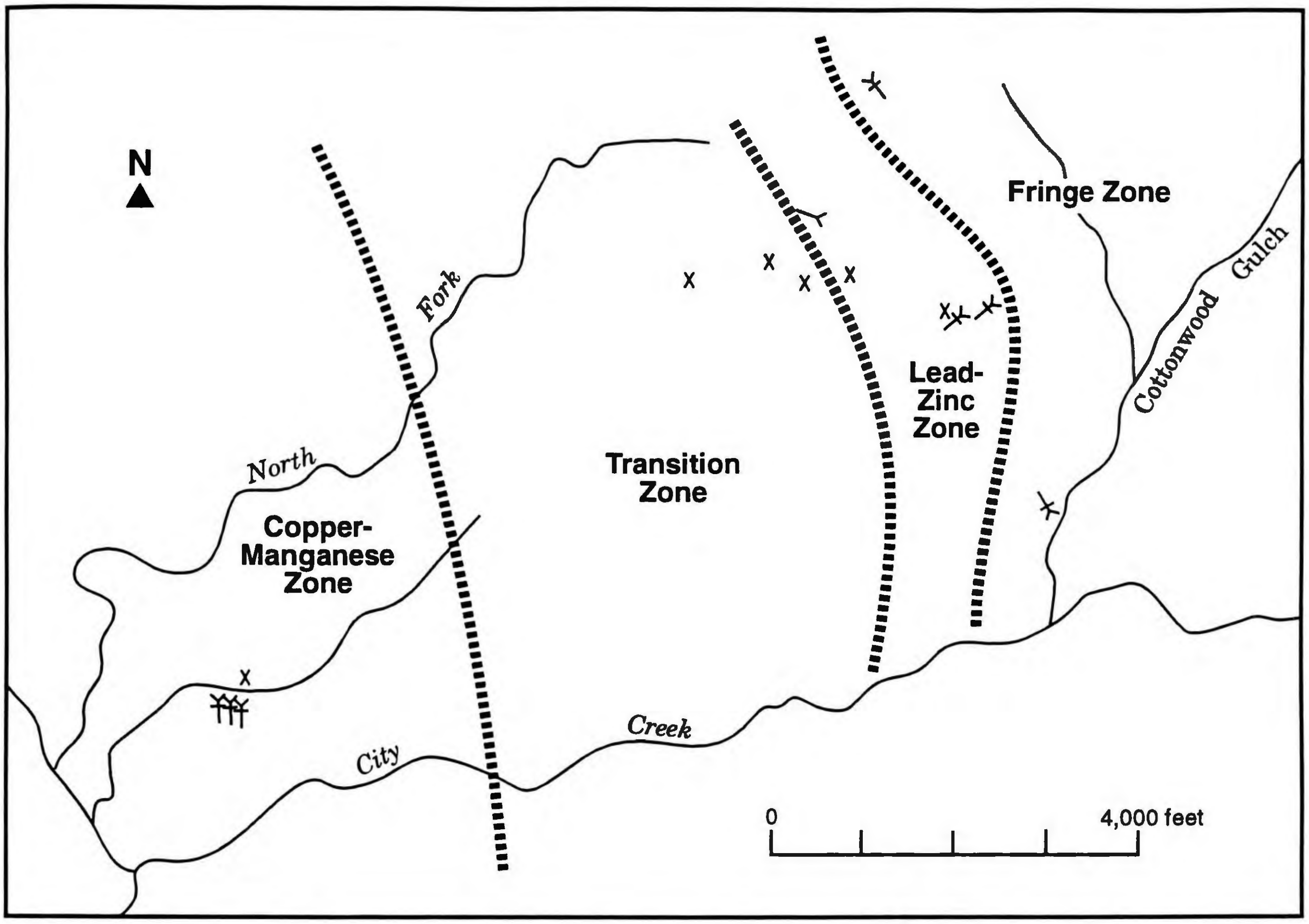


Copper-Lead Zone-- 10,000 to 20,000 ppm Pb; 10,000 to 26,000 ppm Zn; 150 to 700 ppm Cu; less than 300 ppm Mn; Pb/Zn = 0.8 to 2.0

Lead-Zinc Zone-- 600 to 3,500 ppm Pb; 6,400 to 11,000 ppm Zn; 60 to 140 ppm Cu; 100 to 1,250 ppm Mn; Pb/Zn = 0.2 to 0.8

Manganese Zone-- Less than 200 ppm Pb; less than 700 ppm Zn; less than 100 ppm Cu; 2,200 to 3,600 ppm Mn

Figure 3. Metal zoning map of Argenta district



Copper-Manganese Zone-- 400 to 8,300 ppm Pb; 300 to 2,500 ppm Zn; 3,000 to 8,300 ppm Cu; 500 to 900 ppm Mn; Pb/Zn = 1.3 to 3.3

Transition Zone-- 800 to 40,000 ppm Pb; 14,000 to 206,000 ppm Zn; 70 to 350 ppm Cu; 350 to 600 ppm Mn; Pb/Zn = 0.05 to 0.2

Lead-Zinc Zone-- 27,000 to 90,000 ppm Pb; 20,000 to 187,000 ppm Zn; 100 to 750 ppm Cu; less than 350 ppm Mn; Pb/Zn = 0.5 to 1.4

Fringe Zone-- 200 to 2,000 ppm Pb; 900 to 3,600 ppm Zn; less than 300 ppm Cu; less than 150 ppm Mn

Figure 4. Metal zoning map of Hot Springs district

8,300 ppm), low zinc (300 to 2,500 ppm) and moderate manganese (540 to 860 ppm); a central zone (transition zone and lead-zinc zone of figure 4) of moderate copper (70 to 750 ppm), high lead (800 to 98,700 ppm), high zinc (14,000 to 205,800 ppm) and low to moderate manganese (350 to 560 ppm); and an eastern zone of low copper (60 to 100 ppm), moderate lead (235 to 2,000 ppm), moderate zinc (900 to 3,600 ppm) and low manganese (90 to 140 ppm). Within the central zone, the higher zinc values are on the eastern side. There is some indications that lead/zinc ratios increase to the west, but the pattern not consistent. The zoning pattern suggests that the center of the system was to the west of the Rotary Park prospect (Fort Douglas 005).

The is little potential for discovery or development of significant lead-zinc-silver-replacement ore bodies in the Argenta, Morgan or Hot Springs districts. Most of the mines and prospects are small and the observed mineralization narrow and of limited extent. Although some ore grade samples were collected, it would be difficult to develop sufficient tonnage to justify a mine.

The age of the lead-zinc-silver mineralization is not well constrained. It is probably younger than the quartz-chalcopyrite vein mineralization based on the lower temperature, lower pressure nature of the quartz associated with the lead-zinc mineralization compared to the quartz of the quartz-chalcopyrite vein association. Both types of ore are found on the dump at the Mill Creek prospect (Fort Douglas 014), but the workings are caved and cross-cutting relationships were not seen. The lead-zinc-silver mineralization is tentatively thought to be Late Eocene to Early Oligocene (30-38 Ma) based on analogy to other lead-zinc-silver replacement deposits in northern Utah (Bingham, Park City and Tintic districts).

The distribution of the propects and the crude base metal zoning patterns suggests that the lead-zinc-silver replacement deposits developed around two or possibly more centers of mineralization. The origin of these centers of mineralization is problematic since no intrusive rocks were found and aeromagnetic surveys show no magnetic highs indicative of a buried intrusion near the presumed centers (Mabey and others, 1964; Zietz and others 1976).

EXPLORATION GEOCHEMISTRY

Methods:

A total of 123 samples were collected from the mines and prospects in the study area. Plate 3 shows the sample locations. Appendix B is a listing of sample descriptions. All samples were assayed for 17 elements by Chemical and Mineralogical Services, Inc. of Salt Lake City. Analytical results are shown in appendix C. Gold concentrations were determined by the graphite furnace atomic absorption (AA) technique. The remaining element concentrations were determined using the inductively-coupled plasma (ICP) technique.

Univariate Statistics:

Univariate and multivariate statistics were calculated for the initial 119 samples. The four samples collected in 1994 were not included in the analysis but are included in the plates and appendices. Table 1 summarizes the univariate statistics. Because most of the samples were collected from mines and prospects, most of the elements show a highly positive skewed, log-normal distributions. Plate 4 is a map showing the locations of samples with gold concentrations greater than 60 ppb. A threshold value of 60 ppb was selected to separate background gold concentrations from anomalous concentrations on the basis of a histogram for gold concentrations (figure 5). Similarly, plate 5 shows the location of samples with copper concentrations greater than 500 ppm and the corresponding histogram is included as figure 6.

	Mean	Standard Deviation	Minimum	Maximum
Gold	127	705	< 2	7350
Silver	5.2	22.3	< 0.1	204.4
Copper	3058.5	8612.9	5.5	77528
Lead	2672.4	11070.0	1.3	98750
Zinc	4755.0	25605.5	7.4	205800
Arsenic	137.8	562.3	3.7	4554.8
Antimony	5.4	25.1	< 0.1	219.1
Molybdenum	6.1	7.6	0.5	58.2
Bismuth	2.6	16.7	< 0.1	180.1
Cadmium	2.3	7.1	< 0.1	42.4
Barium	635.4	706.3	< 10	4060
Tungsten	3.9	3.8	0.7	29.7
Manganese	466.0	555.1	28.3	3556.7
Vanadium	79.5	52.6	23.4	340.1
Chromium	105.4	79.1	11.5	626.4
Cobalt	17.1	33.0	0.5	316.0
Nickel	22.5	18.1	1.1	98.9

119 samples
All values in parts per million (ppm) except gold which is in parts per billion (ppb)

Table 1 Summary of univariant statistics

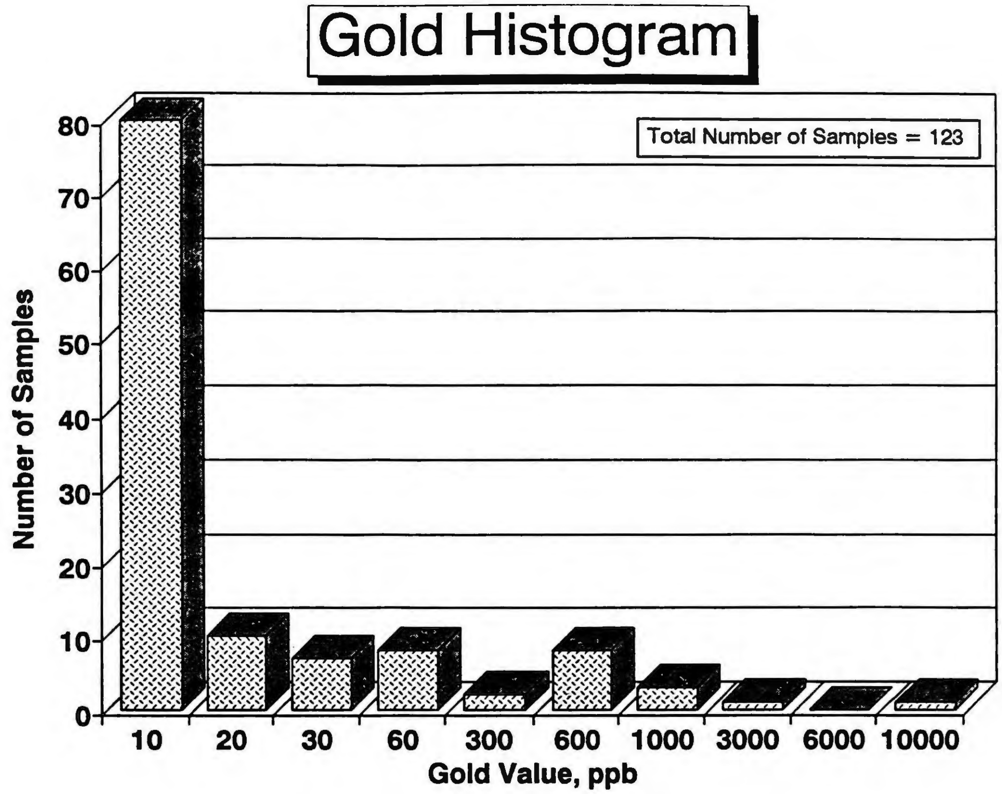


Figure 5 Histogram of gold values

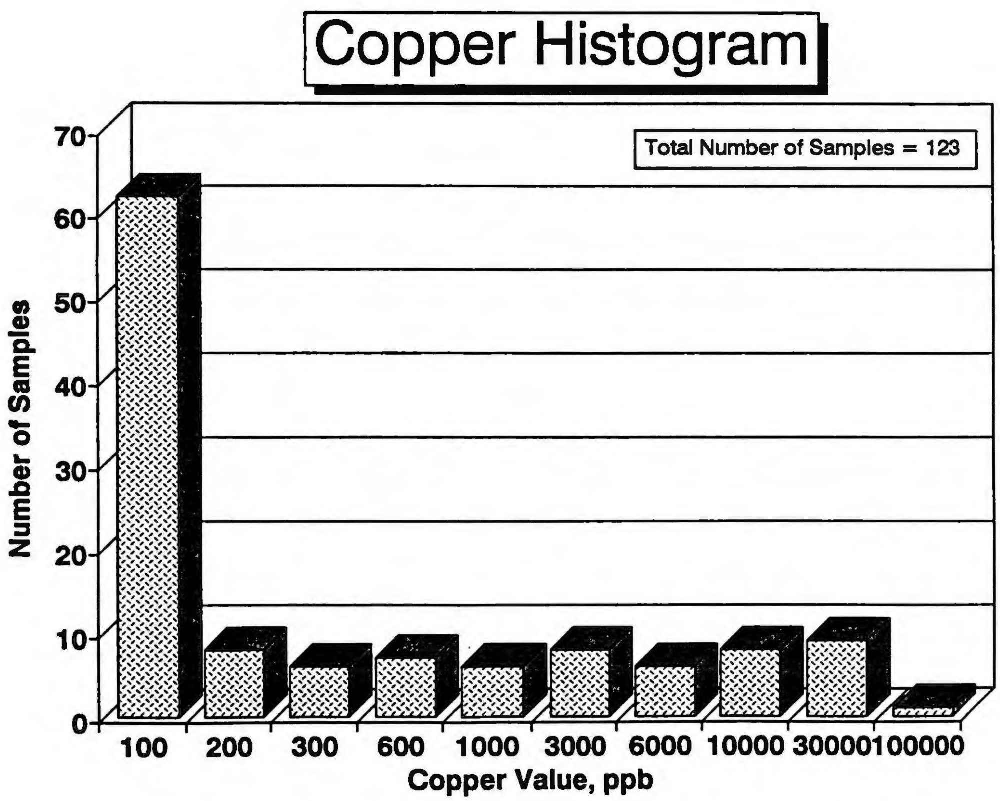


Figure 6 Histogram of copper values

Multivariate Statistics:

Table 2 lists the correlation coefficients computed from the analytical data (appendix III). There are many highly significant correlations among the elements in the data set. We used factor analysis to reduce the number of varibles in the data set by identifying and combining groups of mutually correlatable elements. A five-factor model (table 3) accounting for 89.9 percent of the total variance was created using R-mode factor analysis and the Varimax rotation.

Elements with high factor loadings in factor one are: lead, zinc, silver, cadmium, antimony, and arsenic. Elements with high factor loading in factor two are: gold, copper, molybdenum, and bismuth. Elements with high factor loadings in factor three are: vanadium, manganese, nickel, chromium, and cobalt. Elements with high factor loadings in factor four are: arsenic, cadmium, antimony, and chromium (negative loading). Elements with high factor loadings in factor five are: tungsten, molybdenum, manganese (negative loading), barium (negative loading), and chromium. The five-factor model accounts for all of the significant correlations observed in the data (table 2).

Results of the factor analysis may be interpreted as follows:

1. Factor one represents polymetallic (lead-zinc-silver) mineralization hosted by lower to middle Paleozoic carbonate rocks. The clear geochemical signature of this mineralizing event persists in spite of the nearly complete oxidation of the primary sulfide ore minerals.

2. Factor two represents copper-gold quartz vein mineralization in the Farmington Canyon Complex.

3. Factor three represents the variability of trace metal contents of rocks due to lithology.

4. Factor four differs from factor one in that it lacks significant loadings for lead, zinc, and silver. However, samples with high scores for factors one and four do show a close spatial association. Factor four may represent lead-zinc-silver deposits that have been intensely oxidized and leached. Alternatively, factor four could represent oxidized sulfide deposits peripheral to lead-zinc-silver deposits (leakage halo). The first explanation is prefered since (1) most of the high factor four scores are in the Argenta district which has more extensive oxidation and leaching than the Hot Springs district and (2) the high factor four sample in the Hot Springs district is near the center of the system based on element zoning rather than near the periphery.

	Au	Ag	Cu	Pb	Sn	As	Sb	Mo	Bi	Cd	Ba	W	Mn	V	Cr	Co	Ni
Au	1.000	-0.020	0.850	-0.035	-0.030	-0.038	-0.032	0.218	0.192	-0.049	-0.125	-0.070	-0.105	-0.053	0.041	-0.048	-0.055
		(0.83)	(0.00)	(0.70)	(0.75)	(0.68)	(0.73)	(0.02)	(0.04)	(0.60)	(0.18)	(0.45)	(0.26)	(0.57)	(0.66)	(0.61)	(0.55)
Ag		1.000	0.028	0.839	0.745	0.379	0.946	0.022	-0.016	0.602	-0.028	-0.098	-0.048	-0.078	-0.177	0.076	-0.109
			(0.76)	(0.00)	(0.00)	(0.00)	(0.00)	(0.82)	(0.86)	(0.00)	(0.77)	(0.29)	(0.60)	(0.40)	(0.05)	(0.41)	(0.24)
Cu			1.000	-0.064	-0.055	-0.042	-0.058	0.229	0.153	-0.086	-0.125	-0.109	-0.127	-0.048	0.078	-0.039	-0.060
				(0.49)	(0.55)	(0.65)	(0.53)	(0.01)	(0.10)	(0.35)	(0.18)	(0.24)	(0.17)	(0.60)	(0.40)	(0.67)	(0.51)
Pb				1.000	0.815	0.268	0.858	0.036	-0.026	0.653	-0.015	-0.052	-0.065	-0.074	-0.122	0.087	-0.082
					(0.00)	(0.00)	(0.00)	(0.70)	(0.78)	(0.00)	(0.87)	(0.57)	(0.48)	(0.43)	(0.19)	(0.35)	(0.38)
Sn					1.000	0.159	0.785	0.019	-0.026	0.728	-0.086	-0.085	-0.017	-0.079	-0.181	0.129	-0.097
						(0.08)	(0.00)	(0.83)	(0.78)	(0.00)	(0.35)	(0.36)	(0.85)	(0.39)	(0.05)	(0.16)	(0.29)
As						1.000	0.499	0.022	-0.030	0.623	0.097	-0.062	-0.061	-0.138	-0.241	-0.006	-0.135
							(0.00)	(0.81)	(0.75)	(0.00)	(0.30)	(0.50)	(0.51)	(0.14)	(0.01)	(0.95)	(0.14)
Sb							1.000	0.032	-0.028	0.692	-0.017	-0.086	-0.057	-0.107	-0.205	0.081	-0.128
								(0.73)	(0.76)	(0.00)	(0.86)	(0.35)	(0.54)	(0.25)	(0.03)	(0.38)	(0.16)
Mo								1.000	0.037	0.104	-0.078	0.196	-0.172	-0.078	-0.052	0.004	0.114
									(0.69)	(0.26)	(0.40)	(0.03)	(0.06)	(0.40)	(0.58)	(0.96)	(0.22)
Bi									1.000	-0.042	-0.105	-0.001	-0.081	-0.054	0.095	-0.041	-0.087
										(0.65)	(0.25)	(0.99)	(0.38)	(0.56)	(0.30)	(0.66)	(0.34)
Cd										1.000	0.034	-0.104	-0.024	-0.139	-0.293	0.052	-0.063
											(0.71)	(0.26)	(0.80)	(0.13)	(0.00)	(0.58)	(0.50)
Ba											1.000	-0.144	0.109	-0.033	-0.092	-0.195	-0.242
												(0.12)	(0.24)	(0.72)	(0.32)	(0.03)	(0.01)
W												1.000	-0.103	0.220	0.075	-0.013	0.150
													(0.26)	(0.02)	(0.42)	(0.89)	(0.10)
Mn													1.000	0.322	-0.125	0.141	0.402
														(0.00)	(0.17)	(0.13)	(0.00)
V														1.000	0.284	0.122	0.539
															(0.00)	(0.18)	(0.00)
Cr															1.000	0.138	0.311
																(0.13)	(0.00)
Co																1.000	0.236
																	(0.01)
Ni																	1.000

Table 2 Correlation Coefficients for Analyzed Samples

Computed from 119 samples. The number beneath each correlation coefficient (in parentheses) is the significance level for that coefficient. Significance levels were computed using the null hypothesis that the two samples (sets of analysis) being compared are independent. Thus, the significance level is the probabililty that rejection of the null hypothesis could occur by random chance. To compute a confidence level from the significance level, subtract the significance level from one and multiply by 100. Thus a significane level of 0.05 corresponds to a 95 percent confidence level that the samples are not independent.

Element	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Gold	-0.021	0.897	-0.024	0.007	0.018
Silver	0.914	0.032	-0.018	0.134	-0.040
Copper	-0.030	0.913	-0.026	-0.012	0.015
Lead	0.903	-0.034	-0.010	0.054	0.023
Zinc	0.909	-0.023	0.004	-0.014	-0.033
Arsenic	0.252	-0.040	-0.106	0.835	-0.012
Antimony	0.925	-0.024	-0.041	0.260	-0.012
Molybdenum	0.026	0.230	-0.023	0.123	0.347
Bismuth	-0.014	0.189	-0.086	-0.059	0.100
Cadmium	0.679	-0.051	-0.026	0.559	-0.021
Barium	-0.071	-0.137	-0.158	0.108	-0.354
Tungsten	-0.086	-0.099	0.114	-0.014	0.407
Manganese	-0.053	-0.108	0.511	0.034	-0.411
Vanadium	-0.085	-0.060	0.634	-0.082	0.066
Chromium	-0.149	0.059	0.268	-0.271	0.280
Cobalt	0.120	-0.027	0.295	-0.038	0.084
Nickel	-0.089	-0.037	0.776	-0.018	0.186

Example: Factor 1 = -0.021 Au + 0.914 Ag - 0.030 Cu + 0.903 Pb + 0.909 Zn + 0.252 As + 0.925 As + 0.026 Mo - 0.014 Bi + 0.679 Cd - 0.071 Ba - 0.086 W - 0.053 Mn - 0.085 V - 0.149 Cr + 0.120 Co - 0.089 Ni

Table 3 Element loading value for each factor

5. We could not interpret factor five. Some of the samples with high factor five scores were collected from the Stawberry mine and were enriched in gold, copper, molybdenum, and tungsten.

The sediment-hosted statabound copper deposits were not distinguished by multivariate analysis either due to a non-unique signature or an insufficient number of samples.

Plate 5 shows the distribution of samples with high values for factors one, two and four. It also shows the location of other samples enriched in copper, lead and zinc.

CONCLUSIONS

1. Forty-three mines and prospects were examined in the Farmington, Argenta, Morgan, Mountain Green and Hot Springs districts in the northern Wasatch Mountains. Most of the mines and prospects were small and few had any reported production. Although some of the mines and prospects contained ore-grade material, most are small with very limited tonnage potential. It is unlikely that sufficient ore-grade tonnage could be developed at any of the prospects examined to justify a reasonable-sized operation.

2. Three or possibly four distinct styles of mineralization were found in the mines and prospects examined. From oldest to youngest they include:

(1) Stratabound copper mineralization in Triassic sandstones, shales and rarely limestones,

(2) Quartz-chalcopyrite veins, usually in chloritic shear zones, in the Precambrian Farmington Canyon Complex,

(3) Disseminated pyrite and chalcopyrite in quartzo-feldspathic gneiss and granitic gneiss of the Farmington Canyon Complex, and

(4) Lead-zinc-silver replacements in lower to middle Paleozoic carbonate rocks.

Types 2 and 3 may be the same age with the difference only due to the amount of structural preparation.

3. The stratabound copper mineralization consists of disseminated and replacement copper sulfides (chalcocite, digenite(?)) and secondary copper carbonates in several greenish-gray to brownish gray, micaceous, fine-grained sandstone horizons within a sequence of red-brown, more massive, fine- to medium-grained sandstone. The mineralization is probably early diagenetic and

Triassic in age.

4. The quartz-chalcopyrite vein mineralization consists of white to gray, quartz veins or vein stringer systems containing blebs and stringers of pyrite and chalcopyrite. The veins and vein systems are commonly, but not invariably, developed in quartz-chlorite-phyllonite zones and roughly parallel the foliation of the phyllonite. The quartz veins are emplaced along brittle fault and fracture zones with up to 2- to 3-inches (5 to 8 cm) of gouge. The quartz-chalcopyrite vein style of mineralization is present over a distance of nearly 20 miles and shows little variation or zoning. The widespread distribution and relatively uniform nature of the mineralization suggests a large system as might be developed by basin-wide circulation. Our "best guess" estimate for the age of the quartz-chalcopyrite veins is between 65 and 85 Ma during the later stages of the Sevier orogeny.

5. Disseminated pyrite and chalcopyrite in quartzo-feldspathic gneiss and granitic gneiss is found near quartz-chalcopyrite veins at six prospects. The mineralization consists of 2 to 5 percent disseminated sulfides in weakly argillitized and possibly sericitized gneiss, usually associated with hairline to 1-inch (2.5 cm)-wide quartz veinlets. The mineralization is very similar to the quartz-chalcopyrite veins, but the veins are much thinner and the zones of disseminated mineralization much wider. We believe the age and origin of this mineralization is similar to that of the quartz-chalcopyrite veins.

6. Lead-zinc-silver replacement deposits are found in the Argenta, Morgan and Hot Springs districts. They consist of massive to semi-massive replacements of limestone, presumably once sulfide but now mostly oxidized to porous to siliceous gossan with secondary lead and zinc minerals and rare remnant galena. The ore occurs as linear to tabular replacement bodies along faults, as tabular replacements along bedding and as irregular replacements cross-cutting bedding. At least two centers of mineralization are present and both show a crude element zoning pattern. We believe the origin to be similar to that of other lead-zinc-silver replacement deposits in northern Utah even though there are no indications of any intrusives near the deposits. We tentatively postulate the age of the mineralization as Late Eocene to Early Oligocene based on analogy to other lead-zinc-silver deposits in northern Utah.

7. Factor analysis of the assay data showed that a five-factor model accounted for 89.9 percent of the total variance of the samples. We interpret the five factors as follows:

> Factor 1 (Pb, Zn, Ag, Cd, Sb, As): Polymetallic lead-zinc-silver replacements,
>
> Factor 2 (Au, Cu, Mo, Bi): Copper-gold quartz veins,

Factor 3 (V, Mn, Ni, Cr, Co): Lithology of host units,

Factor 4 (As, Cd, Sb, Cr(neg.)): Highly leached polymetallic lead-zinc-silver replacements, and

Factor 5 (W, Wo, Mn(neg.), Ba): Unknown.

The sedimentary-hosted copper deposits were not distinguished by factor analysis either due to a non-unique signature or an insufficient number of samples.

ACKNOWLEDGEMENTS

The study was partially funded by Union Pacific Resources. Their financial support is gratefully appreciated. Reviews by the following people greatly improved the report: Adolph Yonkee of Weber State University and Bryce Tripp, Jon King, Bill Lund and Doug Sprinkel all of the Utah Geological Survey.

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APPENDIX A

Description of Mines and Prospects

DESCRIPTION OF MINES AND PROSPECTS

The mines and prospects visited are described below. The mines and prospects are discussed by district and within each district divided according to type and nature of the ore or listed according to geographic location from north to south within the district. Mines and prospects are identified by their historical name if known or assigned a map name and number (Bountiful Peak-017) The map name refers to the appropriate 7.5 quadrangle map and the number to the listing in the Utah Geological Survey Utah Mineral Occurrence System (UMOS) files. Known mines are also listed by their map name and number identification (for example, Utah-Pioche mine (Peterson 005)). Map name and number prospects are also given an informal geographic name (for example, Bountiful Peak 013 (Parrish Creek North prospect)).

MOUNTAIN GREEN AREA

Strawberry Mine (Snow Basin 005): The Strawberry mine is located on a southeast facing slope in the NE¼NW¼NW¼ section 34 and the SE¼SW¼SW¼ section 27, T. 5 N., R. 1 E. Workings consist of four adits and small surface trenches. The major workings are developed in a 50- to 80-foot-wide, north-trending zone of chlorite-quartz schist and cataclastite. The lower adit trends N. 50° W. and is partially caved but reported to be 130 feet long(Utah Geological Survey, 1994). The portal is in banded felsic gneiss with abundant pegmatite stringers, but the adit was apparently driven to intersect the chlorite-quartz schist to the northwest. The adit was probably driven in the gneiss because it is much more competent than the chlorite schist. The middle adit is located about 80 feet above the lower adit. It is now caved and the portal covered by talus and dump rock. In 1980, it was still open and reported to be 66 feet long (Utah Geological Survey, 1994). The upper adit is located about 80 feet northwest of the middle adit. It trends N. 50° W. and is caved. It was probably no more than 30 to 40 feet long. A fourth adit is present approximately 60 feet west of the middle adit near the western edge of the chlorite-quartz schist. It is 20 feet long and was driven along a 4- to 5-foot-wide zone of fissile, chlorite-rich schist with malachite staining. Total production from the Strawberry mine was probably small, estimated at less than 5,000 pounds of copper.

The ore consists of coarsely crystalline, white to gray quartz veins and stringers containing thin stringers, blebs, and disseminations of pyrite and chalcopyrite up to 1 inch long. Individual quartz veins and stringers range in thickness from less than 1 inch to over 10 inches and often form anastomosing stringer zones enclosing chloritic-wall-rock fragments. The total width and number of the stringer zones is unknown because of poor outcrop. The chalcopyrite is partially to completely altered to bornite, chalcocite, tenorite, copper pitch, and malachite. The copper sulfides and oxides are restricted to the veins proper, but the copper carbonates are more mobile and are also found in the adjacent chlorite-quartz schist wall rock, particularly in the more fissile or more contorted parts.

The mineralized quartz veins are confined to a 50- to 80-foot-wide, irregular, north-trending, cross-cutting, chlorite-rich retrograde zone. Rocks within the zone range from chloritized biotite-feldspar-quartz gneiss through fissile, chlorite-quartz phyllonite to chlorite-rich schist. Wall rocks to the retrograde zone consist of gray biotite-quartz-feldspar gneiss, pink quartz- feldspar gneiss with minor biotite or hornblende and white equigranular, garnet-quartz-feldspar rock. The chlorite-quartz phyllonite and the chlorite-rich schist may contain very minor disseminated pyrite and are locally cut by thin, milky quartz veins without sulfides.

Five samples (FC 1-5) were collected from the prospect. Selected grab samples (FC-1, FC-3, FC-4) of sulfide-bearing-quartz vein material assayed 0.08, 0.8, and 0.8 percent copper but contained only background lead and zinc values. Gold and silver values were low; from 20 to 90 ppb gold and 0.4 to 1.6 ppm silver. The higher silver and gold values were from a highly oxidized sample and could represent enrichment due to weathering. Samples of the chloritic host units (FC-2, FC-5) showed weak, but anomalous copper (120 to 300 ppm) and vanadium (190 to 200 ppm) values. Sample FC-5 contained anomalous silver (1.4 ppm) and gold (190 ppb). The explanation for these values is not known since the sample contained no visible sulfides or quartz veins.

ARGENTA DISTRICT

Seven mines or prospects were examined in the Argenta district in northern Morgan County. Nearly all of the mines and prospects are irregular, lead-zinc-silver-barite replacement deposits in lower to middle Paleozoic limestones and dolomites. Most of the workings are caved, and the ore on the dumps is mostly oxidized to a porous or siliceous limonite gossan with occasional remnant galena and secondary lead or zinc carbonate minerals. It is nearly impossible to determine ore controls or estimate the size of ore shoots because of poor surface exposure and very limited underground access. According to Perry and McCarthy (1976), the district produced about 683,000 pounds of lead and 600 pounds of zinc between 1905 and 1960. Most production was before 1927. The ore shipped before 1918 contained an average of 16.9 percent lead and 2.7 ounces of silver per ton (Heyl, 1963). Named mines include the Carbonate Gem, Carbonate Hill, Morgan Chief, and Morgan-Argentite mines. Most production came from the Carbonate Gem and Morgan-Argentite mines.

Durst Mountain-007 (West Cottonwood Creek Prospect): The Durst Mountain-007 prospect is in NE¼SE¼NW¼ section 13, T. 5 N., R. 2 E. on the north side of Cottonwood Creek about 170 feet above the creek level. Workings consist of a single caved adit trending approximately N. 35° W. The size of the dump suggests there were about 300 to 400 feet of workings. The adit apparently was driven along an argillite-massive limestone contact in the upper part of the Cambrian Ophir Shale.

The dump consists mostly of medium- to fine-grained, micaceous sandstone, purple micaceous argillite, and dark-gray to black shale. The dump also contains moderately to strongly maroon-brown limonite-stained quartzite and micaceous quartzite. The source of the iron staining is unknown, but it probably is inherent in the quartzite since the limonite staining forms a rind surrounding cores of unstained yellow-brown, porous sandstone. No obviously mineralized rock was found on the dump. A composite sample (FC-36) of the limonite-stained sandstone contained no anomalous base metal values but was high in manganese (2,261 ppm) and contained 50 ppb gold.

Durst Mountain-006 (Cottonwood Creek Prospect): The Durst Mountain-006 prospect is in SE¼NE¼NE¼ section 13, T. 5 N., R. 2 E on the north side of Cottonwood Creek about 100 feet above the creek level. Workings consist of a single adit 70 feet long which is still open. The adit trends N. 30° W. for about 40 feet from the portal and then turns N. 60° W. The workings follow a curved, nearly vertical, fault. The fault is well- developed near the portal with up to 3 to 4 inches of gouge but becomes progressively less prominent to the northwest until it is only a thin, bedding-parallel slip with a thin clay selvage.

The main "ore zone" exposed at the portal consists of a highly irregular, gently east-dipping, zone of gray to tan granular limestone containing pods and stringers of both pulverent hematite and limonite and hard, siliceous limonite gossan. Overall, the mineralized zone is 10 to 15 feet wide and 25 or more feet long. Within the zone, individual gossan pods are up to 1.5 feet thick, 5 feet wide, and 8 to 10 feet long. The mineralized area appears to be roughly zoned with a central zone of abundant gossan grading outward to less abundant gossan and then to limonite-stained limestone with limonite veinlets and stringers and small isolated barite pods. A second small gossan pod is exposed in the back of the adit about 35 feet from the portal. Both zones of gossan are adjacent to the fault which may have acted as a feeder. The host rock is limestone of the Cambrian Maxfield Limestone.

Three samples (FC 28-30) were collected from the prospect. An outcrop sample (FC-28) of coarse, cellular limonite at the portal assayed 102 ppm copper, 1,261 ppm lead, 1,956 ppm zinc, and 3,557 ppm manganese. A dump sample (FC-29) of limestone cut by thin stringers and veinlets of orange, pulverent limonite assayed 22 ppm copper, 308 ppm lead, 780 ppm zinc, and 697 ppm manganese. It also contained 98 ppm arsenic, nearly double the arsenic in the higher grade sample.

A second dump sample (FC-30) of hard, siliceous limonite gossan assayed 38 ppm copper, 572 ppm lead, 750 ppm zinc, and 98 ppm manganese. It also contained 1,810 ppm barium. This gossan contained rounded clasts (?) of greenish-gray, fine- to medium-grained, pyritic quartzite (up to 30 percent intergranular disseminated pyrite). The quartzite clasts(?) show a weathering rind of dark maroon limonite staining. The quartzite clasts(?) are probably from the underlying Ophir Shale or Tintic Quartzite, but it is not known how they reached their present level in the overlying limestone since no breccia pipes or other channelways were seen in the workings.

Morgan Chief Mine (Durst Mountain-003): The Morgan Chief mine is in SE¼NE¼NE¼ section 1, T. 5 N., R. 2 E. on the east side of a small drainage about 1,000 feet north of Cottonwood Creek. Workings consist of an upper pit with an inclined shaft and two lower adits, both caved, driven to intersect the ore exposed in the upper pit. The upper pit is about 20 feet long and 25 feet wide with a caved incline at the eastern edge. The size of the dump indicates that the incline was 50 to 60 feet deep. The northern adit trends N. 45° E. and was less than 40 feet long. It probably did not intersect the ore zone since no gossan was found on the dump. The southern adit is located about 300 feet south of the upper pit and is largely concealed by brush. It trends roughly N. 5° W. and was probably 150 to 200 feet long. Some gossan was found on the dump so the adit apparently intersected the ore zone.

The "ore body" consists a single 4.0- to 5.5 foot-thick gossan developed in massive, gray limestone of the Mississippian Gardison Limestone. The gossan pod is developed in the footwall of a northwest-trending, 55-60° northeast-dipping fault with up to 2 feet of gouge. The gossan pod is roughly triangular in shape and is up to 20-25 feet long adjacent to the fault but less than 2 feet long 20 feet from the fault. The gossan pod has relatively sharp upper and lower contacts, but lateral contacts are more irregular. It is not known if the fault acted as a feeder with subsequent movement to offset the ore body or just offset the ore body.

Five samples (FC 17-21) were collected from the prospect. Two gossan samples from the upper pit area contained 0.21 and 0.36 percent lead and 1.12 and 0.89 percent zinc. Molybdenum was also slightly anomalous (22 and 15 ppm). A sample of brecciated and slightly silicified limestone collected immediately above the gossan pod contained 0.20 percent lead and 0.95 percent zinc but was not anomalous in any of the other assayed elements. The limestone is cut by thin (0.1 to 0.5 inches), hard, cherty, goethite stringers which probably contain the lead and zinc. A sample of brecciated limestone with thin quartz stringers collected from the southern adit dump was not anomalous.

Durst Mountain-009 (Miller Canyon Prospect): The Durst Mountain-009 prospect is on the west side of Miller Gulch in NW¼NW ¼NW¼ section 19, T. 5 N., R. 2 E. Workings consist of a partially caved adit trending N. 65° E. and estimated to be approximately 200 feet long. No evidence of base- metal mineralization was found at the portal; presumably the adit was driven to intersect gossans found upslope.

The host unit is medium-gray massive dolomite mapped as the Devonian Three Forks Formation (Coody, 1957) but is more likely the Hyrum Dolomite based on rock type(Hintze, 1988). No ore was observed in place, but a dump sample of massive, granular gossan contained 63 ppm copper, 584 ppm lead, 6,458 ppm zinc, and 1,130 ppm barium. The samples was also slightly anomalous in molybdenum (33 ppm) and antimony (13 ppm).

Durst Mountain-008 (Durst Creek Prospect): The Durst Mountain-008 prospect is on the west side of upper Durst Creek in NE¼NE¼SW¼ section 24, T. 5 N., R. 2 E. Workings consist of a single adit trending S. 60° W., estimated to be 100 to 150 feet long. The adit was being rehabilitated with shoring installed at the portal in 1992. Recent dump material was all caved roof material and gouge suggesting that the adit is caved at some distance from the portal.

The adit was driven in platy to thin-bedded, dark gray, silty dolomite mapped as belonging to the Devonian Three Forks Formation (Hopkins, 1982) but is more likely the Hyrum Dolomite based on rock type(Hintze, 1988). No obvious indications of ore was found at the portal or on the dump. Presumably the adit was driven to intersect ore at depth but no pits or evidence of mineralization were found upslope from the adit. No samples were collected from the property and the nature of the mineralization, if any, is unknown.

Carbonate Gem Mine (Durst Mountain-001): The Carbonate Gem Mine is on the east side of upper Durst Creek in E½SW¼NE¼, SW¼SE¼NE¼, and NW¼NE¼SE¼ section 24, T. 5 N., R. 2 E. The main workings consist of at least two caved adits, an upper caved shaft, and several small, mostly caved, irregular dogholes and surface stopes. These workings are associated with several large dumps suggesting a minimum of 3,000 feet of workings. Approximately 300 feet northwest of the main workings is a large cut with a small dump which is thought to represent an attempt to access the lower part of the ore body. The size of the dump and absence of any ore suggests that the venture was abandoned before the ore body was reached.

The observed ore consists of oxidized, lead-silver replacements of limestone. The host unit is mostly light- to dark-gray limestone with subordinate brownish-gray, recrystallized limestone mapped as the Cambrian Maxfield Limestone (Hopkins, 1982). The extent, size and control of the ore bodies are unknown, but several surface stopes are from 4 to 5 feet thick and 8 to 10 feet wide. Both the distribution of the workings and the trends of individual adits follow a N. 30-45° W. direction possibly reflecting a zone of faulting or fracturing.

Ore on the dump consists of dark maroon-brown, siliceous gossan and yellow-brown, porous gossan with stringers of dark maroon gossan. Both coarse- and fine-cellular boxworks are developed in the dark maroon gossan. Remnant galena and secondary lead (anglesite and cerrusite) and zinc (smithsonite) minerals are occasionally seen. Massive white barite was also found on the dump. The abundance of limonite and low values of lead and zinc (see below) suggest that the primary sulfide mineralization was pyrite-rich.

Three samples (FC 22-24) of gossan were collected from the Carbonate Gem mine dumps. The samples contain anomalous lead (1.3-2.0 percent), zinc (2.0-2.6 percent), arsenic (0.2-0.45 percent), barium (700-2,300 ppm), and copper (420-720 ppm).

Silver ranged from 2 to 103 ppm and gold was always less than 20 ppb.

Carbonate Hill Mine (Durst Mountain-004): The Carbonate Hill mine is near the head of Miller Gulch in SW¼NW¼NW¼ section 19, T. 5 N., R. 3 E. Workings consist two small caved adits; the lower adit trends N. 5° W. and was probably less than 150 feet long, the upper adit was also probably less than 150 feet long, but its trend could not be determined. The observed workings do not fit the description of the Carbonate Hill mine which reportedly had over 1,200 feet of workings. It is possible that the true Carbonate Hill mine is 1,200 feet further south and that the Carbonate Hill and Morgan-Argentite mines were misidentified by Perry and McCarthy (1976).

The workings are developed in massive to thin-bedded, light- to dark-gray dolomite. The unit was mapped as belonging to the Devonian Three Forks Formation (Stansbury Formation equivalent) by Hopkins (1982), but is more likely the underlying Hyrum Dolomite based on rock type. No indication of ore was found at the portal of either adit and the dumps were composed mostly of unmineralized rock. Apparently the adits were driven to intersect lead-silver-replacement ore since gossan float is found in the area. The distribution and control of the gossan mineralization is unknown.

Two samples (FC 25-26) were collected from the prospect. A sample of highly brecciated, dark-gray dolomite with strong hematite staining contained only minor amounts of lead (542 ppm) and zinc (190 ppm). A composite sample of yellow-brown to maroon gossan float (source unknown) assayed 2.0 percent lead, 1.0 percent zinc, 151 ppm copper and 4,060 ppm barium.

Morgan-Argentite Mine (Durst Mountain-002): The Morgan-Argentite mine is south of the Carbonate Gem mine in W½ section 19, T. 5 N., R. 2 E. The mine was not visited during the present study. Workings are reported (Utah Geological Survey, 1994) to consist of three caved adits of unknown length.

Perry and McCarthy (1976) describe the ore as "lead, silver and zinc mineralization in Cambrian limestones and dolomite as small replacement bodies along bedding planes and in fissures. The ore minerals are galena and cerrusite in a gangue of barite, calcite, pyrite and limonite."

MORGAN DISTRICT

Six prospect were examined in the Morgan district. The Chicago-Utah mine was described by Butler and others (1920). Butler and others (1920) also described three other mines, the Iron King, the Red Eagle-Morgan Consolidated and Morgan Crescent, but these mines were not found.

Several distinct styles of mineralization are found in the Morgan district and include: (1) strata-bound, sedimentary copper deposits in the Triassic Anakareh Formation, (2) oxidized lead-zinc replacement deposits in lower Paleozoic carbonate rocks, and (3) secondary copper deposits of unknown origin in limestone.

Strata-bound Sedimentary Copper Deposits

Three sedimentary copper prospects were examined. There are all very similar and occur at the same stratigraphic horizon in the Mahogany Member of the Triassic Anakareh Formation (Mullens and Laraway, 1964). The three prospects are found over a distance of about 4 miles and it is likely than other copper occurrences are present along the same horizon.

Chicago-Utah Mine (Devils Slide-004): The Chicago-Utah mine is in SW¼SW¼NE¼ section 2, T. 3 N., R. 3 E. along the Tunnel Hollow drainage. Workings consist of a N. 10° W. trending open- cut and adit and several small prospect pits located 300 to 500 feet up-slope from the adit. The adit is caved but was probably about 300 feet long. United State Bureau of Mines records show that 4,300 pounds of copper were produced from this mine, mostly during 1916 and 1920. The average grade of the shipped ore in 1916 was reported to be 6 percent copper and 4 ounces of silver per ton.

Copper mineralization consists of disseminated and replacement dark blue-gray copper sulfides (chalcocite?) and secondary malachite and azurite in gray to greenish-gray, micaceous, fine-grained sandstone and siltstone. The copper sulfides occur both as fine disseminations and replacements of carbonaceous material. The larger plant fragments and twigs are only partially replaced, with the copper sulfides preferentially replacing the rims and the plant cell structure. Both the copper sulfides and secondary malachite are concentrated along the siltier partings of the host units.

The copper "ore" is restricted to a 15- to 20-foot-thick, mixed reduced and oxidized zone of fine-grained sandstone with interbedded micaceous siltstone. A generalized section of the minerallized zone in given below:

Thickness	Lithologic Description
40-50 feet	Red to red-brown, massive to thin-bedded, fine-grained sandstone, local planar crossbedding.
3-4 feet	Gray to buff, massive- to wavy-bedded, fine-grained sandstone and interbedded thinly-bedded siltstone. "Upper Ore Zone"
5-6 feet	Gray to greenish-gray, thin-bedded to laminated, fine-grained sandstone and siltstone. "Middle Ore Zone" (most ore in this zone)
5-6 feet	Red-brown, massive, fine-grained sandstone, may contain thin shale-chip breccia near top.
2-3 feet	Medium to dark-gray, thin-bedded, fine-grained sandstone to silty sandstone. "Lower Ore Zone"

The contact between the reduced (gray to green-gray) and oxidized (red to brown-red) units is usually gradational and locally crosses sedimentary boundaries. Both the "upper ore zone" and the "lower ore zone" grade along strike into red or red-brown oxidized units. The "middle ore zone" is usually reduced throughout. The "ore sequence" occurs stratigraphically below a prominent ridge-forming sandstone and is easily located.

Seven samples (FC 6-12) were collected from the prospect an contained anomalous to ore-grade copper and silver. Copper values ranged from 0.08 to greater than 1.4 percent. Silver values ranged from 0.4 to 3.7 ppm and showed no obvious correlation with the copper values. A sample of the oxidized hanging-wall sandstone showed 250 ppm copper but was collected immediately adjacent to the "upper ore zone" and could represent migrated secondary copper carbonates. Although samples were not assayed for organic carbon, there is a strong correlation between visible carbon trash and copper content.

Devils Slide-004 (Mine Hollow Prospect): The Devils Slide-004 prospect is in SE¼NE¼NW¼ section 11, T. 3 N., R. 3 E. Workings consist of a single caved adit estimated to be 15 feet long. The prospect is stratigraphically below the prominent sandstone ridge in an equivalent stratigraphic position to the "middle ore zone" of the Chicago-Utah mine.

The host rock consists of mottled-gray to light-brownish-tan, fine-grained, micaceous sandstone with minor interbedded shaley horizons and shale-pebble conglomerate. The copper mineralization consists of very minor malachite-staining in the gray sandstone; no copper sulfides were observed and the rock contains very little visible carbon trash. No samples were collected for assay.

Devils Slide-010 (Cottonwood Canyon Copper Prospect): The Devils Slide-010 prospect is in SW¼NW¼NE¼ section 24, T. 4 N., R 3 E. Workings consist of an inclined shaft 80 to 100 feet deep. The shaft is sunk along the contact between red, thinly-bedded to massive, fine-grained sandstone and gray to greenish-gray, fine-grained, micaceous sandstone containing thin, wispy, carbonaceous partings. The beds strike N. 15° E. and dip 50° E.

The observed copper mineralization consists predominately of malachite staining but with minor dark-gray to blue copper sulfides (chalcocite?) as replacements of small twigs and leaf fragments and as very fine-grained disseminations along wispy carbonaceous partings. The carbonaceous material is much finer grained, more macerated, and more concentrated in discrete partings than at the Chicago-Utah mine.

The stratigraphy exposed in the shaft is as follows:

Thickness	**Lithologic Description**
10+ feet	Red to red-brown, thin- to medium-bedded, locally cross-bedded, fine- to medium- grained sandstone. Contains several 1- to 1.5-feet-thick, massive sandstones at base.
0.5 foot	Brownish-gray, fine-grained, silty sandstone.
1.5 feet	Mottled, brownish-gray to greenish-gray, massive, fine- to medium-grained sandstone. "Upper Part of Ore Zone"
4.0 feet	Medium gray, thin-bedded to laminated, medium- to fine-

	grained, micaceous sandstone with up to 2 percent carbonaceous trash, mostly along partings. "Main Ore Zone"
1.0 foot	Brick-red, thin-bedded, fine-grained sandstone.

The favorable zone is traceable for at least 600 feet to the south, but there is only occassional malachite staining. The favorable zone occurs stratigraphically below a resistant ridge of brownish-gray sandstone that is tentatively correlated with the prominent sandstone at the Chicago-Utah mine.

A select sample (FC-16) from the dump assayed 2.29 percent copper and 67 ppm silver. The silver value is significantly higher than those from the Chicago-Utah mine. The reason for the higher value is not known.

Unclassified Deposits

Devils Slide-005 (Phil Shop Hollow Prospect): The Devils Slide-005 prospect is in the SE¼NE¼NW¼ section 3, T. 3 N., R. 3 E. Workings consist of two small cuts with short inclines. The southern incline is about 25 feet long and open. The northern incline is about 25 feet to the north, is caved and was probably less than 10 feet long.

The copper mineralization consists of malachite-staining along the upper contact and along fractures within a 2-foot-thick, massive- to crudely bedded, very fine-grained limestone. The mineralization is apparently strata-bound and is traceable for at least 60 feet until covered by colluvium. No sulfides were observed and the nature of the sulfide mineralization, if any, is unknown.

The stratigraphic sequence exposed in the workings is as follows:

Thickness	**Lithologic Description**
6+ feet	Light-brownish-gray, weathers red-brown, very fine-grained, granular limestone. Some contorted beds in more thinly bedded units.
0.25 foot	Brownish-purple, slightly micaceous siltstone with

	irregular, white to cream, massive limestone beds up to ½-inch-thick.
2.0 feet	Greenish-cream, massive to crudely bedded, very fine-grained limestone. Moderate to strong malachite stain at upper contact and scattered malachite stain throughout. Numerous voids and vugs filled with drusy calcite. "Ore Zone"
2.2-2.5 feet	Brownish-gray, medium- to thick-bedded, fine-grained, laminated, granular limestone with thin (1-2 inch) beds of olive-green, calcareous, micaceous siltstone at base.
4.5-5.0 feet	Purplish-gray to greenish-gray, fine-grained, non-calcareous siltstone or argillite.
6+ feet	Brownish-gray, thick-bedded to massive, finely laminated, fine-grained, granular limestone.

Mullens and Laraway (1964) mapped this unit as belonging to the Lower Triassic Woodside Formation, but the observed stratigraphy better fits the description of the underlying Lower Triassic Dinwoody Formation. There is little outcrop in the area and faults that disrupt the section could be easily missed.

Three continuous chip samples (FC 13-15) were collected from the area of the workings; the mineralized zone, the underlying laminated limestone, and the footwall siltstone. The mineralized zone sample showed slightly anomalous copper (1,264 ppm) and silver (3.7 ppm) but was not anomalous in any other assayed elements. The two other samples were not anomalous in copper or silver.

The copper mineralization could be related to copper-bearing fluids from the overlying Anakareh Formation or possibly even the Woodside Formation migrating down fissures until they hit a favorable, porous host unit in the underlying Dinwoody Formation.

Lead-Zinc-Replacement Deposits

Several mines and prospects were opened in lead-zinc-replacement deposits in the Morgan district. All were small and there was little, if any, production.

Morgan-007 (Cedar Canyon Prospect): The Morgan-007 prospect is in NW¼SW¼SE¼ section 24, T. 4 N., R. 3 E. Workings consist of an upper series of three caved incline shafts and a single adit and a lower caved cross-cut adit located approximately 300 feet down slope and 150 below the upper workings. The upper workings are aligned along a N. 45° W. trend and consist of:

(1) a small inclined shaft - estimated 40 feet of workings,
(2) a small pit and inclined shaft - estimated 120 to 150 feet of workings (largest dump),
(3) a small inclined shaft - estimated less than 20 feet of workings, and
(4) an adit trending S. 45° E. - estimated at 100 to 120 feet of workings and connecting with the small inclined shaft to the south.

The lower cross-cut adit trends N. 70° E. The size of the dump indicates 400 to 500 feet of workings. It was probably driven to intersect the ore body found in the upper pits at depth but was apparently unsuccessful since no gossan was found on the dump.

The ore consists of dark-purplish-brown, siliceous gossan and yellow-brown to orange-brown, porous gossan. Limonite boxworks are rare and, where present, are generally curved and irregular with botryoidal surfaces. No sulfide minerals were found. The gossan was not observed in place so its width is not known but it was probably narrow estimated at less than 4 feet. The distribution and alignment of the workings suggest that the ore body extended along strike for 130 to 140 feet and down-dip for less than 150 feet because it was not intersected by the lower adit. The ore body strikes N. 45° W. (trend of upper workings) and and dips steeply to the NE (dip of inclined shafts).

The host unit is dark-gray, fine-grained, recrystallized dolomite of the Devonian Hyrum Dolomite (Mullens and Laraway, 1973; Hintze, 1988)

Two select gossan samples (FC 34-35) from the upper workings showed weak, but anomalous lead (560 ppm, 331 ppm), zinc (110 ppm, 408 ppm), and copper (49 ppm, 89 ppm). The samples also showed very slightly anomalous molybdenum (40 ppm, 16 ppm), tungsten (17 ppm, 10 ppm) and bismuth (0.5 ppm, 0.2 ppm). Three samples (FC 31-33) of fractured and brecciated dolomite with thin, limonite-filled fractures from the lower cross-cut dump showed no anomalous values. Silver and gold values were low in all samples.

Morgan-008 (Mahogany Canyon Prospects): The Morgan-008 prospects are in NW¼SW¼NW¼ section 19, T. 4 N., R. 3 E. at an elevation of 6,900 feet. Workings consist of two groups of adits. The eastern group consists of an upper caved adit estimated to be about 300 feet long and a lower adit approximately 60 feet long. The lower adit is open at the portal. The upper adit trends S. 60° E. and the lower adit trends S. 40° E. The upper adit was driven along a 1- to 2-foot-wide, rubble breccia zone and the lower adit was driven along joints in massive dolomite. The western group consist of a single, open adit estimated to be 200 to 250 feet long. The adit trends S. 40° E. and was driven in well-jointed, massive, gray dolomite with thin breccia zones.

No indications of ore were seen on the dump or in the workings. The adits were probably driven to intersect surface gossans presumably found upslope. A search for these surface gossans was unsuccessful, but the area is heavily covered with brush and they could easily have been hidden.

No samples were taken from this prospect.

FARMINGTON DISTRICT

Twenty-three mines and prospects were examined in the Farmington district. These mines as well as three other mines previously visited are shown on plate 2. Ogden-014 is not plotted on plate 2 because it is north of the map area. All of the prospects occur in the metamorphic gneiss and schist of the Proterozoic Farmington Canyon Complex. The deposits are remarkably similar. Most consist of relatively narrow, quartz-chalcopyrite veins or veinlet stringer zones which generally cross-cut the gneissic foliation. Some carry significant gold values. The gold-rich prospects are concentrated in the northern part of the district. Many, but not all, of the veins are developed in late chlorite-rich retrograde shear or phyllonite zones. These shear or phyllonite zones (ductile deformation zones (DDZs) of Yonkee, 1990) were formed during the Sevier orogeny with most age dates between 110 and 140 m.y. The quartz-chalcopyrite veins are even younger. Similar veins away from the shear zones are presumed to be similar in age. The prospects are described below in order from north to south.

Ogden-014 (Taylor Canyon Prospect): The Ogden-014 prospect is in SE¼SW¼NE¼ section 35, T. 6 N., R. 1 W. on the south side of Taylor Creek. Workings consist of three shallow pits; the largest pit is about 20 feet by 14 feet, the second pit, immediately to the north, is 14 feet by 10 feet and the third pit, to the west, is 12 feet by 2 feet. The pits are dug in alluvium below an outcrop of slaty, carbonaceous rock of the Cambrian Maxfield Limestone.

No evidence of mineralization, other than minor iron staining, was found and it is unclear exactly what was the object of exploration. The location of the prospect is the same as that for a gold-silver "discovery" described in the Salt Lake Mining Review of August 15, 1923, but the rest of description does not agree with the observed geology or workings.

Five samples (FC 126-130) of country rock were collected. Although most showed no anomalous base or precious metal values, two samples of pink quartz monzonite gneiss showed slightly anomalous zinc (245ppm, 195 ppm) and barium (2,260 ppm, 2,350 ppm).

Kaysville-011 (Lower Bair Canyon Prospect): The Kaysville-011 prospect is in NW¼SW¼SW¼ section 31, T. 4 N., R. 1 E on the north side of Bair Creek. The "workings" consist of a 20- by 50-foot-cut in schist and gneiss, but it is not certain if the disturbance was due to mining or road building. No obvious ore was seen and no samples were collected from this cut. A sample (FC 125) was collected from a talus pile 400 feet northwest of the cut. It contained only background values for all elements assayed.

Kaysville-013 (Pine View Copper Mine): The Kaysville-013 prospect is in SW¼NE¼SE¼ section 31, T. 4 N., R. 1 E. on the south side of the canyon 200 to 300 feet above the creek level. Workings are described as consisting of three small adits: two caved eastern adits and a western adit which is still open (Utah Geological Survey, 1994). Buranek (1942a) reports that one adit is at least 300 feet long. The prospect was not visited during the current investigation and the following description is based on Buranek (1942a) and an on-site visit in 1983 (Utah Geological Survey, 1994).

The ore is described as thin (12- to 18-inch- wide), white quartz veins with irregular blebs of pyrite, chalcopyrite, and bornite. Much of the ore is oxidized to limonite and malachite. The quartz veins are parallel to the foliation planes of the enclosing schist and gneiss of the Farmington Canyon Complex. The most prominent vein strikes N. 80° W. and dips steeply to the southwest. Chlorite-rich retrograde shear or mylonite zones were not reported but are probably present by analogy with other deposits in the area.

A sample collected by Buranek(1942a) contained 1.95 percent copper, 0.01 ounces gold and 0.2 ounces silver. A dump sample collected in 1983 contained 1.02 percent copper, 0.12 ppm gold, and 0.3 ppm silver (Utah Geological Survey, 1994).

Mud Creek Prospect (Peterson-004): The Mud Creek prospect is in SE¼SE¼NW¼ section 9, T. 3 N., R 1 E. approximately 1,000 feet northwest of the Utah-Pioche mine. Workings consists of a single adit that strikes due east along a quartz-veined, mineralized, phyllonite zone. The adit is 145 feet long and straight. The phyllonite/cataclastite zone is 15 to 18 feet wide, strikes due west to N. 65° W. and dips 65° N. The phyllonite zone is traceable to the east for at least 600 feet and is distinct and separate from the phyllonite at the Utah-Pioche mine. The phyllonite is developed in a series of banded biotite gneiss and pegmatite of the Farmington Canyon Complex. The phyllonite cross-cuts the foliation of the gneiss which dips north at 20° to 25°.

Within the phyllonite is a 8- to 10-foot-wide, sheeted and fractured zone containing multiple, quartz veinlets and stringers and numerous brittle faults, often with clay gouge. The quartz veins are from 0.25 to nearly 6 inches wide, but most are less than 2 inches wide. Many of the larger quartz veins have a clay selvedge on one or both sides and some of the gouge zones contain narrow, discontinuous but traceable, quartz veins indicating that the quartz veins are post-faulting.

Ore minerals consist of chalcopyrite, bornite, and pyrite and their oxidation products, mostly limonite, malachite, and "copper pitch". The copper minerals occur as blebs and stringers in the white quartz veins and also as disseminations in sheared, slightly chloritic, muscovite-quartz schist or "quartzite". The best mineralization observed in the adit was in and adjacent to a limonite gossan containing quartz vein fragments with large (up to 0.5 inch) chalcopyrite blebs, partially altered to "copper pitch".

Within the phyllonite zone, there is a set of planar fractures with clay selvedges and coated with malachite, limonite, and possible antlerite. The fractures strike N. 70° W. and dip 70° N. These faults control the distribution of a large percentage of the secondary copper minerals.

The copper mineralization is definitely younger than the phyllonite/cataclastite and the quartz-vein-hosted mineralization is younger than the brittle faulting. The age of the disseminated mineralization is most likely also post-faulting since the disseminated mineralization is concentrated near the faults. The post-brittle faulting age of the copper-gold mineralization suggests that it occurred substantially later than the phyllonite/cataclastite after significant erosion and unroofing of the Farmington Canyon Complex.

Two samples (FC 214-215) were collected. A select dump sample of dark green, chlorite phyllonite with disseminated chalcopyrite and chalcopyrite-quartz veinlets assayed 7.7 percent copper, 2.6 ppm silver, and 7,350 ppb gold, the highest concentration of gold in all of the samples. A similar sample collected from the adit assayed 1.4 percent copper, 0.8 ppm silver, and 1,320 ppb gold.

Utah-Pioche Mine (Free Gold Group), (Peterson-005): The Utah Pioche mine is in NE¼NW¼SE¼ section 9, T. 3 N., R. 1 E. near the top of the ridge between Corduroy Creek and Halfway Creek. Workings consist of an open cut which connects with a adit. The adit trends N. 70° W., is at least 70 feet long and is caved at the face. A short (5-foot) inclined winze is present approximately 20 feet from the portal. Buranek (1942b) reports a larger 50-foot-deep,inclined winze presumably at the end of the adit beyond the caved area. The open cut trends N. 80° E. and is 75 feet long.

The "ore zone" is in a 60-foot-wide, mineralized phyllonite zone that strikes N. 85° W. and dips 40° to 45° N. It consists of dark-green, quartz-chlorite phyllonite with white-quartz veins and lenses parallel to the foliation. The surrounding rock is schist and gneiss with layering commonly striking N. 60° to 70° E. and dipping 30° to 35° N. The bearing of a minor fold axis was N. 70° W.; 13° W. The phyllonite zone is quite complex in detail and cut by numerous limonite and clay-lined "late" faults. A prominent late fault exposed in the adit strikes N. 65° E. and dips 35° N. and was stoped.

Two types of sulfide mineralization are present: (1) pyrite and chalcopyrite blebs and stringers in narrow, white-quartz veins and 2) fine-grained, disseminated sulfides in chlorite-quartz phyllonite. A number of secondary copper minerals were also identified including chalcocite, tenorite(?), malachite, brochantite, chalcanthite and possibly antlerite. Chalcocite and malachite are the dominant secondary minerals. Although multiple quartz veins and veinlet zones are present in the phyllonite, most individual veins are narrow, generally less than 2 feet wide.

Buranek (1942b) described this mine and collected and analyzed several samples. He reported assay values of 1.1 to 1.2 percent copper, and 0.22 to 1.02 ounces gold, and past production of approximately 50 tons of ore with a value of $2,000.00. He also reported that crushing and panning of the ore yielded visible gold.

Two samples (FC 212-213) of quartz-veined, chlorite-quartz phyllonite were collected. The samples contained 1.1 and 0.9 percent copper and 1,250 ppb and 720 ppb gold but were not anomalous in other elements assayed.

Peterson-006 (Corduroy Canyon Prospect): The Peterson-006 prospect is in NW¼NE¼SE¼ section 9, T. 3 N., R. 1 E. Workings consist of two cross-cut adits driven to intersect a east-trending, mineralized shear zone. The western adit is open, trends N. 45° W. and is 30 feet long. The eastern adit is caved, trends roughly north and is estimated to have been 20 feet long.

Ore consists of milky quartz veins and pods with irregular blebs of chalcopyrite as large as 1.5 inches in diameter and quartz-chlorite phyllonite with disseminated sulfides. The ore occurs in a 10-foot-wide, strongly limonite-stained, fault and fracture zone that strikes roughly east and dips north at 30° to 35°. Several prominent faults with well-developed gouge zones are present within the fracture zone. Both the fracture zone and its adjacent footwall are chloritized. The chloritized zone is about 20 feet wide. The mineralized zone is traceable to both the east and west and is equivalent to the zone mined at the Utah-Pioche mine. The geology is similar to that at the Mud Creek prospect where late, brittle faults with gouge cut an earlier chloritic phyllonite and apparently control the emplacement of the quartz-pyrite-chalcopyrite veins.

Two samples (FC 210-211) were collected and assayed. A select sample from the western dump of quartz-chlorite phyllonite with chalcopyrite-quartz veins and stringers assayed 1.45 percent copper, 1.2 ppm silver, and 210 ppb gold. A sample from the eastern dump of chalcopyrite-quartz vein material assayed 3.15 percent copper, 1.2 ppm silver, and 360 ppb gold. Lead and zinc values were not anomalous.

Peterson-003 (Skyline Drive Prospect): The Peterson-003 prospect is in NE¼NW¼NE¼ section 17, T. 3 N., R. 1 E. The prospect is near the bottom of Farmington Canyon about 200 feet from the main road; a prominent trail leads to the workings. The workings consist of 295-foot-long main adit which trends N. 42° E. and a small 80-foot-long spur drift 195 feet from the portal which trends N. 85° E.

The workings are in schist and gneiss of the Farmington Canyon Complex. The gneissic banding strikes N. 65° W. and dips 70° N. No quartz veins or chloritic zones were seen in the adit, but several, small, weakly limonite-stained zones were found which parallel the gneissic banding.

Quartz-veined chlorite-quartz rock was found on the dump and a grab sample (FC 216) assayed 1.16 percent copper, 0.6 ppm silver, and 18 ppb gold. The sample also contained 173 ppm lead and 352 ppm zinc. The source of the sample is unknown.

Farmington-001 (Valley View Prospect): The Farmington-001 prospect is in NE¼SE¼NW¼ section 18, T. 3 N., R 1 E. on the north side of Farmington Creek near the canyon mouth. Workings consist of a 180-foot-long, north-trending adit.

The adit is driven in banded to schistose, biotite gneiss of the Farmington Canyon Complex. The gneissic banding trends roughly north-south. Apparently, the adit was driven along a zone of weakly limonite-stained, metamorphic quartz segregations that parallel the gneissic banding. No sulfides or any other indications of ore mineralization were found on either the dump or in the adit.

Seven samples (FC 118-124) of both the banded and foliated gneiss and the quartz segregations were collected. There were no anomalous base or precious metal values.

Bountiful Peak-005 (Morris Creek East Prospect): The Bountiful Peak-005 prospect is in SE¼NW¼NE¼ section 16, T. 3 N., R. 1 E.

Workings consist of three adits and a small prospect pit. The western adit is on the south side of Farmington Creek just above the creek bottom. It is open, has a total length of 550 feet, and trends S. 17° W. at the portal. There is a caved inclined raise at the face. Apparently the adit was driven to intersect the ore exposed in the upper workings. The central adit is about 300 feet south of the western adit. It is caved but was roughly 50 feet long based on the size of the dump. The eastern adit is about 300 feet east of the central adit. It is open at the portal but partially caved, with bad roof conditions at 50 to 60 feet in from the portal. The adit trends S. 8° E. at the portal but changes to S. 30° W. at 40 feet from the portal. A small 25-foot-long, south-east trending incline is present 35 feet in from the portal. Total length of the workings is estimated to be 160 to 200 feet. The small prospect pit is located about 200 feet south of the eastern adit.

Two types of copper mineralization were found. The first type consists of thin, limonite-stained zones with occasional weak malachite-staining in gneiss or pegmatite. These limonite-stained zones are developed in or adjacent to minor faults. The wall rock adjacent to these faults is often silicified and pyritized with up to 5 percent fine-grained, disseminated pyrite. Narrow, discontinuous quartz veins, stringers, and pods are a common feature. This type of mineralization was observed at the western adit and the prospect pit.

The second type of mineralization consists of thin, chalcopyrite-pyrite-quartz veins and stringers and disseminated chalcopyrite and pyrite blebs and stringers in sericitized, chlorite-quartz phyllonite. The quartz veins roughly parallel the foliation in the phyllonite. This type of mineralization was observed at the eastern adit where the phyllonite zone is 20 to 30 feet wide and dips 10° to 25° S. Within the phyllonite are numerous, thin, discontinuous zones of limonite staining associated with thin, 0.15- to 0.5-inch-wide, quartz stringers. The quartz veins contain pyrite and chalcopyrite, usually near their margins, and disseminated and stringer sulfides are present in the host schist adjacent to the veinlets. The phyllonite also contains several wider quartz veins associated with brittle fault and fracture zones. These quartz veins are up to 1.5 to 2.0 feet wide and contain pyrite, chalcopyrite, and various secondary copper minerals including "copper pitch", cuprite, azurite, and malachite. Most development was on these wider vein zones.

Four samples (FC 217-220) were collected and assayed from this prospect. Samples FC 217 to 219 of the limonite-stained gneiss and pegmatite showed weak, but anomalous, copper values (251 ppm, 126 ppm, 328 ppm), and slightly elevated lead (56 to 71 ppm) and zinc (70 to 131 ppm) values. A single sample of the quartz-veined, sericitized, chloritic phyllonite assayed 1.5 percent copper, 375 ppm lead, 635 ppm zinc, 3.3 ppm silver, and

140 ppb gold. The relationship between the two types of mineralization is unknown but may just represent differences in structural and wall rock control for the same episode of mineralization.

Bountiful Peak-002 (Miller Creek Prospect): The Bountiful Peak-002 prospect is in NW¼SW¼NW¼ section 15, T. 3 N., R. 1 E. along a small ridge between Miller Creek and Farmington Creek. Workings consist of a lower adit, middle prospect pit, and upper inclined shaft. An additional prospect pit was found to the west on the west side of Miller Creek. The lower adit is open, trends S. 27° W. and is 85 feet long. The upper inclined shaft trends S. 73° W. and is about 15 feet deep. The inclined adit and the prospect pit are developed along a northwest-trending, quartz- veined zone. The lower adit was probably driven to intersect this zone, but either did not reach it since no quartz-chalcopyrite-vein material was found on the dump or the quartz veins pinched out and the zone is represented by sheared, granite gneiss with disseminated sulfides.

This prospect was initially thought to represent the Lucky Boy mine described by Buranek (1942b). However, his description of both the mineralization and the extent of the workings does not fit the Bountiful Peak-002 prospect. The true Lucky Boy mine is probably one-half mile further to the south on the west side of Miller Creek. It was not found.

The "ore" at the Bountiful Peak-002 prospect consists of disseminated pyrite and chalcopyrite in vuggy, granular to sugary quartz veins. The veins are strongly limonite- and hematite-stained and the chalcopyrite is variably altered to "copper pitch", malachite, and chalcanthite. The vein zone is about 5 feet wide, strikes N. 23° W. and dips 65° SW. It cross-cuts the gneissic banding. A one-foot-thick gossan is present on the hangingwall of the quartz-vein zone. The gossan consists of hematite and limonite with some remnant pyrite and minor chalcopyrite. Malachite staining in the gossan is much less prominent than in the quartz veins. The host rock is highly folded gneiss of the Farmington Canyon Complex. Some thin (2 inch or less wide) chloritic phyllonite zones are developed in the gneiss and are parallel to the quartz vein zone, but the wide chloritic phyllonite zone, common at many prospects, is not present.

A second style of mineralization was found in the lower adit. It consists of fine-grained, disseminated pyrite and chalcopyrite in bleached, argillitized and sericitized, sheared granite gneiss. The gneiss is cut by a narrow (0.25- to 0.5-inch-wide), drusy quartz veins with minor pyrite and chalcopyrite. Most of the sulfides, however occur as disseminations in the altered gneiss. and up to 5 percent disseminated sulfides were observed in some samples. Disseminated sulfides were found over a width of at least 70 feet in the lower adit.

Five samples (FC 221-225) were collected and assayed. Two samples of the quartz-vein zone showed anomalous copper (0.9, 0.9 percent), silver (7.5 ppm, 7.2 ppm), and gold (260 ppb, 100 ppb) values. One of the samples was slightly anomalous in lead (384 ppm) and both were slightly anomalous in zinc (140 ppm). A sample of the hangingwall gossan zone assayed 0.42 percent copper, 10.8 ppm silver, and 100 ppb gold. The sheared granite gneiss with disseminated sulfides assayed 0.13 percent copper but was not anomalous in any other assayed elements. A sample of vuggy quartz from the margin of a quartz-feldspar pegmatite was barren except for slightly anomalous copper (213 ppm). The relationship of the quartz-vein and gossan mineralization to the disseminated mineralization in the sheared granite gneiss is unknown.

Morning Star Group (Bountiful Peak-016): The Morning Star Group is in NW¼/4NW¼SE¼ section 20, T. 3 N., R. 1 E. The prospect was briefly described by Butler and others(1920) and Bryant(1988a) gave assay values for a sample collected in the area. Workings consist of three adits on the north side of Hornet Creek. The western adit is caved, trends N. 40° W. at the portal, and is estimated to be 100 to 200 feet long. The central adit is open, trends N. 5° W. at the portal, and is estimated to be 100 to 150 feet long. The eastern adit is caved, trends N. 42° W. at the portal, and is estimated to have over 500 feet of workings. This eastern adit is probably the main Morning Star mine.

Two styles of mineralization were found. The best mineralization is associated with 3- to 15-inch-wide quartz veins containing large (up to 1 inch) blebs of pyrite and chalcopyrite. Some veins may contain as much as 10 percent total sulfides. The sulfides are partially oxidized and strong malachite staining is present in many samples. The veins are developed within dark-green, quartz-chlorite phyllonite zones. This style of mineralization is best developed at the eastern adit.

The second style of mineralization is associated with dark-to light-green, quartz-chlorite phyllonite cut by thin, quartz veinlets. The quartz veins are much thinner and contain fewer and smaller sulfides than in the vein-style mineralization. The phyllonite contains fine-grained, disseminated sulfides; mostly pyrite but with some chalcopyrite. This style of mineralization is best developed at the western and central adits.

Three samples (FC 234-236) were collected and assayed. Sample FC-236 of quartz-vein material with coarse-grained pyrite and chalcopyrite from the eastern dump contained 1.5 percent copper, 1.9 ppm silver, and 1,460 ppb gold. The sample also contained a high concentration of bismuth (180 ppm). Samples FC-234 and FC-235 of green phyllonite from the western and central dumps showed weak, but anomalous copper (1,168 ppm, 247 ppm) but were not anomalous in other elements.

Bountiful Peak-004 (Rudd Creek Prospect): The Bountiful Peak-004 prospects is in NE¼NE¼NW¼ section 21, T. 3 N., R. 1 E. just west of hill 8307. Workings consist of two small shallow pits along a quartz vein. On the north side of the hill, there are numerous cuts and shallow trenches 6 to 9 feet wide and 30 to 100 feet long. It is not known if the trenches represent exploration cuts or were for control of runoff. No indications of ore were seen in the trenches.

The prospect pits are in a 1- to 2-foot-wide, white quartz vein with weak limonite staining. The vein trends N. 70° W. and is traceable for 500 feet. The host rock is biotite-quartz-feldspar gneiss with some quartz-rich leucosomes and quartz-feldspar pegmatite. The vein cross-cuts the gneissic banding.

Five samples (FC 131-136) were collected from the vein and adjacent wall rock. All were barren, but a sample of weathered gneiss showed slightly anomalous copper (106 ppm) and zinc (200 ppm) values.

Bountiful Peak-010 (Bountiful Peak Campground Prospects): The Bountiful Peak-010 prospects are in NE¼SE¼ section 22, T. 3 N., R. 1 E. Workings consist of two adits roughly 800 feet apart. The southern adit was examined during this study and the northern adit was previously examined by the UGS in 1982. The southern adit is open, trends S. 53° W. and is 15 feet long. The northern adit is open, and is 75 feet long and contains a 5-foot-deep winze 55 feet in from the portal (Utah Geological Survey, 1994).

The "ore" at the southern adit is in a 6-foot-wide, white quartz vein containing irregular blebs of chalcopyrite and pyrite up to 0.5 inch across. The vein is strongly limonite- and malachite-stained and much of the chalcopyrite has been altered to "copper pitch". The vein also contains folded seams of feldspar-chlorite rock and knots of coarse biotite. The vein trends N. 75° E. and dips 68° S. The vein is adjacent to a quartz-feldspar pegmatite which is also cut by quartz veins and stringers.

The "ore" at the northern adit is in a limonite-stained, quartz vein containing pyrite, chalcopyrite, "copper pitch", bornite, and malachite. The vein is 2 feet wide, strikes N. 48° E. and dips 49°S.

The mineralization in this area differs slightly from most prospects in the Farmington district because it is closely associated with pegmatites and is not developed in quartz-chlorite-phyllonites. The pegmatite contacts apparently acted as favorable zones for quartz veining in the absence of the foliated phyllonite.

A dump sample from the southern workings (FC-226) assayed 0.3 percent copper. A dump sample from the northern workings assayed 0.7 percent copper (Utah Geological Survey, 1994). Neither sample was anomalous in lead, zinc, or precious metals.

Bountiful Peak-015 (Steed Canyon Prospect): The Bountiful Peak-015 prospect is in SE¼SW¼SW¼ section 20, T. 3 N., R 1 E. Workings consist of an inclined shaft about 40 deep bearing S. 30° E., 50° SE.

The shaft follows a fault breccia zone striking N. 56° E. and dipping 50° SE. The fault breccia zone is in 15- to 20-foot-wide, strongly limonite-stained phyllonite. The fault zone is strongly iron-stained with limonite, hematite, and jarosite all presumably derived from pyrite. No copper staining was seen in outcrop or on the dump.

A dump sample (FC-233) showed slightly anomalous copper (85 ppm) and gold (100 ppb Au) values.

Bountiful Peak-011 (Bountiful Peak Northwest Prospect): The Bountiful Peak-011 prospect is along the crest of a northwest-trending ridge in SE¼NE¼NE¼ section 28, T. 3 N., R. 1 E. Workings consist of a small (5 feet by 10 feet by 2 feet deep) prospect pit along a quartz vein cutting amphibolite of the Farmington Canyon Complex.

The vein consists of white, coarsely crystalline quartz with inclusions of chlorite-quartz-feldspar rock, dark-green amphibolite and gray-green chlorite rock. Sulfides in the vein occur as irregular, small blebs less than 0.5 inch in diameter. All the sulfides are oxidized to limonite or "copper pitch". Some vein samples have abundant malachite staining and malachite coatings along fractures. The malachite-rich rocks are usually rich in gray-green chlorite. The vein was not observed in outcrop so thickness and trend are unknown.

A quartz-vein sample (FC-227) assayed 0.74 percent copper. Bryant(1988a) also collected a sample from this location which assayed 1.40 percent copper. The samples were not anomalous in any other base or precious metals.

Bountiful Peak-013 (Parrish Creek North Prospect): The Bountiful Peak-013 prospect is on the north side of Parrish Creek in NW¼NE¼NW¼ section 9, T. 2 N., R. 1 E. Workings consist of a caved adit estimated to be 200 feet long. The adit trends N. 20° W. at the portal and was driven in a shear zone. The dump is orange and very obvious.

The adit was driven in a strongly limonite- and jarosite-stained, chlorite phyllonite. At the adit portal, the phyllonite trends N. 20° W. and dips 30° SW. The phyllonite zone is 10 feet wide at the portal, but narrows to 3 feet wide north of the portal. The phyllonite cross-cuts the gneissic banding in the country rock. Vuggy, porous, limonite gossan is very abundant but no sulfides were observed. No copper staining was seen and the limonite and jarosite were presumably all derived from pyrite.

A single dump sample (FC-232) showed no significant base or precious metal values. In fact, the sample assayed only 60 ppm copper in spite of being close to other prospects with good copper values.

Bountiful Peak-017 (Parrish Creek Prospect): The Bountiful Peak-017 prospect is on the north side of Parrish Creek about 200 feet higher above the creek in NW¼SW¼NE¼ section 9, T. 2 N., R. 1 E. Workings consist of two north-trending adits and a small prospect pit. The two adits are about 25 feet apart and the prospect pit or possibly caved shaft is 50 feet north of the main (western) adit. The western adit is caved and is estimated to have 200 to 300 feet of workings. The eastern adit is also caved and estimated to be 30 to 50 feet long. The adits were probably driven to intersect a vein exposed upslope. Although roughly in the correct location, these workings do not represent the Buckland Mining and Development prospect described by Butler and others(1920). The workings are too small and the distribution of the workings and the topography do not agree with the published description. The main Buckland Mining and Development prospect is most likely northeast of the Bountiful Peak-017 prospect.

No ore was observed in place but two styles of mineralization were found on the dump. The first style consists of narrow (0.5- to 1-inch-wide), vuggy, quartz veins with pyrite and chalcopyrite. The veins cut the gneissic layering and have a chloritic alteration selvage. Some chlorite is also in the veins proper. The second style consists of strongly limonite- and jarosite-stained gneiss containing 2 to 5 percent disseminated pyrite. The relationship between the two styles of copper mineralization is not known.

Two samples (FC-230, FC-231) were collected from this prospect. The vein-style sample contained 1.54 percent copper and 120 ppb gold. It was also slightly anomalous in zinc (652 ppm). The disseminated-style sample contained only anomalous copper (320 ppm).

Bountiful Peak-012 (Parrish Creek South Prospect): The Bountiful Peak-012 prospect is on the ridge line between Parrish Creek and Centerville Canyon in SW¼SE¼NE¼ section 9, T. 2 N., R. 1 E. Workings consist of a single small pit measuring 20 feet by 20 feet and approximately 20 feet deep.

"Ore" consists of argillitized and chloritized biotite-quartz-feldspar gneiss containing disseminated chalcopyrite now altered to malachite and "copper pitch". The altered gneiss is also cut by thin (0.5- to 1-inch-wide) quartz veinlets containing partially oxidized chalcopyrite. The width and trend of the mineralized zone are unknown.

A single dump sample (FC-229) assayed 0.8 percent copper and 65 ppb gold. It was not anomalous in lead, zinc or silver. Bryant (1988a) also collected a sample from this location. It contained 1.40 percent copper.

Bountiful Peak-003 (Centerville Canyon North Prospects): The Bountiful Peak-003 prospects are near the range front north of Centerville Canyon in SW¼NW¼SE¼ and SW¼SW¼SE¼ section 8, T. 2 N., R. 1 E. Workings consist of two adits about 800 feet apart. The northern adit is a 70-foot-long, irregular cut up to 15 feet wide ending in a 12- to 15- foot-long adit opening into a 12 foot-diameter room with a low ceiling. The cut and adit trend N. 85° E. The southern adit is of a 25-foot-long adit with a short 20-foot-long side cut near the face. The main adit trends N. 20° E. and the side cut trends nearly due east.

The north workings follow a N. 85° E.-trending zone of silicification in locally chloritized, banded, biotite gneiss and biotite-quartz-feldspar gneiss. The silicified zone is either a silicified breccia or a brecciated vein. Limonite staining is weak. No malachite stain was seen.

The south workings follow a northeast-trending zone of shearing, brecciation, and minor veining in banded, contorted, biotite gneiss.

Seven samples (FC 101 to FC-103, FC-137 to FC-139, FC-142) of both vein material and country rock gneiss were collected from the northern area. The vein material showed no significance base or precious metal values; the only weakly anomalous value was 107 ppm zinc. The county rock gneiss was equally disappointing; the only slightly anomalous values were 125 ppm copper and 220 ppm zinc, 90 ppm copper and 96 ppm zinc, and 124 ppm zinc from three separate samples.

Four samples (FC-114 to FC-117) of country rock gneiss and quartz-feldspar pegmatite were collected from the southern area. Base and precious metal values were low. One sample of country rock assayed 66 ppm copper and the two pegmatite samples assayed 107 ppm and 150 ppm lead.

Bountiful Peak-008 (Centerville Canyon Southwest Prospect): The Bountiful Peak-008 prospect is in NE1/4NW1/4NE1/4 section 17, T. 2 N., R. 1 E. It was not found during the current investigation and has apparently been covered by recent road work. It was visited in 1983 (Utah Geological Survey, 1994). Workings consisted of a single caved adit estimated to be approximately 200 feet long trending N. 85° E. The ore mineral was reported to be malachite, probably associated with quartz veining, in a chloritic shear/cataclastite zone in gneiss of the Farmington Canyon Complex.

Bountiful Peak-009 (Centerville Canyon Southeast Prospect): The Bountiful Peak-009 prospect is just north of a small drainage in NE¼SE¼NE¼ section 17, T. 2 N., R. 1 E. A single adit 30 feet long trends N. 80° E.

The adit follows a quartz or quartz pegmatite vein with disseminated pyrite and chalcopyrite, now mostly altered to limonite, "copper pitch", and malachite. The vein trends due east to N. 80° E. and dips 70° to 75° N. The vein is 18 inches wide. County rock is biotite gneiss.

Five samples (FC-109 to FC-113) were collected from this prospect. Malachite-stained quartz veins contained 0.26 and 0.54 percent copper but only trace amounts of gold (2-3 ppb). Quartz veins with no malachite staining contained 433 ppm copper and 45 ppb gold. A sample of footwall gneiss contained 200 ppm copper and 35 ppb gold. An unusual quartz-rich rock collected north of the portal contained 124 ppm lead but was very low in copper (9.5 ppm) and is probably not genetically related to the copper-bearing quartz veins.

Bountiful Peak-014 (Centerville Canyon East Prospect): The Bountiful Peak-014 prospect is in NW¼NW¼NW¼ section 16, T. 2 N., R. 1 E near a ridge line south of Centerville Canyon. The prospect was not visited, but based on air photos the workings consist of a small prospect pit and dump.

Bountiful Peak-007 (Upper Ward Canyon Prospects): The Bountiful Peak-007 prospects are on both sides of Ward Canyon roughly miles from the canyon mouth in NE¼SE¼SE¼ section 14, T. 2 N., R. 1 E. Workings consist of two small prospect pits on the north side of the canyon and four small adits and an inclined shaft on the both sides near the bottom of the canyon. The northern prospect pits are small, measuring 20 feet by 20 feet and 8 to 10 feet deep. The workings in the canyon bottom consist of a group of three short interconnected adits on the south side of the canyon and a adit and decline on the north side of the canyon. The south-side workings are: (1) a southwestern adit at least 100 feet long, (2) a central adit at least 150 feet long that connects with the southwestern adit, and (3) a northeastern adit probably 150 feet long that connects with a winze in the central adit. These adits could be entered in 1983, but roof conditions were bad and many area had collapsed. The north-side workings consist of a caved adit estimated to be 100 feet long and a small 10 foot decline up-slope from the caved adit. Only the northern prospect pits were visited during the current investigation. Information on the southern workings is based on a field investigation by Tripp in 1983 (Utah Geological Survey, 1994).

The northern prospect pits are in an argillitized and limonite-stained fracture zone with thin (less than 1- to 1.5-inch-wide), vuggy, quartz veins and stringers. The fracture zone trends N. 20° E. and dips steeply to the SE. The county rock is banded schist, gneiss, and quartzite with pegmatite stringers and pods. The quartzite strikes N. 10° W. and dips 65° W. No malachite staining was seen and all sulfides were altered to limonite.

The north-side canyon workings are in a nearly vertical north-trending shear zone containing abundant mica. The south-side canyon workings are along narrow (4- to 12-inch-wide) shear zones with abundant mica. Although minor limonite and malachite staining was seen, the prospects were probably developed for mica.

A single sample (FC-228) of quartz-veined, limonite-stained gneiss from the northern prospect pits assayed 390 ppb gold, 8.3 ppm silver, 653 ppm copper, 8,809 ppm lead and 652 ppm zinc. It also contained anomalous bismuth (11.1 ppm). Two samples collected in 1983 from the south-side canyon workings showed background to slightly anomalous silver (1.2ppm, 0.4 ppm), copper (18ppm, 170 ppm), lead (185ppm, 150 ppm) and zinc (95ppm, 195 ppm). The high lead and zinc values for the quartz-vein style is unusual for prospects in the Farmington district.

Fort Douglas-013 (Mill Creek West Prospect): The Fort Douglas-013 prospect is in NE¼SW¼NE¼ section 35, T. 2 N., R. 1 E. Workings consist of two small, caved adits 25 feet apart. Both adits trend N. 35° E. and are estimated to be 100 feet long each. The adits were probably cross-cuts driven to intersect an ore zone at depth.

There is no outcrop in the area, but the dump gives some information about the "ore" mineralization and county rock. The "ore" consists of porous limonite gossan, vuggy quartz veins with sparse sulfides now oxidized to limonite, and quartz vein breccia. Host rocks are quartz-muscovite schist, muscovite-schist, quartz-feldspar pegmatite, and green phyllonite. The thickness and orientation of the veins, breccias and gossans and their relationships to the various host rocks are not known.

A single dump sample (FC-237) of quartz vein and vein breccia material contained 103 ppm copper, 78 ppm lead, 92 ppm zinc, and 71 ppm arsenic.

Fort Douglas-014 (Mill Creek Prospect): The Fort Douglas-014 prospect is in NW¼SE¼NE¼ section 35, T. 2 N., R. 1 E. Workings consists of two adits and an open cut. The lower (western adit) is caved, trends N. 3° E. at the portal and is estimated to have 500 feet of workings. The upper (eastern) adit is 100 feet northeast of the lower adit. It is caved, trends N. 10° E. at the portal and is estimated to have 400 feet of workings. The open cut is about 70 feet wide and located south of the upper adit.

Several types of "ore" are found on the dump and usually occur in separate samples. The first type consists of white, moderately limonite-stained, quartz veins in chlorite-quartz schist or phyllonite. The veins contains blebs of limonite and "copper pitch" mostly replacing chalcopyrite. The second type consists of vuggy, quartz vein stockworks or quartz-cemented breccias containing large (up to 0.5 by 1.5 inch) clots of galena and sphalerite. The quartz is generally white to cream colored with a rough rubbly to vuggy surface. The lead and zinc sulfides are usually in vugs or associated with the younger, rough, rubbly quartz. Limonite associated with this type of mineralization is light- orange to light-yellow-brown and usually fluffy or porous as opposed to the maroon-brown to dark-brown limonite "wash" of the copper-bearing veins. A third type of quartz was also found on the dump. It is light gray, very vitreous quartz with a crude layering or foliation and contains minor sericitized feldspar laths and light-green chlorite. The origin is unknown, but we believe it is be pre-metamorphic based on the fabric and inclusions. No sulfide or remnant sulfides were observed and the quartz is not limonite stained. No cross-cutting relationships were found between the lead-zinc- and the copper-bearing quartz, but the copper mineralization is thought to be earlier for the following reasons:

(1) The quartz associated with the copper is more fractured,
(2) The quartz associated with the copper has fewer and smaller vugs,
(3) The quartz associated with the copper has a "moderate-temperature look" as opposed to the "low-temperature" look of the lead-zinc quartz, and
(4) The copper quartz veins are narrower and more anastomosing than the lead-zinc quartz veins suggesting emplacement under higher effective pressure conditions.

Four samples (FC-37 to FC-39, FC-238) were collected from the prospect. A single composite dump sample (FC-238) containing both copper and lead-zinc mineralization contained 3.1 ppm silver, 1,714 ppm copper, 40,790 ppm lead, and 755 ppm zinc. A select sample of a lead-zinc quartz vein (FC-37) contained 8.8 ppm silver, 95 ppm copper, 70,500 ppm lead, and 236 ppm zinc. The sample also assayed 370 ppb gold. A select sample of a copper-quartz vein (FC-39) contained 2.5 ppm silver, 829 ppm copper, 191 ppm lead and 192 ppm zinc. It also assayed 70 ppm in gold. A select sample of the vitreous, pre-metamorphic (?), quartz (FC-38) contained mostly background values for the elements assayed but was slightly anomalous in lead (522 ppm), zinc (135 ppm), and gold (55 ppb). Bryant (1988a) collected a sample of a quartz vein with sphalerite and galena from this same area. It contained 18 percent lead, 1.7 percent zinc and 220 ppm copper. Silver was not assayed.

Fort Douglas-015 (Mill Creek East Prospect): The Fort Douglas-015 prospect is in SE¼NE¼NE¼ section 35, T. 2 N, R. 1 E. A single caved adit trends N. 40° W. The dump size suggests 100 to 300 feet of workings.

Two styles of mineralization were seen in the dump rocks. The first style consists of quartz veins and quartz-cemented breccia with pyrite and chalcopyrite in a dark-green, chlorite-quartz phyllonite. The chlorite-quartz phyllonite contains coarse muscovite. which could represent unaltered remnants from parent rock (quartz-muscovite schist or pegmatite). The chalcopyrite is present as both blebs less than 1 inch in size and as veinlets. Chalcopyrite is more abundant in the vuggier portions of the vein. Malachite is very abundant.

The second style of mineralization consists of strongly limonite- and jarosite-stained, silicifed rock containing abundant pyrite. The pyrite occurs as disseminations in both the silicified rock and in the adjacent chloritic-quartz host rock.

Two samples (FC 239 to FC-240) were collected from the dump. Sample FC-239 of the quartz-veined phyllonite contained 3,073 ppm copper, 105 ppm lead, and 36 ppm zinc. Sample FC-240 of the silicified pyrite rock contained 128 ppm copper, 123 ppm lead, and 104 ppm zinc.

HOT SPRINGS DISTRICT

Six areas were examined in the Hot Springs district including the Treasure Box Mine. Most of the prospects are small, oxidized lead-zinc replacement deposits in carbonate rocks. Most samples contained anomalous to ore-grade lead, zinc and silver; up to 10 percent lead, 20 percent zinc, and 6 ounces per ton of silver. Prospects on the southwest side of the district also contained anomalous copper; up to 0.8 percent copper. All of the samples collected contained less than 100 ppm barium in contrast to the higher barium values for similar deposits in the Argenta and Morgan districts. All of the prospects were small and according to Butler and others(1920) only a few tons were actually shipped.

Based on a description by W. C. Higgins in the Salt Lake Mining Review of August 30, 1910, the Burro Mine should be one of the largest mines in the district. He described the workings as consisting of a lower cross-cut tunnel, 435 feet long with a 133-foot-long drift, an intermediate 75-foot-deep shaft with 100-foot-long drift and an upper 30-foot-deep shaft. In spite of a diligent search using both air photos and ground traverses, no mine fitting this description was found during this study.

Fort Douglas-005 (Rotary Park Prospect): The Fort Douglas-005 prospect is in SW¼SW¼SE¼ section 11, T. 1 N., R. 1 E. Workings consist of four adits, all now caved, and a small prospect pit. The eastern adit has the largest dump and workings are estimated to be 400 to 500 feet long. This adit is on the north side of the drainage and trends approximately N. 40° E. The other three adits are on south side of the drainage. The easternmost of these adits is approximately 150 feet long but the other two are short; estimated to be only 20 to 30 feet long. No gossan was observed at the portals and the adits were presumably cross-cuts driven to intersect gossans found on the surface.

Dark-brown to orange-brown gossan is present on the two eastern dumps. No sulfides were observed in the gossan, but coarse-grained specularite is common. Malachite is locally present as nodules in the gossan. The gossan was probably developed from copper-lead-zinc veins or replacements. The width, size, and orientation of these veins or replacements are unknown, but the distribution and orientation of the workings suggest that there are two possible ore zones; an eastern zone trending approximately N. 40° W. and a western zone trending roughly east-west. The host rock is moderately fractured and locally brecciated, gray limestone of the middle Cambrian Maxfield Limestone(Van Horn and Crittenden, 1987).

Three samples (FC-202 to FC-204) were collected from the prospect. Two select gossan samples contained anomalous copper (0.33 percent and 0.80 percent), lead (8,247 ppm and 408 ppm), zinc (2,494 ppm and 313 ppm), and arsenic (1,136 ppm and 1,155 ppm). The gossans were also anomalous in silver (2.9 ppm and 2.2 ppm) but contained only trace amounts of gold (6 ppb). The anomalous copper and arsenic values are unusual for mines in the Hot Springs district and might reflect some regional mineral zonation. A sample (FC-203) of unmineralized host rock showed no anomalous base metal values, but assayed a suprisingly high 55 ppb gold.

Fort Douglas-004 (Burro Peak Pits): The Fort Douglas-005 pits are in the N½NW¼NE¼ and the NW¼NE¼NE¼ section 12, T. 1 N., R. 1 E. Workings consist of four prospect areas approximately 500 to 800 feet apart. The western prospect area is a short adit, the west-central prospect area a small irregular pit measuring 30 feet by 30 feet and about 20 feet deep, the east-central prospect area contains three small pits with the largest measuring 10 feet by 10 feet and about 5 feet deep and the eastern prospect area is a small pit.

Limonite gossan is present in all prospect areas. Most gossan exposures are narrow, less than 2 to 3 feet wide, and represent replacements along bedding or breccia and fault zones. The western prospect is a gossan replacing a breccia zone in the Middle Cambrian Maxfield Limestone. The west-central prospect is is a narrow (6- to 12-inch-wide) gossan replacement along a N. 40° W.-trending cross-cutting breccia zone with irregular bedding replacements up to 18 inches wide extending three to four feet from the breccia. The host rock is gray, massive dolomite of the lower part of the Devonian Stansbury Formation. The east-central prospect is a 2- to 3-foot-wide gossan replacement of a bedding parallel breccia zone which strikes N. 62° E. and dips 80° SE in the Devonian Pinyon Peak Limestone.

A gossan sample (FC-207) from the west-central prospect area contained high lead (3.9 percent), zinc (20.6 percent), silver (55 ppm), and anomalous copper (322 ppm), arsenic (219 ppm), and antimony (81 ppm). The sample contained oxidized lead and zinc minerals, probably cerrusite and smithsonite. A gossan sample (FC-206) from the east-central prospect area contained anomalous lead (818 ppm), zinc (14,082 ppm), arsenic (198 ppm) and silver (3.6 ppm).

Fort Douglas-003B (Upper Burro Peak Adit): The Fort Douglas-003B prospect is in SW¼SE¼SE¼ section 1, T. 1 N., R. 1 E. approximately 300 feet southeast of Burro Peak. Workings consist of an N. 60° W.-trending adit. The adit is reported to be 250 feet long and is partially collapsed 150 feet from the portal. The adit was probably a cross-cut driven to intersect surface gossans at depth, since no indication of ore was seen at the portal.

The dump consists of buff to maroon shale, buff limestone, and gray limestone tentatively assigned to the Devonian Stansbury Formation. The dump also contains minor gossan. Thickness, size and trend of the mineralized zone are unknown.

A select dump sample (FC-208) of gossan contained abundant lead (9.87 percent), zinc (18.7 percent), and silver (204 ppm). It was also anomalous in copper (745 ppm), arsenic (301 ppm), and antimony (219 ppm). Gold content was low (20 ppb).

Fort Douglas-009 (Burro (?) Mine): The Fort Douglas-009 prospect is in SE¼NE¼SE¼ section 1, T. 1 N., R. 1 E on the north side or the ridge between Mill Creek and City Creek. The prospect is a single caved adit that trends southeast. Although the dump is much eroded, it is still small indicating less than 500 feet of workings. The location corresponds to the Burro mine as labeled on the Fort Douglas 7.5 topographic map, but the geology and extent of workings do not fit the description of the Burro mine by Higgins(1910). It is possible that the mine was mislabeled on the topographic map.

The dump material consist mostly of medium-gray, massive, mottled, micritic limestone of the Middle Cambrian Maxfield Limestone. The "ore" consists of massive, vuggy, limonite gossan with no remnant sulfides. It probably was derived from massive lead-zinc replacement or vein deposits. The width, size, and orientation of the ore zone are unknown.

A selected dump sample (FC-241) of the gossan contained anomalous zinc (3,625 ppm), lead (2,004 ppm), silver (1.9 ppm), copper (243 ppm), and arsenic (135 ppm).

Fort Douglas-003A (Lower Burro Peak Adits): The Fort Douglas-003A prospect is in S½NW¼NW¼ section 7, T. 1 N., R. 2 E. The lower adit is located just above the stream bed, is small and still open. The upper adit is caved, trends S. 45° W. and is reported to be 130 feet long(Utah Geological Survey, 1994). A small prospect pit is located about 100 feet west of the upper adit. The adits were probably cross-cuts driven to intersect the ore body.

The upper dump contains of gray, massive limestone, tan, limonite-stained limestone, and minor dark-brown to orange-brown, limonite gossan. No sulfides were observed in the gossan. The lower dump is fresher-looking, but did contain some pieces of gossan. The gossan probably developed from lead-zinc replacement or vein deposits. Thickness, size, and orientation are unknown but the distribution and trend of the upper workings suggest that the ore zone trends approximately N. 45° W. It is not known if the upper and lower workings accessed the same ore body.

A single select sample (FC-205) of gossan from the upper dump contained abundant zinc (1.9 percent), lead (2.7 percent), and silver (23 ppm).

Treasure Box Mine (Fort Douglas 002): The Treasure Box mine is in NW¼NE¼SW¼ section 7, T. 1 N., R. 2 E. along Cottonwood Gulch approximately 1300 feet north of City Creek. Workings consist of a caved adit estimated to be 800 to 1000 feet long and surface facilities consisting of a concrete pad, remains of a compressor shack, steam engine and boiler. The Salt Lake Mining Review in 1918 reported that mine consisted of two adits with over 10,000 feet of workings but on-site examination showed no evidence of such an extensive operation. The adit trends N. 35° W. and was presumably driven to intersect ore at depth. The adit is flooded.

The dump material consists mostly of gray limestone of the Mississipian Donut Formation and limestone with disseminated limonite presumably derived from pyrite. Mineralized rock is not abundant on the dump and consists of gray limestone with thin limonite stringers and irregular gossan replacements. No massive gossan was found on the dump.

An assay of a composite dump sample (FC-209) showed slightly anomalous lead (235 ppm), zinc (895 ppm), and silver (1.3 ppm).

The nature and grade of the "ore" found on the dump hardly justify the size and extent of the workings. Perhaps more massive gossan was found but has all been removed.

APPENDIX B

Sample Descriptions

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-1	Rock-Dump Select Grab High Grade	R.W. Gloyn 9-21-92	NW¼,NW¼,NW¼, Sec. 34, T. 5 N., R. 1 E., Strawberry mine (SB-5) Lower adit dump	White-gray, coarsely-crystalline, quartz vein with minor thin slivers and fragments of dark-green "retrograde" quartz-chlorite rock. Contains 2-3% chalcopyrite as irregular stringers and disseminations up to 8-12 mm long and 4-5% pyrite as irregular stringers and fine crystalline disseminations. Chalcopyrite preferentially concentrated around chlorite clots and as fine disseminations in chlorite. Chalcopyrite preferentially alters to bornite, chalcocite, and tenorite (?). Minor jarosite stain and trace of malachite.
FC-2	Rock-Otc. Continuous chip 5′ vertical	R. W. Gloyn 9-21-92	SW¼,SW¼,SW¼, Sec. 27, T. 5 N., R. 1 E., Strawberry mine (SB-5) Upper adit--caved Immediately above caved adit	Medium- to dark-green, weathers tan, highly sheared "retrograde" quartz-chlorite rock cut by < 2% thin glassy, milky quartz stringers with muscovite selvage. No obvious ore mineralization.
FC-3	Rock-Otc. Select Grab of 4" wide quartz vein	R. W. Gloyn 9-21-92	SW¼,SW¼,SW¼, Sec. 27, T. 5 N., R. 1 E., Strawberry mine (SB-5) Approx. 30′ below caved upper adit on east side of dump area	Strongly hematite-stained, fractured, gray, glassy, massive, 3-5" quartz vein. Vein developed parallel to foliation in highly sheared quartz-chlorite rock. Trace to 2 % Fe-oxide spots after pyrite and minor remnant pyrite. No secondary copper stain or copper minerals observed.
FC-4	Rock-Dump Select Grab	R. W. Gloyn 9-21-92	NW¼,NW¼,NW¼, Sec. 34, T. 5 N., R. 1 E., Strawberry mine (SB-5) middle adit dump	Massive to slightly porous. locally botyroidal gossan with quartz vein material. Some fine cellular boxworks after chalcopyrite, but mostly "sponge" after pyrite (?). Abundant "turgite" and some (approx. 5%) "Cu pitch".

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-5	Rock-Dump Grab	R.W. Gloyn 9-21-92	NW¼,NW¼,NW¼, Sec. 34, T. 5 N., R. 1 E., Strawberry mine (SB-5) middle adit dump	Medium- to light-green, quartz-chlorite schist. Consists of 30-40% clear to glassy quartz as 1-8 mm elongate grains and lenses in foliated chlorite matrix. Represents altered retrograde shear zone most likely developed from biotite-feldspar-quartz gneiss. No obvious quartz veining or ore minerals. No sulfides observed. Main host rock.
FC-6	Rock-Otc. Chip 1.5′	R.W. Gloyn 9-22-92	NW¼,SW¼,NW¼, Sec. 2, T. 3 N., R. 3 E., Chicago-Utah mine (DS-4) "Ore Zone" approx. 800′ north of adit--hanging wall	Maroon to red-brown, fine-grained, slightly micaceous sandstone with minor thin (1 mm thick) light-gray "bleached" zones. Massive to thinly bedded. Hanging wall of ore zone.
FC-7	Rock-Otc. Select Grab	R.W. Gloyn 9-22-92	As FC-6	Light-gray to buff, fine-grained, slightly micaceous sandstone with minor (< 2%) carbonaceous trash fragments. Chalcocite partially replaces carbonaceous trash with surrounding halo of "malachite wash" and inner rim of malachite. Malachite stain concentrated on fine-grained bedding planes and near replaced carbonaceous material. Select grab in 2-3′ thick ore zone.
FC-8	Rock-Otc. Grab	R.W. Gloyn 9-22-92	As FC-6	Gray to greenish-gray, fine-grained, micaceous sandstone-siltstone with 2-3% fine-grained disseminated carbonaceous material and rare twigs and wood fragments (1-5 mm). Twigs and wood fragments concentrated on bedding planes. No obvious primary or secondary copper mineralization. Footwall of ore zone approx. 6′ below sample FC-7.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-9	Rock Talus Grab represents zone about 4′ thick	R.W. Gloyn 9-22-92	SW¼,SW¼,NE¼, Sec. 2, T. 3 N., R. 3 E., Chicago-Utah mine (DS-4) Approx. 300′ north of adit Uppermost part of "Ore Zone"	Red-brown to gray-brown, thinly-bedded, siltstone and fine- to very fine-grained, gray to brown, massive, slightly micaceous sandstone. Sandstone contains abundant molds and casts of plant fragments (mostly leaves, some twigs) and up to 1% disseminated carbonaceous trash. Larger leaves and twigs usually weathered away leaving only molds. Minor light-green, chalky malachite, usually concentrated on bedding planes or fractures. No sulfides observed.
FC-10	Rock-Dump Select Grab	R.W. Gloyn 9-22-92	Sec. SW¼,SW¼,NE¼, 2, T. 3 N., R. 3 E., Chicago-Utah mine (DS-4) Small dump from small pits approx. 300′ north of adit. Middle, thin bedded, part of the "Ore Zone"	Light-gray to brownish-gray, thinly-bedded to laminated, fine-grained sandstone. Abundant mica and carbonaceous trash on thin partings. Planar to wavy bedding. Recognizable twigs and plant fragments (up to 5 mm long). Sooty to crystalline chalcocite partially replacing plant fragments and twigs (< 0.5% Cc) usually on bedding planes. Fine-grained, light-green malachite coating on bedding planes. Estimated Cu content < 0.5%.
FC-11	Rock-Otc. Chip 2′	R.W. Gloyn 9-22-92	NE¼,NW¼,SE¼, Sec. 2, T. 3 N., R. 3 E., Chicago-Utah mine (DS-4) Immediately above main caved adit	Greenish-gray, thinly-bedded to laminated, very fine-grained sandstone to siltstone. Strongly micaceous, particularly along bedding planes. Approx. 1% very fine-grained disseminated carbonaceous material. Trace malachite sporadically on bedding planes and fractures. Note: Adit driven along this unit-probably for ease of driving-not for better mineralization.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-12	Rock-Dump Select High grade	R.W. Gloyn 9-22-92	SW¼,SW¼,NE¼, Sec. 2, T. 3 N., R. 3 E., Chicago-Utah mine (DS-4) Shipping dump (approx. 250-300′ northwest of adit along drainage).	Gray to gray-brown, medium-grained massive sandstone. Contains large twig fragments (up to 15-20 cm long x 1-2 cm wide). Twig fragments partially to completely replaced by chalcocite (chalcocite preferentially replaces rims and along cell structure in twig fragments--core of fragments still charcoal although may be replaced by calcite). Wood fragments generally rimmed by 2-5 mm wide zone of malachite staining and films of malachite often present along fractures and along cell walls in twig fragments.
FC-13	Rock-Otc. Continuous Chip 2′	R.W. Gloyn 9-23-92	SE¼,NE¼,NW¼, Sec. 3, T. 3 N., R. 3 E., Phil Shop Hollow Copper project (DS-5) Along south wall of southern adit and just north of southern adit	Greenish-cream, massive- to crudely-bedded, very fine-grained limestone. Weathers reddish-brown. Rubbly to blocky weathering. Numerous voids and vugs filled with drusy calcite. Greenish-cream look suggests possible calc-silicates. Moderate to strong malachite stain at upper contact and rare scattered malachite throughout on fractures. No sulfides observed.
FC-14	Rock-Otc. Continuous Chip 2.5′	R.W. Gloyn 9-23-92	As FC-13 Along south wall of southern adit	Brownish-gray to greenish-gray, medium- to thick-bedded, laminated fine-grained granular limestone with thin (1-2") beds of olive-green to olive-brown, micaceous siltstone at base. No copper mineralization observed, but drove decline along this unit.
FC-15	Rock-Otc. Continuous Chip 5′	R.W. Gloyn 9-23-92	As FC-13 Along south wall of southern adit	Purplish-gray to greenish-gray, fine siltstone to argillite, non-calcareous. Footwall unit.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-16	Rock-Dump Select Grab	R.W. Gloyn 9-23-92	NW¼,SW¼,NE¼, Sec. 24, T. 4 N., R. 3 E., Cottonwood Canyon Copper project (DS-10)	Medium-gray to gray-brown, thinly-bedded to laminated, medium- to fine-grained, micaceous sandstone with numerous thin carbonaceous partings and minor fine-grained sandstone-siltstone interbeds. Planar to wavy bedding. Contains 1-2% carbonaceous trash, mostly twig and leaf fragments (up to 3-4 cm, but usually much smaller). Minor chalcocite replacement of carbonaceous fragments with moderate to strong malachite stain, particularly along bedding planes. Much of carbonaceous trash note replaced particularly in shaley partings, but disseminated carbon trash in sandstone locally replaced with crystalline or sooty chalcocite.
FC-17	Rock-Otc. Chip/Grab 1′	R.W. Gloyn 10-6-92	SE¼,NE¼,NE¼, Sec. 13, T. 5 N., R. 2 E., Morgan Chief mine (DM-3) Argenta district Upper cross-cut adit approx. 50′ below "gossan pit" Note: drove cross-cut along sampled brecciated zone	Brownish-gray to tan-gray, strongly brecciated, fetid limestone. Numerous voids and fractures often fill with white pulverent caliche. Weak limonite stain throughout and weak apple-green algal (?) stain. Probably barren.
FC-18	Rock-Dump Select Grab	R.W. Gloyn 10-6-92	SE¼,NE¼,NE¼, Sec. 13, T. 5 N., R. 2 E., Morgan Chief mine (DM-3) Upper gossan pit incline	Maroon-brown to yellow-ochre, very porous, goethite gossan. Coarse cellular boxwork. No sulfides or secondary Pb minerals observed.
FC-19	Rock-Otc. Continuous Chip 4.5′	R.W. Gloyn 10-6-92	As FC-18 Across main gossan zone of southeast corner of prospect pit	Yellow-brown to maroon-brown, porous and pulverent gossan with abundant remanent limestone. Gossan highly calcareous. Possible minor cerrusite. No sulfide observed

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location-Mine Name	Sample Description
FC-20	Rock-Otc. Grab	R.W. Gloyn 10-6-92	As FC-18 Above main gossan pod on south side of prospect pit	Highly brecciated and slightly silicified limestone cut by numerous small veinlets and stringers of hard, cherty goethite 2-10 mm wide.
FC-21	Rock-Dump Non-select Grab	R.W. Gloyn 10-6-92	SE¼,NE¼,NE¼, Sec. 13, T. 5 N., R. 2 E., Morgan Chief mine (DM-3) Lower caved adit dump which is approx. 300' southeast of prospect pit	Brownish-gray to dark-gray, highly brecciated and veined limestone. Often cut by stockwork of 0.5-2 mm wide milky-white quartz veinlets. Local fault limonite-stained. No sulfides observed
FC-22	Rock-Dump Select Grab	R.W. Gloyn 10-8-92	SW¼,SE¼,NE¼, Sec.24, T. 5 N., R. 2 E., Carbonate Gem mine (DM-1) Main adit (caved) dump	Dark maroon-brown, hard, siliceous gossan. Generally massive with only locally developed fine cellular boxworks. No sulfides or secondary Pb minerals observed.
FC-23	Rock-Dump Select Grab	R.W. Gloyn 10-8-92	As FC-22 Main adit (caved) dump	Yellow-brown to maroon-brown, soft, porous gossan. Generally consists of soft, clayey, yellow-brown gossan with stringers and pods of dark maroon-brown limonite with medium to coarse cellular boxworks. No sulfides or secondary Pb minerals observed.
FC-24	Rock-Dump Select Grab	R.W. Gloyn 10-8-92	NW¼,NE¼,SE¼, Sec. 24, T. 5 N., R. 2 E., Carbonate Gem mine (DM-1) At caved shaft--uppermost workings	Dark maroon-brown to purplish-brown gossan. Generally coarse cellular boxworks developed with remnant galena. Secondary anglesite (pristine needles) and cerrusite (tabular and pyramidal) develop as small crystals in voids and vugs. No secondary Zn minerals identified. Some good cubic to elongate boxworks of galena.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-25	Rock-Dump Select Grab	R.W. Gloyn 10-13-92	SW¼,NW¼,NW¼, Sec. 19, T. 5 N., R. 3 E., Carbonate Hill mine (?) (DM-4) At upper caved adit	Highly brecciated and fractured, dark-gray dolomite. Strong red-brown hematite stain, but no gossan observed. Very barren looking. Local greenish-yellow stain (epidote ?) developed along fractures.
FC-26	Rock-Dump Select Grab	R.W. Gloyn 10-13-92	SW¼,NW¼,NW¼, Sec. 19, T. 5 N., R. 3 E., Carbonate Hill mine (?) (DM-4) At lower caved adit	Yellow-brown, orange-brown, and maroon-brown gossan. Porous and botyroidal. No cellular boxworks developed. Looks very superficial--possibly transported limonite. Note: Some of sample unknown--does not look like it came from caved adit.
FC-27	Rock-Dump Select Grab	R.W. Gloyn 10-13-92	NW¼,NW¼,NW¼, Sec. 19, T. 5 N., R. 2 E., Miller Canyon prospect (DM-9) Adit dump	Maroon-brown, massive, granular gossan. Very few coarse boxworks. Much may be transported limonite.
FC-28	Rock-Otc. continuous chip 3′	R.W. Gloyn 11-12-92	SW¼,NE¼,NE¼, Sec. 13, T. 5 N., R. 2 E., Cottonwood Creek prospect (DM-6) At adit	Maroon-brown to yellow-brown, coarse cellular limonite boxwork. Relatively thin walled (0.5-1.0 mm). Cubic to diamond mesh boxwork (galena ?). No sulfides observed. Some granular-botyroidal cell fillings and pitchy looking limonite.
FC-29	Rock-Dump Select Grab	R.W. Gloyn 11-12-92	As FC-28 Dump at adit portal	Brownish-gray to tan, slightly porous limestone. Cut by thin (2-3 cm) stringers and veinlets of orange, pulverent to clayey limonite. Very fine-grained disseminated Fe-oxides (after pyrite) in limestone adjacent to limonite veins. Estimate 3-5%, but only extends 10-20 mm from veins.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-30	Rock-Dump Select Grab	R.W. Gloyn 11-12-92	As FC-28 Halfway down dump	Maroon-brown to purplish-brown, hard, siliceous, limonite gossan. Generally massive, containing rounded to glob-like clasts of quartzite with up to 30% very fine-grained disseminated pyrite and up to 5% disseminated Fe-oxides (after pyrite). Hard siliceous gossan cut by drusy quartz ± calcite veins and quartz + calcite filling voids and vugs in gossan.
FC-31	Rock-Dump Select Grab	R.W. Gloyn 11-13-92	NW¼,SW¼,SE¼, Sec. 24, T. 4 N., R. 3 E., Cedar Canyon prospect (M-7) Lower adit dump	Highly fractured and brecciated, medium-gray limestone with light orange-tan, stained granulated limestone/clay matrix. Cut by late coarse calcite veinlets (up to 5 mm wide) and irregular void fillings of coarse crystalline calcite. No sulfides observed.
FC-32	Rock-Dump Select Grab	R.W. Gloyn 11-13-92	As FC-31 Lower adit dump	Highly fractured, medium- to light-gray limestone-dolomite. Cut by stockwork of hairline to 2 mm wide Fe-oxide veinlets. Veinlets usually open and filled by later cream to tan botyroidal, crustiferous calcite. Fe-oxide veinlets usually hard, purple-brown goethite.
FC-33	Rock-Dump Select Grab	R.W. Gloyn 11-13-92	As FC-31 Lower adit dump	Highly fractured and brecciated, brownish-gray to medium gray limestone-dolomite. Cut by numerous hairline, yellow-orange to yellow-green limonite ± clay filled fractures.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-34	Rock-Dump Select Grab	R.W. Gloyn 11-13-92	NW¼,SW¼,SE¼, Sec. 24, T. 4 N., R. 3 E., Cedar Canyon prospect Upper central pit--largest dump	Maroon-brown to purplish, hard, siliceous gossan. Massive to porous, but with few boxworks developed. Some crusts and stringers of more porous yellow-brown to orange-ochre gossan. Some "pitchy looking" botyroidal crusts developed on hard siliceous gossan particularly in voids.
FC-35	Rock-Dump Select Grab	R.W. Gloyn 11-13-92	As FC-34 Upper central dump	Very porous and vuggy, light-orange to yellow-brown, clayey gossan with minor remnant zones of dark purplish-brown coarse to medium limonite boxworks. Boxworks generally curved and irregular with botyroidal texture. May be transported.
FC-36	Rock-Dump Select Grab	R.W. Gloyn 11-13-92	NE¼,SE¼,NW¼, Sec. 13, T. 5 N., R. 2 E., West Cottonwood Creek prospect (DM-7)	Yellow-gray to dark maroon-brown, strongly limonite stained, medium- to coarse-grained, slightly micaceous sandstone. Strongly stained with dark maroon-brown limonite along joints and fractures and as weathering rinds surrounding cores of yellow-gray, porous sandstone with disseminated dark-green grains (altered lithic or volcanic fragments ?). No sulfides or Fe-carbonates noted and source of Fe unknown.
FC-37	Rock-Dump Select Grab	R.W. Gloyn 10-24-94	NW¼,SE¼,NE¼, Sec. 35, T. 2 N., R. 1 E., Mill Creek prospect (FD-14) Upper dump	White to cream, vitreous, quartz vein containing stringers and blebs of galena and dark gray to black sphalerite. Sulfides generally in vugs and on associated with slightly later gray, more vitreous, vuggy quartz. Vuggy quartz coated with orange, pulverent limonite.
FC-38	Rock-Dump Select Grab	R.W. Gloyn 10-24-94	As FC-37	Light-gray, very vitreous, glassy quartz with minor (< 15%) laths of sercitized feldspar and light green chlorite. Crude layering or foliation. Origin unknown but probably pre-metamorphic--may be strongly recrystallized quartzite. No limonite stain observed.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-39	Rock-Dump Select Grab	R.W. Gloyn 10-24-94	AS FC-37	White, milky quartz with minor crystal-lined vugs. Quartz contains blebs of stockwork limonite (0.5-2.0 cm long-probably after chalcopyrite). Minor malachite stain and "Cu pitch". Strong yellow-orange to red-brown limonite stain on quartz. Quartz more vitreous, glassier-looking and more fractured than quartz in FC-37. Veins appear to be narrower and more anastomosing than for FC-37.
FC-000	Rock-Float Grab	B. Mayes 9-30-91	NW¼,NE¼,SE¼, Sec. 8, T. 2 N., R. 1 E., No prospect--in drainage above Bonneville level bench	Pinkish, granitic gneiss with abundant quartz veins and stringers.
FC-101	Rock-Otc. Grab	B. Mayes 9-30-91	SW¼,NW¼,SE¼, Sec. 8, T. 2 N., R. 1 E., Centerville Canyon Main prospect (BP-3) Pit with small adit. On north wall of pit approx. 30′ west of adit portal	Banded biotite-quartz gneiss with some bleached biotite or muscovite.
FC-102	Rock-Otc. Grab	B. Mayes 9-30-91	As FC-101 On north wall of pit approx. 15′ west of adit portal	Dark gray to black, banded biotite-quartz gneiss with well-developed schistosity. Biotite-rich zone.
FC-103	Rock-Otc. Grab	B. Mayes 9-30-91	As FC-101 From south wall of adit portal	Very weathered, gray, feldspathic-biotite-quartz gneiss with faint banding.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-108	Rock-Otc. Grab	B. Mayes 10-1-91	NW¼,SE¼,NE¼, Sec. 17, T. 2 N., R. 1 E., No prospect. From small drainage approx. 600' northwest of adit of Centerville Canyon Southeast prospect (BP-9)	Slightly chloritized, biotite-quartz gneiss.
FC-109	Rock-Otc. Grab	B. Mayes 10-3-91	NE¼,SE¼,NE¼, Sec. 7, T. 2 N., R. 1 E., Centerville Canyon Southeast prospect (BP-9) Back of adit approx. 15' from portal	Limonite- and malachite-stained quartz vein with "Cu pitch" after chalcopyrite
FC-110	Rock-Otc. Grab	B. Mayes 10-3-91	As FC-109 South wall at end of adit approx. 30' from portal	Fractured biotite gneiss. Footwall to vein of FC-109
FC-111	Rock-Otc. Grab	B. Mayes 10-3-91	As FC-109 From back of adit approx. 18' from portal	Malachite-stained quartz vein with "Cu pitch" after chalcopyrite.
FC-112	Rock-Otc. Grab	B. Mayes 10-3-91	As FC-109 Adjacent to sample FC-109 location	Strongly limonite-stained, quartz vein without malachite.
FC-113	Rock-Otc. Grab	B. Mayes 10-3-91	As FC-109 Outcrop approx. 20' north of portal of Centerville Canyon Southeast prospect (BP-9)	Quartz-rich gneiss or quartzite. No malachite stain and little or no limonite staining.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-114	Rock-Otc. Grab	B. Mayes 10-4-91	SW¼,SW¼,SE¼, Sec. 8, T. 2 N., R. 1 E., Centerville Canyon North prospect (BP-3) South adit from west side approx. 10′ from portal	Biotite-quartz gneiss cut by white to gray quartz veinlets. Moderate limonite stain.
FC-115	Rock-Otc. Grab	B. Mayes 10-4-91	As FC-114 South adit from back approx. 20′ feet from portal	Sheared, banded, biotite-gneiss with gray to white quartz veinlets. More veining than FC-114.
FC-116	Rock-Dump Grab	B. Mayes 10-4-91	As FC-114 Dump of south adit	Quartz-mica pegmatite
FC-117	Rock-Dump Grab	B. Mayes 10-4-91	As FC-114 Dump of south adit	Quartz-mica pegmatite
FC-118	Rock-Otc. Grab	B. Mayes 10-15-91	NE¼,SE¼,NW¼, Sec.18, T. 3 N., R. 1 E., Valley View prospect (F-1) Adit halfway down slope on east wall of adit approx. 20′ from portal	Sheared and foliated, biotite-quartz gneiss. Weak limonite stain.
FC-119	Rock-Otc. Grab	B. Mayes 10-15-91	As FC-118 On east wall of adit approx. 20′ from portal	Schistose, biotite-quartz gneiss. As FC-118 but less altered (weathered)

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-120	Rock-Otc. Grab	B. Mayes 10-15-91	As FC-118 On west wall of adit approx. 20′ from portal	Tan to rusty-weathering quartz vein or segregation. Developed at contact between schistose and banded biotite gneiss.
FC-121	Rock-Otc. Grab	B. Mayes 10-15-91	As FC-120	Banded biotite gneiss.
FC-122	Rock-Otc. Grab	B. Mayes 10-15-91	As FC-118 On east wall of adit approx. 30′ from portal	Strongly limonite-stained, schistose, biotite-quartz gneiss.
FC-123	Rock-Otc. Grab	B. Mayes 10-15-91	As FC-118 On west wall of adit approx. 30′ from portal	Quartz vein or segregation with minor limonite stain.
FC-124	Rock-Otc. Grab	B. Mayes 10-15-91	As FC-118 Outcrop to east of adit portal	Quartz vein or segregation with strong Fe and Mn stain.
FC-125	Rock-Talus Grab	B. Mayes 10-16-91	NE¼,SE¼,SE¼, Sec. 36, T. 4 N., R. 1 W., No workings Approx. 400′ N 65 W from Lower Bair Canyon prospect (K-11)	Pinkish, quartz-feldspar rock. Pegmatite or coarse granitic gneiss.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-126	Rock-Slope Wash Grab	B. Mayes 10-17-91	SE¼,SW¼,NE¼, Sec. 35, T. 6 N., R. 1 W., Taylor Canyon prospect (O-14) From wall of eastern pit. Slope wash	Weathered, pinkish-gray, quartz monzonite gneiss.
FC-127	Rock-Slope Wash Grab	B. Mayes 10-17-91	As FC-126 From wall of eastern pit Slope wash cobble	Black, slaty, carbonaceous, silty limestone-dolomite (Maxfield Limestone). Some brown to maroon iron-staining.
FC-128	Rock-Float Grab	B. Mayes 10-17-91	As FC-126 Float in bottom of eastern pit	Dark, slaty, carbonaceous, silty limestone, weathering light gray.
FC-129	Rock-Float Grab	B. Mayes 10-17-91	As FC-126 Float in bottom of eastern pit	White to gray, quartz monzonite gneiss.
FC-130	Rock-Float Grab	B. Mayes 10-17-91	As FC-126 Float in bottom of eastern pit	Pink, weathered, quartz monzonite gneiss.
FC-131	Rock-Otc. Grab	B. Mayes 10-18-91	NE¼,NE¼,NW¼, Sec. 21, T. 3 N., R. 1 E., Rudd Creek prospect (BP-4) Vein at crest of ridge	White quartz vein with little or no iron-staining.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-132	Rock-Otc. Grab	B. Mayes 10-18-91	As FC-131 Along vein approx. 100' northwest from FC-131 location	White quartz vein with weak iron-staining.
FC-133	Rock-Float Grab	B. Mayes 10-18-91	As FC-131 Down slope from vein to northeast approx. 50' north of FC-131	White quartz with minor feldspar and chlorite. May represent chloritized pegmatite.
FC-135	Rock-Float Grab	B. Mayes 10-18-91	As FC-131 Near FC-133 location	Pink, feldspar-quartz rock with minor mica. May represent pegmatite.
FC-136	Rock-Otc. Grab	B. Mayes 10-18-91	As FC-131 Approx. 300' east of FC-131. West of 8307 hill along ridge line	Weathered, biotite gneiss with dark maroon-brown and tan limonite staining (possibly from biotite).
FC-137	Rock-Dump Select Grab	B. Mayes 10-4-91	SW¼,NE¼,SE¼, Sec. 8, T. 2 N., R. 1 E., Centerville Canyon North prospect (BP-3) north adit dump	Limonite-stained, schistose, biotite gneiss with quartz-rich leucosomes.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-138	Rock-Dump Select Grab	B. Mayes 10-4-91	As FC-137	White, siliceous quartz vein or silicified zone.
FC-139	Rock-Dump Select Grab	B. Mayes 10-4-91	As FC-137	Biotite-quartz gneiss. Biotite-rich bands partially altered to chlorite.
FC-140	Rock-Dump Select Grab	B. Mayes 10-1-91	SW¼,NE¼,NE¼, Sec. 17, T. 2 N., R. 1 E., No prospect Small gravel pit on Bonneville Bench	Schistose, chlorite-quartz rock and cataclastic with some minor quartz veining.
FC-141	Rock-Dump Select Grab	B. Mayes 10-1-91	As FC-140	Siliceous, quartz-rich rock with muscovite, possibly pegmatite
FC-142	Rock-Dump Select Grab	B. Mayes 10-1-91	SW¼,NE¼,SE¼, Sec. 8, T. 2 N., R. 1 E., Centerville Canyon North prospect (BP-3) North adit dump	White, siliceous, quartz vein or quartz-rich pegmatite with greenish-white muscovite.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location-Mine Name	Sample Description
FC-201			Unknown	No Description
FC-202	Rock-Dump Select Grab	M. Shubat 10-15-91	SW¼,SW¼,SE¼, Sec. 11, T. 1 N., R. 1 E. Rotary Park prospect (FD-5) Easternmost dump	Mottled, orange-brown and dark-brown gossan. Some sulfide smell but no sulfides seen.
FC-203	Rock-Dump Grab	M. Shubat 10-15-91	As above	Gray limestone with thin calcite veinlets. Unmineralized. Maxfield Limestone.
FC-204	Rock-Dump Select Grab	M. Shubat 10-14-91	As above	Mottled, orange-brown and dark-brown gossan with bright green nodules of malachite. Abundant clay.
FC-205	Rock-Dump Select Grab	M. Shubat 10-16-91	SW¼,NW¼,NW¼, Sec. 7, T. 1 N., R. 2 E. Lower Burro Peak Southeast prospect (FD 3-A) Upper adit dump	Mottled, dark-brown to orange-brown gossan. No sulfides observed.
FC-206	Rock-Otc. Select Grab	M. Shubat 10-16-91	NE¼,NW¼, NE¼, Sec. 12, T. 1 N., R. 1 E. Burro Peak South prospect (FD-4) Lowermost pit of east-central prospect area	Mottled goethite - limonite gossan with minor hematite. Appears to be replacement of bedding parallel breccia zone in Pinyon Peak Limestone.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-207	Rock-Otc. Select Grab	M. Shubat 10-16-91	NE¼,NW¼,NE¼, Sec. 12, T. 1 N., R. 1 E. Burro Peak South prospect (FD-4) Pit in west-central prospect area.	Mottled, limonite-goethite gossan with whitish secondary mineral (cerrusite?, smithsonite?). Developed as irregular replacement along bedding and along N. 40 W. fracture zone.
FC-208	Rock-Dump Select Grab	M. Shubat 10-16-91	SW¼,SE¼,SE¼, Sec. 1, T. 1 N., R. 1 E. Upper Burro Peak Southeast prospect (FD 3-B) Upper adit.	Mottled, limonite-goethite gossan.
FC-209	Rock-Dump Grab	M. Shubat 10-16-91	NW¼,NE¼,SW¼, Sec. 7, T. 1 N, R. 1 E. Treasure Box Mine (FD-2) Adit Dump	Gray limestones with thin gossan stringers along fractures and partially replacing limestone. Some disseminated limonite after pyrite in limestone.
FC-210	Rock-Dump Select Grab	M. Shubat 7-12-92	NW¼,NE¼,SE¼, Sec. 9, T. 3 N, R. 1 E., Corduroy Canyon prospect (P-6) Western Dump	Fissile quartz-mica-chlorite rock with disseminated sulfides and secondary azurite-malachite stain on fractures cut by milky quartz veins with massive, irregular chalcopyrite blebs (up to 3 cm diameter). Chalcopyrite partially altered to dark indigo blue secondary sulfide (chalcocite?). Sample mostly quartz vein material.
FC-211	Rock-Dump Select Grab	M. Shubat 7-12-92	NW¼,NE¼,SE¼, Sec. 9, T. 3 N., R. 1 E., Corduroy Canyon prospect (P-6) Eastern Dump	Milky quartz vein with chalcopyrite blebs, partially altered to secondary sulfides. Some voids/vugs after weathered sulfides.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-212	Rock-Otc. Grab	M. Shubat 7-21-92	NE¼,NW¼,SW¼ Sec. 9, T. 3 N., R. 1 E., Utah Pioche mine (P-5) West end of open cut	Strongly copper-stained, green quartz-mica-chlorite rock with discontinuous quartz blebs and stringers. Quartz stringers contain irregular chalcopyrite blebs and secondary sulfides. Some disseminated Cu sulfides in quartz-chlorite rock. Abundant secondary Cu carbonates and sulfates (malachite and brochantite).
FC-213	Rock-Otc. Grab	M. Shubat 7-21-92	NE¼,NW¼,SE¼, Sec. 9, T. 3 N., R. 1 E, Utah Pioche mine (P-5) In adit-30′ from portal Footwall to late cross-cutting shear zone	Strongly copper-stained, quartz-mica-chlorite rock with discontinuous quartz veins and stringers containing chalcopyrite blebs. Abundant secondary minerals - mostly malachite but some chalcanthite and possibly antlerite. Secondary sulfides mostly chalcocite (?) but some tenorite.
FC-214	Rock-Dump Select Grab	M. Shubat 7-30-92	SW¼,SE¼,NW¼, Sec. 9, T. 3 N., R. 1 E., Mud Creek prospect (P-4) Adit dump	Medium to dark-green chloritic, micaceous "phyllonite" and quartz-chlorite cataclastite with disseminated chalcopyrite blebs. Some chalcopyrite-bearing quartz veins and stringers. Abundant malachite stain and "Cu pitch".
FC-215	Rock-Otc. Chip	M. Shubat 7-30-92	As FC-214 In adit approx. 40′ from portal. Sample from highly copper-stained zone in roof.	As above but with more abundant secondary copper stain (malachite).
FC-216	Rock-Dump Select Grab	M. Shubat 7-30-92	NE¼,NW¼,NE¼, Sec. 17 T. 3 N., R. 1 E., Farmington Creek North prospect (P-3) Adit dump	As FC-214 but source unknown since no mineralization observed in adit.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-217	Rock-Dump Grab	M. Shubat 7-31-92	SE¼,NW¼,NE¼, Sec. 16, T. 3 N., R. 1 E., Morris Creek East prospect (BP-5) Western adit dump	Strongly iron-stained pegmatite. Coarse-grained (5-8 cm) quartz-feldspar-pegmatite with interstitial chlorite (after biotite) and pyrite (now oxidized to limonite).
FC-218	Rock-Otc. Grab	M. Shubat 7-31-92	As FC-217 Lower adit - 150' from portal	Orange-brown to red-brown Fe-oxide layer in chloritized gneiss. Gneiss contains abundant (2-5%) small (1 mm) disseminated pyrite grains. Cut by thin (1 cm wide) quartz veins and stringers. Faint Cu stain (malachite).
FC-219	Rock-Dump Grab	M. Shubat 7-31-92	NE¼,SW¼,NE¼, Sec. 16, T. 3 N., R. 1 E., Morris Creek East prospect (BP-5) Small prospect pit	Limonite-stained gneiss with Fe-oxide layers parallel to gneissic banding (after disseminated pyrite).
FC-220	Rock-Float Grab	M. Shubat 7-31-92	SE¼,NW¼,NE¼, Sec. 16, T. 3 N., R. 1 E., Morris Creek East prospect (BP-5) In eastern adit 50' from portal. Sample from floor.	Green, chloritic, micaceous "phyllonite" with thin (1 cm) quartz stringers. Quartz stringers contain blebs of pyrite and chalcopyrite.
FC-221	Rock-Dump Select Grab	M. Shubat 8-5-92	NW¼,SW¼,NW¼, Sec. 15, T. 3 N., R. 1 E., Miller Creek prospect (BP-2) Small inclined shaft.	Contorted gneiss with quartz stringers (veinlets) and limonite-stained zones with chalcanthite, chalcopyrite, and pyrite.
FC-222	Rock-Otc. Grab	M. Shubat 8-5-92	As FC-221 Small prospect pit north of inclined shaft. Upper part of mineralized zone.	Strongly iron-stained, vuggy, quartz-veined gossan with remnant pyrite and chalcopyrite. Weak copper stain. Sulfides mostly pyrite.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-223	Rock-Otc. Grab	M. Shubat 8-5-92	As FC-222 Small prospect pit north of inclined shaft. Below sample 222.	Vuggy, quartz-chlorite vein with disseminated blebs (1 cm) of chalcopyrite, mostly altered to "Cu pitch." Vugs lined with quartz crystals. Strong malachite stain. Main mineral zone.
FC-224	Rock-Otc. Grab	M. Shubat 8-5-92	As FC-221 Western (lower adit) at 70′ from portal	Vuggy, quartz vein developed adjacent to coarse-grained quartz-feldspar-biotite pegmatite. Zone trends N80E, dips 65°N (Does not represent mineralized zone of samples 221-223.
FC-225	Rock-Otc. Select Grab over 60 feet	M. Shubat 8-5-92	As FC-221 Western (lower) adit at 10-70′ from portal	Limonite-stained, argillitized, chloritized gneiss, with abundant disseminated pyrite and chalcopyrite. Local malachite stain. Highly fractured throughout with chlorite alteration and local jarosite staining.
FC-226	Rock-Dump Select Grab	M. Shubat 8-5-92	SW¼,NE¼,SE¼, Sec. 22, T. 3 N., R. 1 E., Bountiful Peak campground prospect (BP-10) Southern adit dump	Limonite-stained quartz vein. Vein contains blebs and pods of pyrite and chalcopyrite (mostly altered to copper pitch) 5-6 mm across. Malachite stain on fractures. Vein developed adjacent to quartz-feldspar ± chlorite pegmatite and roughly parallel to gneissic banding.
FC-227	Rock-Float Select Grab	M. Shubat 8-6-92	SE¼,NE¼,NE¼, Sec. 28, T. 3 N., R. 1 E., Bountiful Peak Northwest prospect (BP-11) Small 5′ x 10′ x 2′ prospect pit	Coarsely-crystalline, white quartz vein containing patches of amphibolite and chlorite-quartz-feldspar wall rock. Fe-oxide blebs (5-6 mm) after sulfides; now all oxidized to limonite and "Cu pitch". Local strong malachite stain on fractures particularly in chlorite-rich parts.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-228	Rock-Dump Select Grab	M. Shubat 8-7-92	NE¼,SE¼,SE¼, Sec. 14, T. 2 N., R. 1 E., Upper Ward Canyon prospect (BP-7) Southern prospect pit	Limonite-stained, quartz-veined, argillitized gneiss. Veins are vuggy and well-fractured with some limonite blebs probably after sulfides. No copper stain observed.
FC-229	Rock-Dump Select Grab	M. Shubat 8-7-92	SW¼,SE¼,NE¼, Sec. 9, T. 2 N., R. 1 E., Parrish Creek south prospect (BP-12) Small prospect pit on ridge	Argillitized and chloritized gneiss cut by narrow quartz veinlets less than 2 cm wide. Gneiss contains disseminated grains of oxidized chalcopyrite. Malachite coatings on fractures.
FC-230	Rock-Dump Select Grab	M. Shubat 8-12-92	NW¼,SW¼,NE¼, Sec. 9, T. 2 N., R. 1 E., Parrish Creek prospect (BP-17) Main (western) adit dump	Pyrite and chalcopyrite-bearing quartz vein with chlorite. Quartz vuggy with vugs lined with fine-grained quartz. Some chlorite.
FC-231	Rock-Dump Select Grab	M. Shubat 8-12-92	As FC-230 Main (western) adit dump	Limonite and jarosite-stained gneiss with 2-3 % disseminated pyrite. No copper stain observed.
FC-232	Rock-Dump Grab	M. Shubat 8-12-92	NW¼,NE¼,NW¼, Sec. 9, T. 2 N., R. 1 E., Parrish Creek North prospect (BP-13) Adit dump	Orange-brown, strongly limonite-stained, micaceous, chlorite-quartz "phyllonite." No sulfides observed. No copper stain, but some vuggy porous "gossan."
FC-233	Rock-Dump Grab	M. Shubat 8-13-92	SE¼,SW¼,SW¼, Sec. 20, T. 3 N., R. 1 E., Steed Canyon prospect (BP-15) Inclined shaft dump	Highly limonite-stained, chloritic, phyllonite/cataclastite. Iron-staining probably after disseminated pyrite. No copper stain observed.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-234	Rock-Dump Grab	M. Shubat 8-13-92	NW¼,NW¼,SE¼, Sec. 20, T. 3 N., R. 1 E., Morning Star Group (BP-16) Lower (western) caved adit dump	Dark-green to light-green, micaceous, quartz-chlorite phyllonite/cataclastite cut by thin quartz veins and stringers. Pyrite and chalcopyrite associated with veins and disseminated in "phyllonite." Disseminated mineralization both fine-grained and as large (1 cm) blebs. Most sulfides oxidized to Fe oxides. Minor malachite stain.
FC-235	Rock-Dump Grab	M. Shubat 8-13-92	NW¼,NW¼,SE¼, Sec. 20, T. 3 N., R. 1 E., Morning Star Group (BP-16) Central adit dump	Dark-green to light-green, "phyllonite" with quartz veining and disseminated sulfides. Similar to FC-234. Probably represents wall rock to vein (if present).
FC-236	Rock-Dump Select Grab	M. Shubat 8-13-92	NW¼,NW¼,SE¼, Sec. 20, T. 3 N., R. 1 E., Morning Star Group (BP-16) Uppermost eastern dump Largest dump of group Probably represents main Morning Star	White quartz vein with up to 10 % sulfides. Sulfides consist of pyrite and chalcopyrite as irregular blebs up to 2 cm across. Partly oxidized to limonite and "copper pitch". Strong malachite stain.
FC-237	Rock-Dump Select Grab	M. Shubat 8-14-92	NE¼,SW¼,NE¼, Sec. 35, T. 2 N., R. 1 E., Mill Creek West prospect (FD-13) Small double adit dump	Vuggy quartz vein and vein breccia with very minor iron oxide blebs (< 1 cm) after sulfides and faint malachite stain.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
FC-238	Rock-Dump Select Grab	M. Shubat 8-14-92	NW¼,SE¼,NE¼, Sec. 35, T. 2 N., R. 1 E., Mill Creek prospect (FD-14) Double adit and open cut dump	Mixed sample--contains 2 types/ styles of mineralization. 1. Dark-green to blackish green, quartz-chlorite schist with irregular stringers (3-10 mm wide) of white "granular" quartz. Quartz contains chalcopyrite stringers and blebs up to 1 cm long, mostly altered to "Cu pitch." Moderate to strong malachite stain. 2. Quartz vein/stockwork in light-green, slightly-talcose quartz-clay rock. Quartz veins (0.5 to over 2 cm wide) consist of white, very coarse-grained vitreous quartz containing blebs and stringers of galena (up to 1x3 cm) and sphalerite. Some vugs in quartz vein. NOTE: No chalcopyrite in these veins and wall rock looks more altered and argillitized than type I mineralization. Suggests two possible generation of mineralization with quartz-sphalerite-galena later than quartz-chalcopyrite.
FC-239	Rock- Dump Select Grab	M. Shubat 8-14-92	SE¼,NE¼,NE¼, Sec. 35, T. 2 N., R. 1 E., Mill Creek East prospect (FD-15) Adit dump	Quartz-veined, green, chloritic "phyllonite". Phyllonite contains coarse remnant muscovite (from pegmatite parent?). Quartz veins vuggy and contains stringers and veinlets of pyrite and chalcopyrite. Best chalcopyrite associated with vuggier parts of vein. Abundant malachite.
FC-240	Rock-Dump Select Grab	M. Shubat 8-14-92	As FC-239	Silicified-pyrite rock with strong limonite-jarosite stain. Pyrite occurs with quartz veins/silicified zones and disseminated in chloritic phyllonite host.
FC-241	Rock-Dump Select Grab	M. Shubat 8-14-92	SW¼,NE¼,SE¼, Sec. 1, T. 1 N., R. 1 E., Burro Mine (?) (FD-9) Adit dump	Massive, vuggy, porous limonite gossan. No sulfides observed. No copper staining.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
14401	Rock-Otc. Discontinuous chip 9.5' (2-3")	R.W. Gloyn 5-20-91	SE¼,NE¼,SE¼, Sec. 28 T. 3 N., R. 3 W., Molly's Nipple Shear Zone 0 to 9.5' - Represents main shear on southeast side of shear zone	Light to medium apple green, quartz-chlorite phyllonite. Contains 30% quartz as ¼- to 2"-wide, lens-like segregations and as thin, discontinuous 1 - 4"-wide-veinlets, both parallel to foliation. Minor narrow cross-cutting quartz veinlets. Weak limonite. No sulfides observed.
14402	Rock-Otc. Discontinuous chip 55' (12-18")	R.W. Gloyn M. Shubat 5-20-91	SE¼,NE¼,SE¼, Sec. 28 T. 3 N., R. 3 W., Molly's Nipple Shear Zone 9.5 to 55' - Represents central part of shear/mylonite zone	Light to medium green quartz-chlorite phyllonite. Less abundant quartz veins and segregations than in 14401. Contains 4.0'-wide, tan, mylonite zone. Minor disseminated hematite after pyrite or magnetite.
14403	Rock-Otc. Discontinuous chip 19' (4-6")	R.W. Gloyn 5-20-91	SE¼,NE¼,SE¼, Sec. 28, T. 3 N., R. 3 W., Molly's Nipple Shear Zone 65 to 84' - Represents northwest part of shear zone	Light apple green, very fine-grained, quartzite or silicified mylonite, and light- to medium-green, chlorite-quartz phyllonite. One-third of sample is quartzite or mylonite; two thirds is phyllonite. "Quartzite" cut by up to 30% pod-like, milky, quartz veinlets up to 6" wide. Phyllonite similar to sample 14401 with up to 30% quartz as pod-like segregations and 3 - 6"-wide, folded, quartz veins.
14404	Rock-Otc. Discontinuous chip 110' (18-24")	M. Shubat 5-20-91	SW¼,SW¼,SW¼, Sec. 5, T. 3 N., R. 3 W., Antelope Island Shear Zone Eastern part of shear zone	Brown to tan, quartz-feldspar-sericite schist and medium to dark-green, chlorite-quartz phyllonite with quartz and feldspar augen. Up to 3-5% specular hematite disseminated in matrix of quartz chlorite phyllonite. Several 1- to 3'-wide bands of very hematite-rich, brecciated feldspar-chlorite rock with epidote in west-central part of zone.

SAMPLE DATA

Sample Number	Type Length Frequency	Sampler Date	Location - Mine Name	Sample Description
14405	Rock-Otc. Discontinuous chip 160′ (18′24")	R.W. Gloyn 5-20-91	SW¼,SW¼,SW¼, Sec. 5 T. 3 N., R. 3 W., Antelope Island Shear Zone Western part of shear zone	Medium-green, moderately granulated, chloritized and locally phyllonitized granite gneiss and medium- to dark-green, chlorite phyllonite (highly schistose). Phyllonite contains veinlets and dissemination of specular hematite and up 2% thin, irregular, anastoming quartz veins and stringers. 70% of sample altered gneiss, 30% phyllonite.

APPENDIX C

Sample Assay Results

SAMPLE ASSAY RESULTS

sample number	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Sb (ppm)	Mo (ppm)	Bi (ppm)	Cd (ppm)	Ba (ppm)	W (ppm)	Mn (ppm)	V (ppm)	Cr (ppm)	Co (ppm)	Ni (ppm)
14401	7	0.5	22.2	11.1	37.6	22	1.1	8.5	9	<0.1	205	26.3	161.8	75.3	126.1	3.8	6.5
14402	9	0.2	29.7	13.7	81.6	12.2	0.6	3.9	2.8	0.1	490	5.4	258.7	87.9	93	7.6	10.6
14403	5	0.2	18.9	7.4	21.7	15.1	0.4	1.3	0.9	0.1	130	3.4	124.8	63.2	103.4	3.8	5
14404	3	0.6	14.7	15.8	159.5	16.3	0.7	1.6	0.5	<0.1	500	3.8	783	137	143.8	11.1	39.5
14405	3	0.2	12.4	17.8	61.2	9.2	0.5	1.9	0.3	<0.1	590	3.6	534.7	103.9	102.3	6.9	9.1
FC-1	30	0.4	7961.4	4.6	27.1	8.5	0.3	5.4	0.6	<0.1	50	3.5	158.1	90.4	174.1	28.4	60
FC-2	4	0.8	121.9	7.9	46.9	8.6	2.4	4.2	0.5	<0.1	145	29.7	165.7	197.1	174.9	16.4	59.2
FC-3	20	0.2	892.7	8.3	15.3	7.1	0.5	8	0.8	<0.1	235	3.8	79.7	78.2	187.9	11.2	16.7
FC-4	90	1.6	3067.6	10.7	7.4	8.7	0.8	58.2	1.3	0.1	30	4.3	52.3	61.7	107	18.4	21.1
FC-5	190	4.8	306.8	10.1	60.1	7.2	0.3	6.1	0.8	<0.1	590	2.1	273.2	191.4	219.1	20.3	69.7
FC-6	4	0.4	251.3	12.9	45.7	10.5	0.7	2.2	0.4	<0.1	650	2.7	328.6	84.1	88.9	4.7	12.2
FC-7	5	0.4	14318.1	8.6	58.3	7.8	0.4	4.8	0.7	0.3	1930	2.6	554.1	125	129.5	4.9	23.4
FC-8	4	0.5	856.4	7.1	61.6	9.4	0.4	1.6	0.4	<0.1	980	2.8	551.6	103.1	99.8	7.5	14.1
FC-9	2	1.3	2500	8.6	91.6	8.7	0.8	1.9	0.3	<0.1	560	2.8	524	130.2	83.1	13.1	22.5
FC-10	6	3.6	3984.3	6.6	69.2	11.5	0.6	1.2	0.3	<0.1	1380	2.2	548.7	112.7	73.8	8.9	16.3
FC-11	4	1.9	2824.1	7.1	158.4	8.1	0.5	1.4	0.2	<0.1	670	3.1	570.7	167.6	85.3	22.8	40.4
FC-12	2	1.5	12110.8	9.1	42.6	15	0.6	3.2	0.5	1.2	1100	2.4	883.8	78.3	90.4	5.6	14.4
FC-13	5	3.7	1264.3	44.7	37.9	45.6	1	1.6	<0.1	<0.1	730	2.5	1887.1	82.7	27.1	17.6	21.6
FC-14	3	1.2	61.7	9	66.3	26.9	0.9	0.8	0.2	0.1	790	3.6	1282.6	110	56.4	11.7	20.2
FC-15	5	0.8	19.1	11.5	119.1	21.8	1.2	0.5	0.1	<0.1	570	4.3	823	162.1	71.3	11.9	33.3
FC-16	4	66.9	22900	62	78.3	28.1	0.4	9.1	0.2	0.5	1740	2.8	461.8	100	68.1	12.8	20
FC-17	2	1.2	67.2	444.3	342.8	50	0.4	0.9	<0.1	3.2	1380	2.4	297.4	50.6	15.5	6.1	25.7
FC-18	6	6.3	132.7	2110	11211	168.8	5.1	22.1	<0.1	9.5	65	2.9	293	46	18.7	12.8	42.5
FC-19	6	2.5	62.7	3577.6	8911.8	100.9	3.1	15.5	<0.1	5.3	40	3.2	343.7	34.5	17.3	78	29.3
FC-20	10	2.5	22	2018.6	9501.7	59.1	1.3	2.7	<0.1	13.6	110	1.2	1230.5	45.8	14.8	11.7	33.6
FC-21	12	0.6	11.2	22.5	136	47	0.7	0.7	<0.1	0.6	30	2.5	490.4	44.8	13	2.6	20.4
FC-22	2	25.5	420.4	20109	25349	3049	49.4	13.3	0.2	19.4	2350	0.9	266.9	44.3	17.2	7.4	5.3
FC-23	4	1.9	707.5	12779	26564	2325.4	6.6	5	0.1	42.4	1130	2.8	170.5	55.8	20.2	8.1	12.1
FC-24	20	103.2	421.9	20027	20099	4554.8	140.6	3.7	0.2	31.2	700	0.9	83	28.1	11.7	3	1.1
FC-25	8	0.8	8.3	542.6	190.4	62.3	1	0.9	<0.1	1.1	120	2.7	343.5	41.3	15.9	3	25.2
FC-26	2	9	151.7	20598	10410	167.1	23.2	18.7	0.3	9.8	4060	3.4	81.9	51.1	25.9	6	19

sample number	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Sb (ppm)	Mo (ppm)	Bi (ppm)	Cd (ppm)	Ba (ppm)	W (ppm)	Mn (ppm)	V (ppm)	Cr (ppm)	Co (ppm)	Ni (ppm)
FC-27	7	3.6	63.5	584	6458.5	140.1	13.1	33.6	<0.1	11.4	1130	7.6	110.2	67.4	38.1	21.2	52
FC-28	8	1.9	102.7	1261.4	1956.5	31.1	1.6	14.1	<0.1	8.1	390	2.4	3556.7	29.3	16.7	77.3	98.9
FC-29	12	1	21.9	308.4	780.2	98.5	4.4	4.7	<0.1	1.1	185	2.7	696.9	59.2	19.2	11.2	35.6
FC-30	7	2.9	38.1	572.8	753.1	49.1	3.5	11.1	0.1	0.8	1810	2.2	98.3	34.3	47	14.7	20.5
FC-31	8	0.6	9.2	46.7	91.8	56.9	0.4	1.3	<0.1	<0.1	35	3.5	423.4	61.5	15.8	6.6	30.3
FC-32	5	0.9	5.5	32.5	72.1	41	0.5	0.8	<0.1	<0.1	40	2.1	421.5	51.2	12.4	5.8	28.6
FC-33	10	0.6	7.6	20.6	21.8	52.3	0.2	0.6	<0.1	0.1	20	3.3	390.5	58.6	11.5	7.9	30.1
FC-34	5	0.5	49	559.5	110	40.5	3.9	40.5	0.5	0.2	125	17.1	144.4	116.4	21.3	5.3	22.7
FC-35	12	0.3	81.9	331.5	408.2	44.9	4.1	15.5	0.2	0.1	100	9.7	317.2	102.4	28.8	7.7	42.3
FC-36	55	1.5	10.9	12.3	47.7	8.3	49.3	10.6	1.7	0.4	495	3.2	2261.6	60.1	166.5	15.5	13.0
FC-37	370	8.8	95.5	70500.0	236.3	7.0	2.8	6.6	1.0	0.8	70	5.1	57.2	12.8	246.9	2.0	4.9
FC-38	55	2.0	29.0	522.5	135.4	6.7	0.8	7.5	0.5	0.1	20	1.5	56.6	27.9	146.4	1.5	5.4
FC-39	70	2.5	829.1	6684.0	191.9	9.5	1.3	5.9	2.5	0.7	95	4.9	172.1	100.7	177.7	6.3	13.5
FC-000	2	<0.1	5.6	146.3	19.8	3.7	0.3	0.6	<0.1	<0.1	720	4.4	47.3	36.9	51.4	0.5	1.5
FC-101	2	0.2	125.6	38.5	219.9	11.1	0.3	1.5	<0.1	<0.1	710	3.6	1718.1	318.7	122.6	38	63.8
FC-102	3	0.3	90.4	34.2	96.5	14.9	0.3	3.1	0.2	<0.1	960	3.5	1243.1	340.1	129	34.4	55.2
FC-103	3	0.2	21	71.1	46.3	6.5	0.3	0.9	<0.1	<0.1	2950	3.2	154.1	61.4	84.7	5.4	4.6
FC-108	5	0.1	9.9	9.3	17.8	5.2	0.2	3.7	<0.1	<0.1	170	3	51.6	51.7	155.4	1.2	6.6
FC-109	2	<0.1	5376.1	52.9	32.6	7.7	0.3	6	1.9	0.2	460	3	97.4	58.2	149	16.1	9.3
FC-110	35	<0.1	209.4	27.5	73.6	8.6	0.4	4.8	0.6	<0.1	780	5.6	614.6	126.5	151.7	20.3	30
FC-111	3	0.4	2601.2	91	21	7.3	0.5	8.7	1.4	<0.1	600	4.5	53.1	57	175.1	6.8	5.7
FC-112	45	0.3	433.4	69.3	29.2	7.3	0.4	8.2	1.4	<0.1	1260	4.2	157.7	54.3	131.7	5.9	12.7
FC-113	4	<0.1	9.3	124.5	28.1	4.5	<0.1	3.2	0.8	<0.1	1700	4	144.4	33.3	141.2	1.1	3.5
FC-114	<2	<0.1	24.5	54.7	46.5	5	<0.1	3.6	0.4	<0.1	1060	3.4	189.6	54.1	110.2	2.9	10.5
FC-115	3	<0.1	66	46.6	54	5.8	0.4	4	0.1	<0.1	1440	3.2	189.6	67.9	130.6	7.3	11.1
FC-116	2	<0.1	9.5	149.8	18	5.9	0.1	3.7	<0.1	<0.1	900	7.2	60.1	64.6	130.4	1.4	3.8
FC-117	2	<0.1	7.6	107.7	15	5.4	0.2	5.2	0.3	<0.1	750	5.1	57.1	44.7	235.9	0.6	37.2
FC-118	<2	<0.1	23.7	45.8	87.1	7.8	0.7	4.4	0.2	<0.1	910	4.6	636.1	53.5	182.2	4.1	3.9
FC-119	3	<0.1	38	65.5	137.9	7.9	0.4	2.3	<0.1	0.1	1630	4	1415.3	56.6	101.2	3.3	3.5
FC-120	<2	<0.1	9.7	63.7	19.7	6.8	0.5	1.9	<0.1	<0.1	1120	0.7	110.5	26.1	38.2	0.5	1.8
FC-121	<2	<0.1	30.9	76.2	78.2	16	0.2	1.9	<0.1	<0.1	1730	2.7	654.5	54.7	90.3	3.2	1.6
FC-122	<2	<0.1	33.1	78.2	197.8	17.3	0.5	1.3	<0.1	0.2	1720	3.1	1126.2	93.6	97.2	10.5	24.1
FC-123	4	<0.1	28.2	74.8	64.6	16.2	0.3	3.3	<0.1	0.1	890	4.1	421.1	54.4	103.4	3.2	3.6
FC-124	3	0.1	14.4	81.8	29	11.7	0.1	2.6	<0.1	<0.1	1860	2.5	136.3	24.2	63.6	1.8	4.2
FC-125	2	<0.1	14.3	76.3	27	12.7	0.1	1.2	<0.1	0.2	690	2.3	207.2	34.4	52.5	2.8	2.8

sample number	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Sb (ppm)	Mo (ppm)	Bi (ppm)	Cd (ppm)	Ba (ppm)	W (ppm)	Mn (ppm)	V (ppm)	Cr (ppm)	Co (ppm)	Ni (ppm)
FC-126	<2	0.6	27.9	40.4	244.9	15.1	0.4	2.5	0.1	0.2	2260	2.4	1748.9	56.3	62.4	8.7	8.3
FC-127	6	0.4	13.7	6.5	63.4	70.9	0.3	1.2	<0.1	<0.1	150	2.6	408.1	55.4	23.5	7.8	27.8
FC-128	<2	0.3	12.4	13.2	32.8	51.3	0.4	0.5	<0.1	<0.1	230	1.9	451.8	54.6	24.4	8.5	32.1
FC-129	<2	0.2	50.1	24.8	30.3	13.6	0.1	3.6	<0.1	<0.1	140	3.8	315.4	46.7	110.2	5.5	24.2
FC-130	3	0.2	18.6	74.4	195.2	11.5	0.2	4.1	0.2	0.8	2350	1.7	1254.7	54.2	118.8	4.4	3.9
FC-131	<2	0.3	11.7	74.1	24.4	10.4	0.1	2.9	<0.1	0.2	540	1.8	149	34.7	96.3	2.5	3.4
FC-132	5	0.1	9.2	115.1	22.2	11.1	0.2	1.9	<0.1	0.3	380	1	43.6	23.4	91	1.7	3
FC-133	4	<0.1	8.4	4.4	7.6	9.6	0.1	3.3	<0.1	<0.1	25	1	28.3	27.1	98.9	1.5	3.4
FC-135	4	<0.1	10	122	24.6	9	0.4	2.9	<0.1	<0.1	1910	1.2	56.5	55.4	87.9	2	3.7
FC-136	2	0.4	106.8	37.1	200.7	24	0.3	1.7	0.4	0.2	480	3.3	2346.5	296.6	234.8	46.5	64.4
FC-137	3	0.2	13.4	11.7	123.9	10.6	0.3	1.3	0.3	0.2	1300	1.9	1164.9	72	74.4	10	9.3
FC-138	3	<0.1	25	26.4	107.9	13.4	0.2	3	<0.1	0.2	1390	3.2	882.6	100.5	91.4	9.9	17.5
FC-139	2	<0.1	10.2	14.2	54.6	11.2	0.4	2.5	<0.1	<0.1	530	1.7	355.5	62.3	99.5	4.4	5.1
FC-140	3	0.2	37.5	39.6	91.1	10.2	0.2	1.1	0.2	<0.1	680	4.9	891.3	175.6	160.5	22	56
FC-141	7	0.4	12.7	60.6	43.2	13.3	1.2	3.8	1.1	<0.1	690	10.9	66.8	51.7	89.2	2.9	5.2
FC-142	2	0.5	12.5	1.3	11.6	12.8	0.6	4.8	0.5	<0.1	90	4.5	35.4	54	211.4	2.3	33.9
FC-201	2	0.6	10.8	10.1	24.3	162.5	1.7	3.2	0.3	<0.1	170	4.6	2774.1	64.3	31.8	32.6	26.8
FC-202	6	2.9	3309.9	8247	2493.7	1136.7	12.4	7.1	1.3	1	20	5.2	863.1	61.2	35.2	78.2	26.2
FC-203	55	0.4	27.8	28.4	27.2	55.1	0.6	1.2	0.2	<0.1	20	2.9	256.7	55.2	15.8	5.9	23.2
FC-204	6	2.2	8018.3	408.6	313.5	1555.4	3.2	2.2	0.6	0.8	25	9.6	544.1	54.2	18.4	28.7	22.9
FC-205	20	23	96	27530	19608	153.7	16.3	8.2	0.4	15.4	30	7.4	212.4	135.1	100.1	5.8	35.4
FC-206	16	3.6	67.4	818.3	14082	198.1	5.9	6.9	0.2	9.2	40	6	86.8	104.2	83.4	6.5	11.5
FC-207	4	55.3	322.6	39600	205800	219.2	80.9	5.6	0.2	40.6	25	1.6	563.6	54.1	22.3	55.4	10.3
FC-208	20	204.4	745	98750	186800	301.7	219.1	5.2	0.3	28.9	30	1.8	347	54.5	25.2	50.1	9.3
FC-209	2	1.3	65.1	234.4	895.5	25.6	1.3	8.8	<0.1	2.1	60	1.5	137.4	52.2	125.4	4.2	26
FC-210	210	1.2	14499	83.5	167	9.3	0.6	7.6	0.8	<0.1	175	2.3	111.6	60.2	226.4	6.6	15.8
FC-211	360	2.1	31580	76.9	122.8	12.5	0.5	10.4	2	0.2	80	2.5	40.1	50.4	123	7.9	6.5
FC-212	1250	0.6	11028	61.2	95.1	9.4	0.3	9.4	1	0.2	250	3.9	145.3	67.4	175.9	11.8	36.9
FC-213	720	0.4	9592.5	25.5	62.2	9	0.3	4.2	0.8	0.1	360	2.5	88.9	81.4	146.3	10.7	20.8
FC-214	7350	2.6	77528	29.3	75.9	9.5	0.4	22.6	3.6	0.2	60	1.8	102.7	55	101.5	5.8	11.4
FC-215	1320	0.8	13972	48.5	157.3	14.3	0.3	7.8	2.1	0.6	220	1.6	182.4	74.8	92.6	9.2	20.7
FC-216	18	0.6	11611	173	352.7	15.3	0.5	8.3	0.3	0.2	510	1.9	196	62.3	106.4	7.9	18
FC-217	6	0.4	251.4	70.6	131.2	15.8	0.2	4.3	0.2	<0.1	400	2.5	667.2	93.8	109.9	22.7	30.5
FC-218	7	0.3	126.5	56.9	71.9	142.2	0.3	3.9	0.3	1	1160	2.8	289.8	40.6	89.9	12.8	10.1
FC-219	25	0.3	328.6	55.7	69.9	16.5	0.2	3.9	0.2	<0.1	770	4.1	591.4	129.7	626.4	36.4	90.7

sample number	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	As (ppm)	Sb (ppm)	Mo (ppm)	Bi (ppm)	Cd (ppm)	Ba (ppm)	W (ppm)	Mn (ppm)	V (ppm)	Cr (ppm)	Co (ppm)	Ni (ppm)
FC-220	140	3.3	15003	375.3	634.8	15.9	0.2	13.6	0.7	1.2	180	2.7	310.3	111.3	178.9	10.9	30.4
FC-221	260	7.5	9022	25.2	140.1	13.8	0.5	6.6	4.5	<0.1	40	4.8	299.7	50.5	124	13.3	43.6
FC-222	100	10.8	4176.4	90.8	112.2	46	0.5	4.7	3.4	0.3	20	2	583.1	50.2	120.8	22.6	17.7
FC-223	100	7.2	9024.5	384.5	141.1	15	0.1	3.6	29	0.4	30	2.7	554.1	42.2	107	15.5	26.8
FC-224	6	0.4	213.1	28	53.5	14.1	0.2	8	3.4	0.2	300	3.5	234.7	45.9	230	12	43.5
FC-225	8	0.6	1321.8	40	25.8	20.6	0.4	8.9	1.1	0.1	190	3.7	286.5	140.7	217.2	30.8	34.9
FC-226	35	0.4	2960.2	7.6	25.7	11.4	0.2	6	0.1	0.6	90	2.1	32.1	54	152.8	3.9	6.8
FC-227	20	0.8	7335.7	10.8	41.3	10.3	0.2	6.8	0.2	0.2	20	1.9	214.9	64.1	139.8	17.3	13.8
FC-228	390	8.3	653.8	8809.2	652.3	12.7	1.6	10.8	11.1	0.4	350	4.9	163.7	85.1	157.2	6.6	14.6
FC-229	65	0.8	8155.4	25.5	44.6	10.1	0.2	4.4	1.8	0.2	25	2.6	401.5	132.3	161.1	35.3	37.9
FC-230	120	6.3	15388	62	279.6	13.7	0.4	10.8	2.8	1.1	480	3.4	494.6	76.2	97.7	40.2	28.8
FC-231	7	0.5	319.8	55.5	86.4	14.1	0.1	5.1	0.8	0.3	1080	3.1	813.4	61	136.8	7.4	12.1
FC-232	13	0.4	58.8	12.9	48.1	14.2	0.4	11.9	3.9	1	60	2.7	174.7	84	127.5	42.1	18.6
FC-233	100	0.5	84.8	44.2	68.5	20.7	0.4	3.8	0.5	0.1	560	5.9	667	158.6	86.5	29.2	30.6
FC-234	65	0.2	1168.4	54.3	73.7	12.9	0.2	3.9	6.6	0.5	560	3.3	585.7	81.2	120.2	8.2	12.6
FC-235	14	0.3	247.6	16.8	45.4	13.5	0.5	5.3	2.7	0.2	490	7.9	241.8	76.8	109.9	10.6	25.2
FC-236	1460	1.9	14903	75.9	59	12.2	0.3	8.4	180.1	0.2	50	2.9	45	54.6	173	1.5	6.1
FC-237	20	0.3	103.8	78.2	92.6	71.5	0.8	507	2.3	<0.1	195	5	135.1	94.8	117.6	95.1	14.9
FC-238	7	3.1	1714	40790	755.1	12.5	2.3	4	1.3	0.8	340	5.9	175.7	80.9	260.2	9.5	30.9
FC-239	8	0.4	3073.3	105	36.5	12.8	0.4	3.1	1	0.1	70	3.2	132.7	74.2	299.5	106.9	21.1
FC-240	9	0.2	128.4	123.8	104	13	0.2	3.5	0.7	<0.1	<10	3.5	117.9	59	154.6	316	25.1
FC-241	14	1.9	243.5	2004.5	3625.2	134.7	1.3	5	0.3	1	30	3.3	142.9	79.2	52.6	11.5	17.5

UTAH GEOLOGICAL SURVEY
OPEN-FILE REPORT

Plate 1
Geologic Map of Farmington Canyon Complex and Surrounding Areas

Compiled by
Michael Shubat

Data sources: Bryant (1988,1990), Coody (1957), Davis (1983,1986), Hintze (1988), Hopkins (1982), Mullens (1972), and Mullens and Laraway (1964, 1973).

Scale 1:100,000

0 1 2 3 4 5 6 7 8 KM

0 1 2 3 4 5 MI

DESCRIPTION OF MAP UNITS

Q — Quaternary sedimentary units (Holocene and Pleistocene)-- Pebble and cobble gravel, sand, silty sand, silt and clay of alluvial, colluvial, lacustrine, and glacial origin. Includes terrace gravels, alluvial fan deposits, lacustrine deposits (Lake Bonneville), alluvial stream and floodplain deposits, pediment deposits, glacial till and landslide deposits.

Tc — Younger conglomerate (Pliocene(?) and Miocene(?))-- Pale-brown to gray, pebble and cobble conglomerate and sandstone. Thickness: 0 to 1,500 feet.

Tkb — Lahar, flow breccia, and tuff (Oligocene and Eocene)-- Gray lahar, flow breccia, and volcanoclastic sandstone and conglomerate. Thickness: 0 to 1,000 feet.

Tn — Norwood Tuff (Oligocene and Eocene)-- Gray to white, volcanoclastic sandstone and conglomerate with minor flow breccia. Thickness: 0 to 5,000 feet.

Toc — Older conglomerate (Oligocene and Eocene(?))-- Boulder, cobble, and pebble conglomerate with clasts of Nugget Sandstone and other Mesozoic and upper Paleozoic formations. Mapped separately in southern half of map area; included with Tn in northern half of map area. Thickness: 0 to 900 feet.

Tw — Wasatch Formation--Eocene and Paleocene(?))-- Red, grayish-red, red-brown, and gray sandstone, conglomerate, siltstone, shale, with scattered lenses of silty limestone. Thickness: 0 to 4,500 feet.

Twc — Wasatch Formation (Eocene and Paleocene(?))-- Conglomerate-dominant Wasatch Formation. Mapped separately in southern half of map area; included with Tw in northern half of map area.

Keh — Hams Fork Conglomerate Member of Evanston Formation-- (Upper Cretaceous)-- Light-gray to brownish-gray conglomeratic sandstone, sandstone, sandy siltstone, and claystone. Thickness: 80 to 600 feet.

Ke — Echo Canyon Conglomerate (Upper Cretaceous)-- Pale-red to yellow-brown cobble conglomerate with discontinuous lenses of coarse-grained sandstone. Thickness: 1,400 to 3,100 feet.

Kf — Frontier Formation (Upper Cretaceous)-- Light yellow-gray to gray, fine-grained sandstone and light- to dark-gray shale. Some interbedded conglomerate, claystone and coal. Unit is both marine and non-marine. Thickness: 7,000 to 9,000 feet.

Kk — Kelvin Formation (Lower Cretaceous)-- Yellow-gray to reddish-gray sandstone, siltstone, claystone, and conglomerate. Also contains light-gray limestone and siltstone. Thickness: About 1,700 feet.

Jp — Preuss Sandstone (Middle Jurassic)-- Reddish-brown, reddish-gray, and light-red silty sandstone, sandstone, and silty shale. Thickness: 400 to 1,000 feet.

Jt — Twin Creek Limestone (Middle Jurassic)-- Thin- to medium-bedded, gray to purplish-gray limestone with some interbedded brown siltstone and sandstone. Thickness: 1,400 to 2,800 feet.

Jn — Nugget Sandstone (Lower Jurassic)-- Pale grayish-orange, fine-grained sandstone and white, quartz sandstone. Thickness: 1,100 to 1,400 feet.

TRa — Ankareh Formation (Upper and Lower Triassic)-- Purplish-gray to reddish-brown siltstone, claystone and sandstone. Also contains white, coarse-grained to pebbly quartzite. Thickness: 1,300 to 1,700 feet.

TRt — Thaynes Formation (Lower Triassic)-- Light-gray, thin- to thick-bedded limestone with interbedded brownish-gray siltstone, sandstone, and shale. Thickness: 1,500 to 2,600 feet.

TRw — Woodside Shale (Lower Triassic)-- Grayish-red, grayish-purple, and reddish-brown shale, siltstone, fine-grained sandstone and thin, white limestone. Thickness: 400 to 800 feet.

TRd — Dinwoody Formation (Lower Triassic)-- Olive-gray limestone, siltstone and sandstone. Thickness: About 500 feet.

Pp — Park City Formation (Permian)-- Gray to pinkish-gray, fossiliferous, cherty limestone, calcareous siltstone, and sandstone; contains dark-gray, phosphatic mudstone in middle part. Thickness: 700 to 1,700 feet.

PPw — Weber Sandstone (Permian and Upper to Middle Pennsylvanian)-- Pale-yellow to light-gray, quartzitic and calcareous sandstone with minor interbedded light-to dark-gray limestone and dolomite. Thickness: 1,200 to 2,500 feet.

PPm — Morgan Formation (Middle Pennsylvanian)-- Grayish-red to reddish-brown sandstone and calcareous siltstone and light-gray limestone. Thickness: 0 to 1,000 feet.

PPr — Round Valley Limestone (Lower Pennsylvanian)-- Light- to dark-gray, fossiliferous, cherty limestone with interbedded gray, green and grayish-red shale and siltstone. Thickness: 300 to 1,000 feet.

Mdo — Doughnut Formation (Upper Mississippian)-- Medium- to dark-gray, thin- to thick bedded limestone and grayish-red to grayish-green siltstone. Thickness: 400 to 900 feet.

Mh — Humbug Formation (Upper Mississippian)-- Medium- to dark-gray limestone, dolomite and limestone breccia. Also contains light-gray to reddish-brown, fine-grained sandstone. Thickness: 400 to 900 feet.

Md — Deseret Limestone (Upper and Lower Mississippian)-- Interbedded dark-gray, thick-bedded dolomite and limestone and light-gray sandstone; contains zone of phosphatic shale and chert at base. Thickness: 250 to 900 feet.

Mg — Gardison Limestone/Lodgepole Limestone (Lower Mississippian)-- Medium- to dark-gray, thin- to thick-bedded, locally cherty, fossiliferous limestone. Thickness: 400 to 800 feet.

Dp — Pinyon Peak Limestone (Upper Devonian)-- Pale-gray to pale-tan, thin-bedded, nodular limestone with interbeds of gray shale. Thickness: 150 to 180 feet.

Ds — Stansbury Formation/Beirdneau Formation (Upper Devonian)-- Pale-gray to orange-gray quartzitic sandstone, grayish-yellow to reddish-brown siltstone, yellow-tan limestone and silty limestone, and reddish-brown siltstone conglomerate. Thickness: 0 to 450 feet.

Dh — Hyrum Dolomite (Upper Devonian)-- Medium- to dark-gray, massive-bedded dolomite with interbedded olive-gray siltstone. Thickness: 800 to 900 feet.

Cm — Maxfield Limestone (Middle Cambrian)-- Dark-gray to grayish-black, thin-bedded to massive, locally oolitic, limestone and dolomite with thin interbeds or laminae of yellow-gray to olive-gray calcareous siltstone. Thickness: 350 to 1,100 feet.

Co — Ophir Formation (Middle Cambrian)-- Yellow-brown sandstone and siltstone, blue-gray to light-gray limestone and olive-gray micaceous shale. Thickness: 200 to 650 feet.

Ct — Tintic Quartzite (Middle and Lower Cambrian)-- White to yellowish-gray and pale-reddish-brown, medium- to thick-bedded quartzite and conglomerate. Thickness: 800 to 2,000 feet.

XAf — Farmington Canyon Complex (Proterozoic and Archean(?))-- A complex assemblage of meta-sedimentary and meta-igneous schist and gneiss. Rocks have been subjected to several episodes of Precambrian metamorphism and deformation and a Cretaceous episode of retrograde metamorphism, hydrothermal alteration and deformation. Major rock types include: migmatitic gneiss; biotite-rich gneiss; mica-rich schist and gneiss; granitic gneiss; quartz-rich gneiss and quartzite; amphibolite; hornblende-plagioclase gneiss; and abundant muscovite-quartz-feldspar pegmatite.

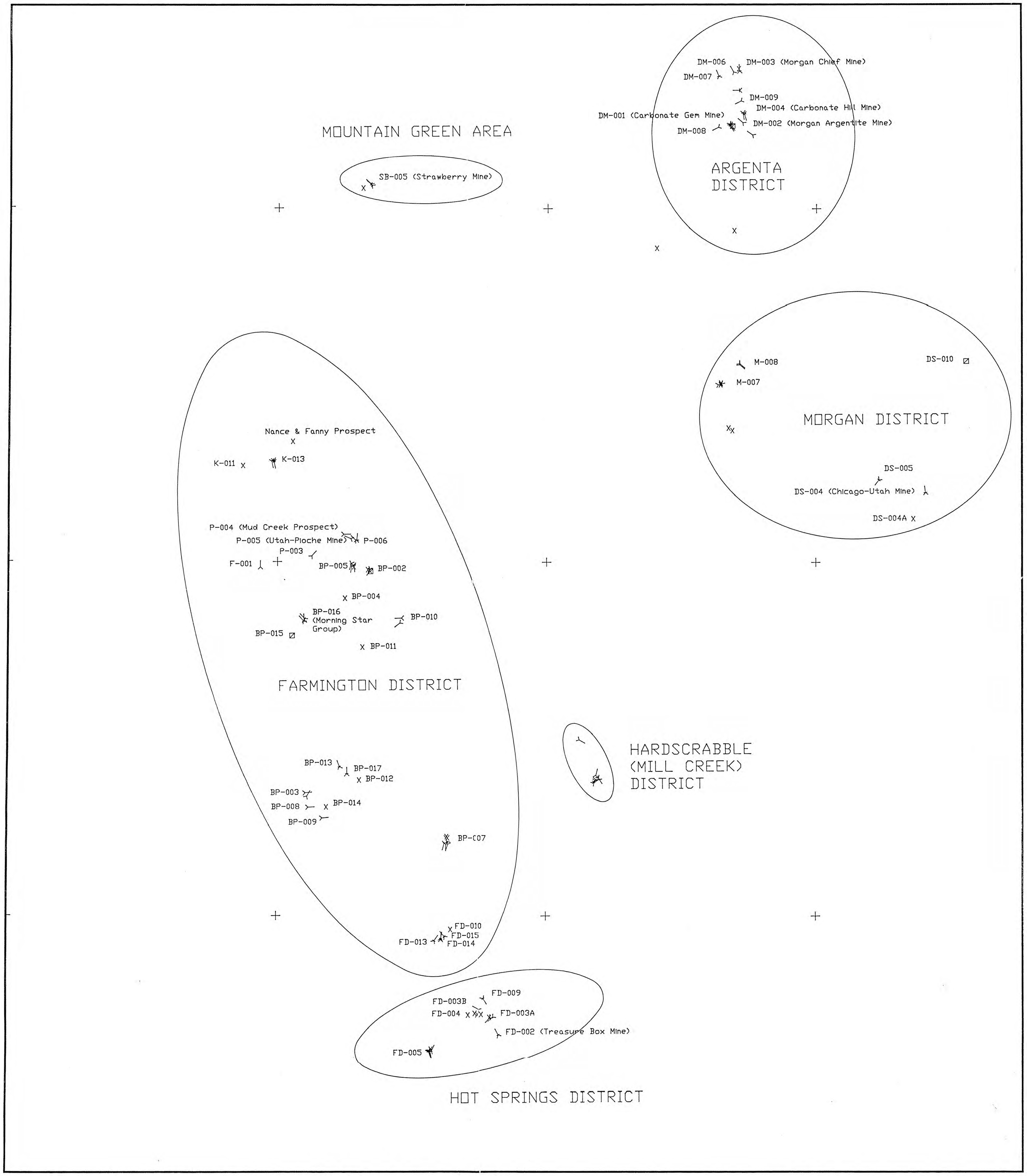
Contact

Fault-- dashed where approximate, dotted where covered; bar and ball on downthrown side

Thrust--sawteeth on upper plate

Same formation

Compiled 6-11-93 by M. Shubat
from: Bryant (1990), Davis (1983, 1985), Mullens and Laraway (1964, 1973), Mullens (1972), Hopkins (1982), and Coody (1957).



UTAH GEOLOGICAL SURVEY
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Plate 2
Mine and Prospect Location Map
and Mining Districts

By
Robert W. Gloyn and Michael Shubat

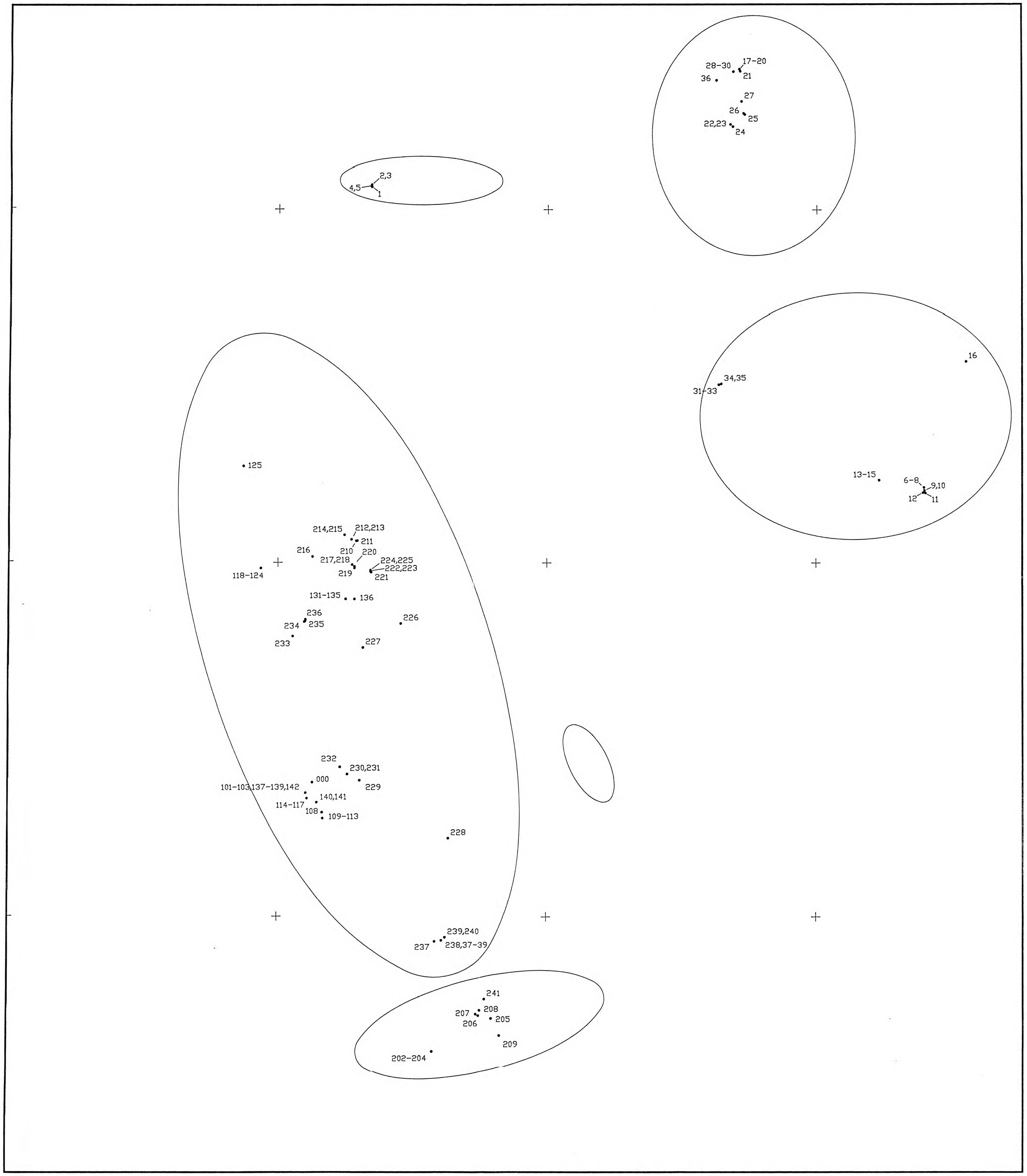
EXPLANATION

- Adit
- Caved adit
- Shaft
- Prospect pit
- BP-005 (Utah Pioche mine)-- Prospect designation and mine name

Scale 1:100,000

0 1 2 3 4 5 6 7 8 KM

0 1 2 3 4 5 MI



UTAH GEOLOGICAL SURVEY
OPEN-FILE REPORT

Plate 3
Sample Location Map

By
Robert W. Gloyn and Michael Shubat

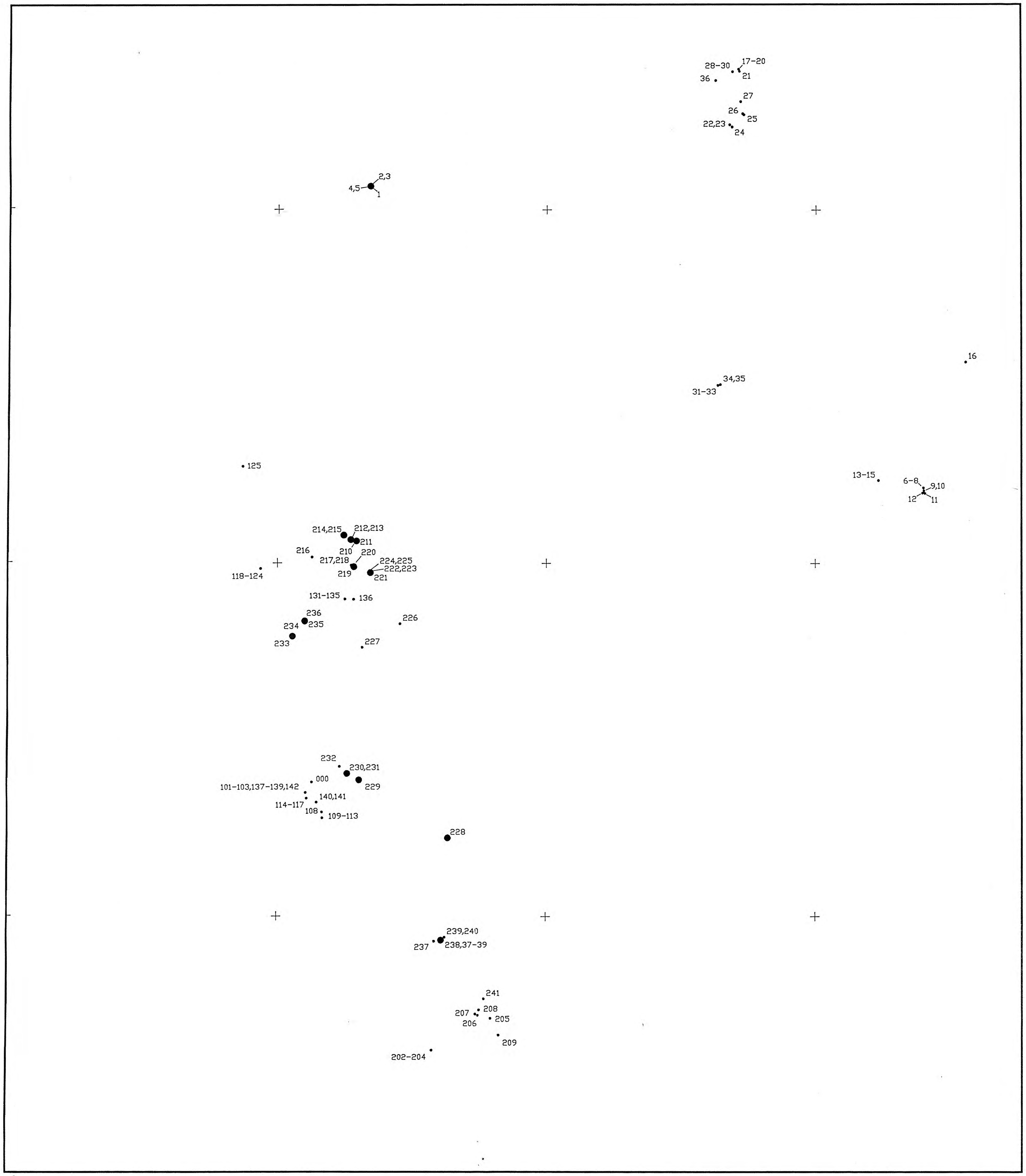
EXPLANATION

•241 Sample location and number

Scale 1:100,000

0 1 2 3 4 5 6 7 8 KM

0 1 2 3 4 5 MI



UTAH GEOLOGICAL SURVEY
OPEN-FILE REPORT

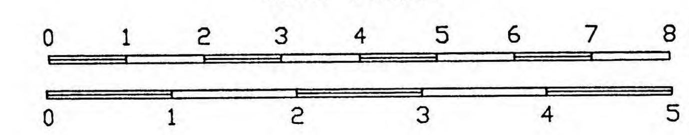
Plate 4
Gold Anomaly Map

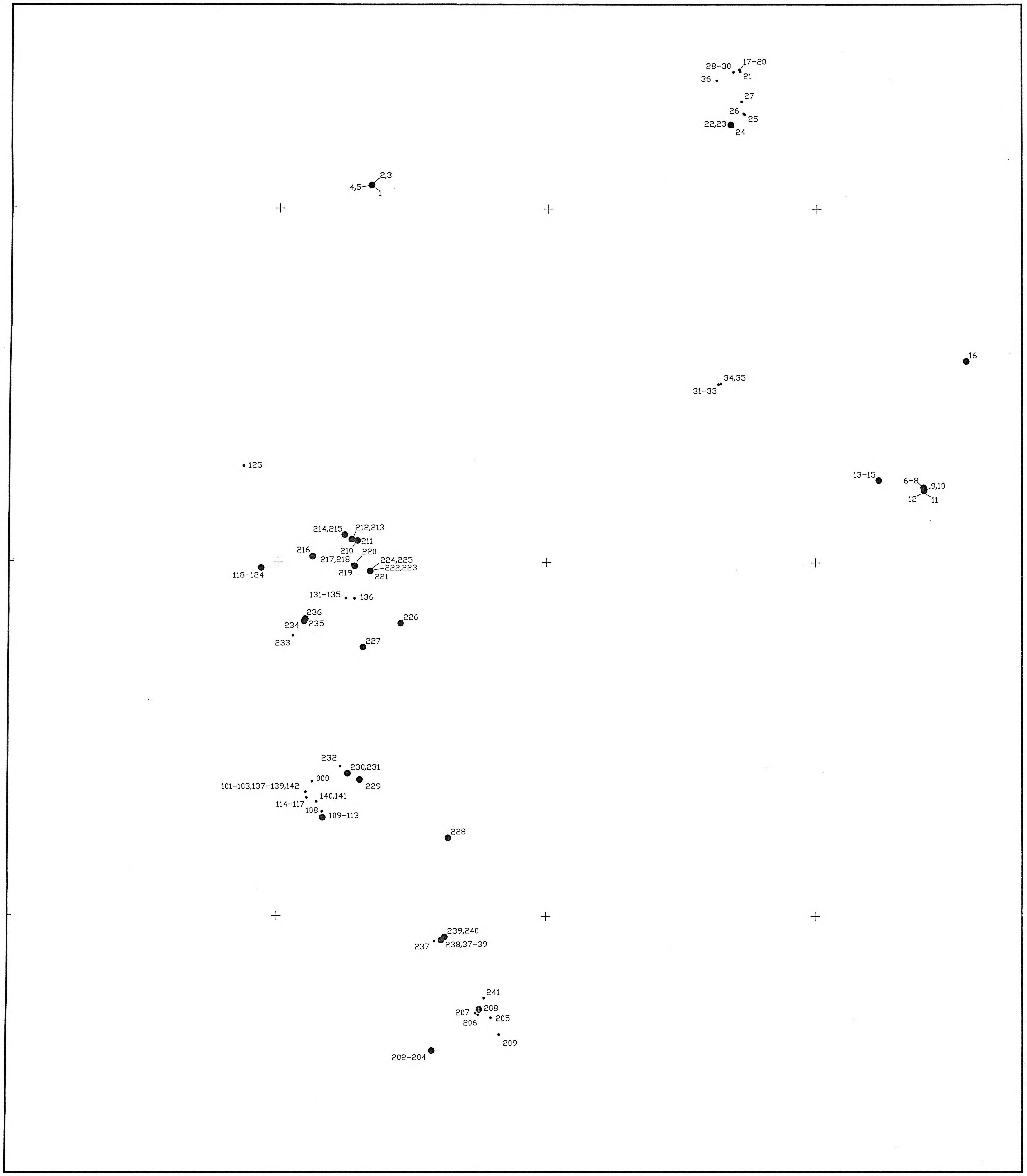
By
Michael Shubat

EXPLANATION

● 241 Location of sample with greater than 60 ppb gold

Scale 1:100,000





UTAH GEOLOGICAL SURVEY
OPEN-FILE REPORT

Plate 5
Copper Anomaly Map

By
Michael Shubat

EXPLANATION

● Location of sample with greater than 500 ppm copper

Scale 1:100,000

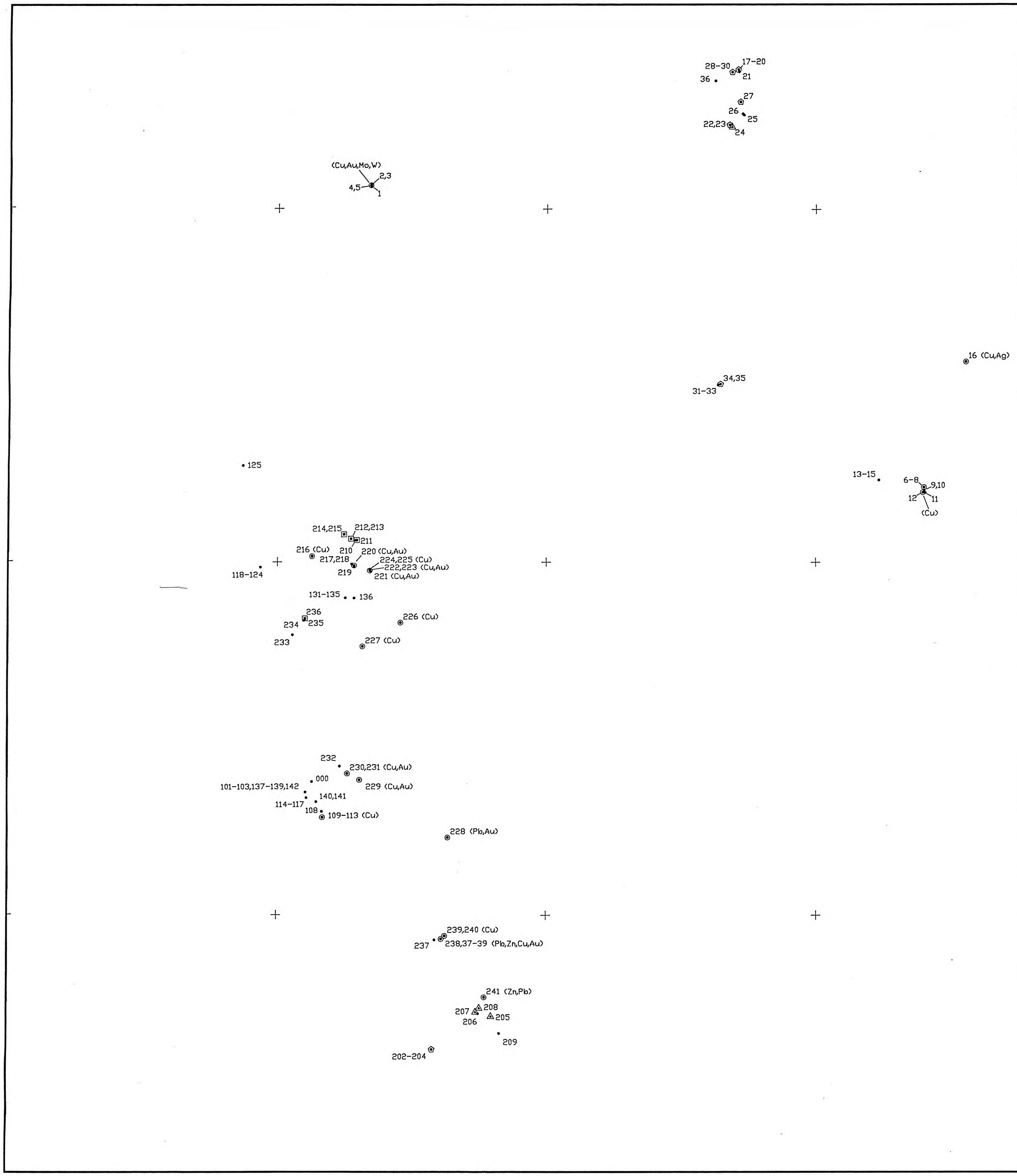
0 1 2 3 4 5 6 7 8 KM

0 1 2 3 4 5 MI

UTAH GEOLOGICAL SURVEY
OPEN-FILE REPORT

Plate 6
Geochemistry Summary Map

By
Michael Shubat



EXPLANATION

- .241 Sample location and number
- Factor 1 anomalies-- (greater than mean plus one standard deviation for factor 1 (Pb-Zn-Ag-Cd-Sb-As) (lead-zinc-silver replacement ore)
- Factor 2 anomalies-- greater than mean plus one standard deviation for factor 2 (Au-Cu-Mo-Bi) (gold-copper-quartz vein ore)
- Factor 4 anomalies-- greater than mean plus one standard deviation for factor 4 (As, Cd, Sb) (leached lead-zinc-silver replacement ore)
- Samples enriched in various elements as shown

Cu=Copper
Ag=Silver
Mo=Molybdenum
Pb=Lead
Zn=Zinc
W=Tungsten