Exploration geology of the Golden Arrow gold-silver district, Nye County, Nevada

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ABSTRACT

The Golden Arrow district is located along the northern margin of the Walker Lane and on the western rim of the Oligocene Kawich Mountains caldera.

Principal elements of the geologic framework include: (1) pre-caldera andesite, overlain by (2) rhyolite ash-flow tuff from the Kawich volcanic center. Both units are cut by (3) a caldera-margin fault with bonanza quartz-adularia-gold veins. Straddling the caldera-margin lies the tilted block of (4) Confidence Mountain rhyolite ignimbrite, interpreted as a collapse block along the caldera margin. Extending northwestward from Confidence Mountain is a structural depression with (5) volcaniclastic rhyolite-dominant moat sediment.

Epithermal volcanic-rock-hosted Au-Ag mineralization occurs in two distinct styles. Low-sulfidation epithermal quartz-adularia-gold veins fill open faults and fault-breccia. Disseminated hot-springs-style mineralization overprints earlier veins within pre-caldera andesite and rhyolite volcaniclastic sediment.

Two deposits—Gold Coin and Hidden Hill—have been defined by exploration drilling. Within these, gold mineralization is disseminated in breccia zones with intense clay-pyrite alteration surrounding vitrophyre dikes, and gold is concentrated in near-horizontal stratabound chalcedony layers within volcaniclastic sediment.

Modeling of gravity data reveals a prominent gravity high interpreted to be caused by a high-density intrusive body at depth. Upward apophyses coincide with latite dikes within the known deposit.

Key Words: Golden Arrow, epithermal, gold, silver, Kawich, rhyolite, adularia, volcanic, hot-springs

INTRODUCTION

The Golden Arrow district is located in south-central Nevada, approximately 60km east of Tonopah on the western flank of the Kawich Range and on the eastern margin of Stone Cabin Valley (Figure 1).

Gold was discovered at Golden Arrow in 1905, five years after the discovery of silver at Tonopah and two years after the discovery of gold at Goldfield. The district was intensely explored, but production was limited during the early years of the district. Small-scale mining operations continued to produce gold through the years of the Great Depression. Rising precious metals prices rekindled interest in the district in the 1980's. Over the past three decades, a sequence of companies has explored the district with modest success, defining a measured and indicated mineral resource of 296,000 ounces of gold and four million ounces of silver in two deposits.

Recent compilation and reinterpretation of historic exploration data, combined with additional geological mapping and drilling, have improved definition of the geometry and character of gold mineralization within the district and identified targets for future exploration. The modern exploration history, geology, and mineral resources of the district are well summarized in Ristorcelli and Christensen (2009).

HISTORY

Historic Exploration

Gold was discovered in the Golden Arrow mining district in June 1905. By 1917, gold vein deposits were being explored at

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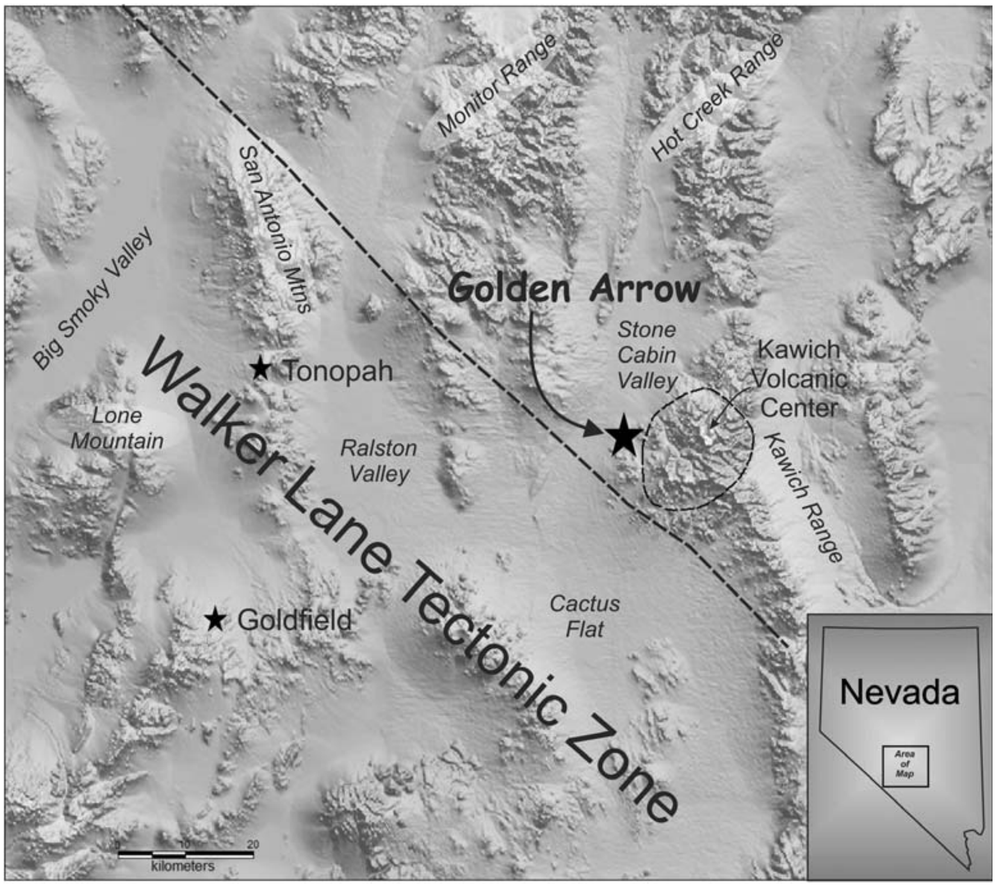

Figure 1. Location map of the Golden Arrow district, Nye County, Nevada.

the Golden Arrow, Gold Bar, and Desert shafts (Cornwall, 1972). Gold production continued until the 1930s from several shafts up to 150m deep, at which depth production was limited by water. Historic production was from quartz-adularia-gold veins and fault-controlled quartz-cemented tabular breccia bodies. Ore lenses and shoots averaged only about 1 meter thick (Breckon, 1949).

Total historic gold production from the district is not known. Most production was realized by individual miners or small informal companies, and most material was transported elsewhere for processing. Records of ore shipments to the McGill, Nevada, smelter had grades between 0.344 and 1.50 ounces gold per short ton. Ferguson (1917) reported very little production of gold and silver during the early years of the district. Kral (1951) estimated gold production of 600 ounces from about 900 tons of rock during the 1940s.

During the early 1980s, a small surface mine was opened, and cyanide leach pads were constructed by Einar Erickson and Associates in the southern part of the district. The mined material contained very little gold or silver; mineralized material present on the leach pads appears to have been moved from historic mine dumps elsewhere in the district. No gold production was realized.

Modern Exploration

The Golden Arrow district has been explored by a succession of companies since 1981. This work has included geological mapping, numerous geochemical and geophysical surveys, and drilling. The historical ownership and exploration work are summarized in a number of company reports, as reviewed in Ristorcelli and Christensen (2009) and briefly summarized in Table 1.

Although historic exploration and mining were focused mainly upon discrete high-grade quartz-adularia-gold veins, modern exploration has been directed primarily toward discovery of zones of stockwork veining and disseminated mineralization amenable to larger-tonnage surface mining. A stockwork of gold-bearing quartz veins crops to surface on the western flank of Confidence Mountain (Figure 2) and it is here that modern exploration first focused in the 1980’s.

Following are a few highlights of the past two decades of exploration. Work by Homestake Mining conducted in 1988 led to the drill-definition of the Gold Coin zone, one of two defined gold resource zones on the property. Western Gold Exploration and Mining Company further advanced understanding of the property, completing a comprehensive exploration program, in-

Table 1. SUMMARY OF MODERN EXPLORATION PROGRAMS, GOLDEN ARROW DISTRICT, NEVADA. DRILLING LENGTHS CITED ARE THOSE FOR WHICH SOME RECORD HAS BEEN RECOVERED.

Year	Company	Drilling, m	Significant Activities
1981–84	Golden American JV	?	Sampling, shallow drilling. Gold Coin Zone.
1984–85	Vector Exploration Inc.	?	Sampling, trenching, shallow drilling
1986–87	Clogau Gold Mines	?	Geologic mapping, trenching, shallow drilling
1988	Homestake Mining Co.	5054	Sampling, metallurgical tests, drilling, Gold Coin definition
1989–90	Westgold	12133	Mapping, sampling, IP, drilling, Hidden Hill discovery
1991–92	Independence Mining Co.	2071	Airborne geophysics, drilling
1993–94	Coeur Exploration	6145	IP/SP, structural analysis, drilling
1996	Kennecott Exploration Co.	1678	Geophysical interpretation, drilling
1997	Tombstone Exploration Co.	12238	Sampling, extensive drilling
2000–01	Bonanza Explorations Inc.	0	Mapping, sampling, resource modeling
2003	Nevada Sunrise LLC	0	Consolidated property
2003	Pacific Ridge Exploration Inc.	5804	Property-wide soil geochemistry, drilling
2008–09	Intor Resources Corp.	6238	Geologic mapping, soil geochemistry, drilling, resource model

cluding geophysical work that led to the discovery in 1990 of the second gold resource zone, completely hidden beneath more than 30 meters of alluvium and appropriately called Hidden Hill. Independence Mining continued exploration in 1992, completing an extensive ground and airborne geophysical program and drilling a few holes. Subsequently, Tombstone Exploration completed a very aggressive drilling program in 1997, but abruptly dropped the property before all of the analytical results were received. Nevada Sunrise LLC consolidated the property in 2002. Intor Resouces Corporation, the wholly-owned Nevada subsidiary of Nevada Sunrise Gold Corporation began exploration of the property in 2008.

GEOLOGY

Regional Geologic Setting

The Golden Arrow district is situated along the northern limit of the Walker Lane structural zone and at the western margin of the Kawich volcanic center (Figure 1). There is clear evidence that both of these regional-scale geological features influenced development of the geological setting for mineral deposits of the district.

The Walker Lane is a geologic province stretching in a northwest-southeast direction along the Nevada-California border (Stewart, 1980), measuring about 700 km long by 100–300 km wide. It is a zone of complex faulting and igneous intrusion resulting from the inboard deformation of the North American continent by collision with the Pacific tectonic plate. The faulting and igneous activities have controlled the formation of a large number of deposits of gold, silver and other metals in Nevada. Notable mineral districts within the Walker Lane include the Comstock Lode, Tonopah and Goldfield.

Golden Arrow is located along the western margin of the Kawich Range. The Kawich Range contains the remains of a late Oligocene (~22.6 Ma) volcanic caldera that was the source for the extensive ash-flow tuff sheets of the Pahranagat Formation that blankets a large area of south central Nevada (Best et al., 1995, Honn, 2003). The oldest rocks in the Kawich Range are Paleozoic shale, carbonate, and quartzite that are exposed in the northern end of the range. However, most of the range is underlain by Oligocene to Miocene ash-flow tuff sheets that unconformably overlie the Paleozoic sedimentary and metasedimentary rocks (Gardner et al., 2000). The center of the caldera is delimited by intracaldera tuffs, domes, and flows, surrounded by younger circular fracture zones and caldera-margin rhyolite intrusive bodies. Caldera margins are poorly preserved because of deep dissection along range-front faults and offset along a series of northwest-striking faults. On the west side of the Kawich caldera, at Golden Arrow, older andesitic caldera wall rocks are in contact with heterogeneous intracaldera tuff of the Pahranagat Formation. Two to three compound ash-flow cooling units are exposed outside the caldera margins as thick sheets, particularly on the west flank of the range.

Large volumes of hydrothermal alteration are common along caldera-bounding faults of the Kawich Range. Mining districts located along the margin of the Kawich volcanic center include Golden Arrow, Silverbow, Bellehelen, and Eden. Mineralization in these districts is frequently associated with rhyolite to andesite intrusive rocks.

District Geology

The geology of Golden Arrow is defined by a variety of extrusive and intrusive volcanic rock units associated with the Kawich volcanic center and by structures formed during the evolution of the caldera and later deformation within the Walker Lane structural corridor (Figure 2). Principal elements of the geologic framework of the district include: (1) a “basement” of pre-caldera andesite flows, volcanic breccia and pyroclastic rocks, which was overlain by (2) welded rhyolite ash-flow tuff erupted from the Kawich volcanic center. Both units are cut by (3) the 2.5-km-long northeast-striking Page Fault, a caldera-margin fault, which hosts bonanza quartz-adularia-gold veins. Situated at the northern interpreted extend of the Page fault is (4) Confidence Mountain, a coherent steeply-dipping

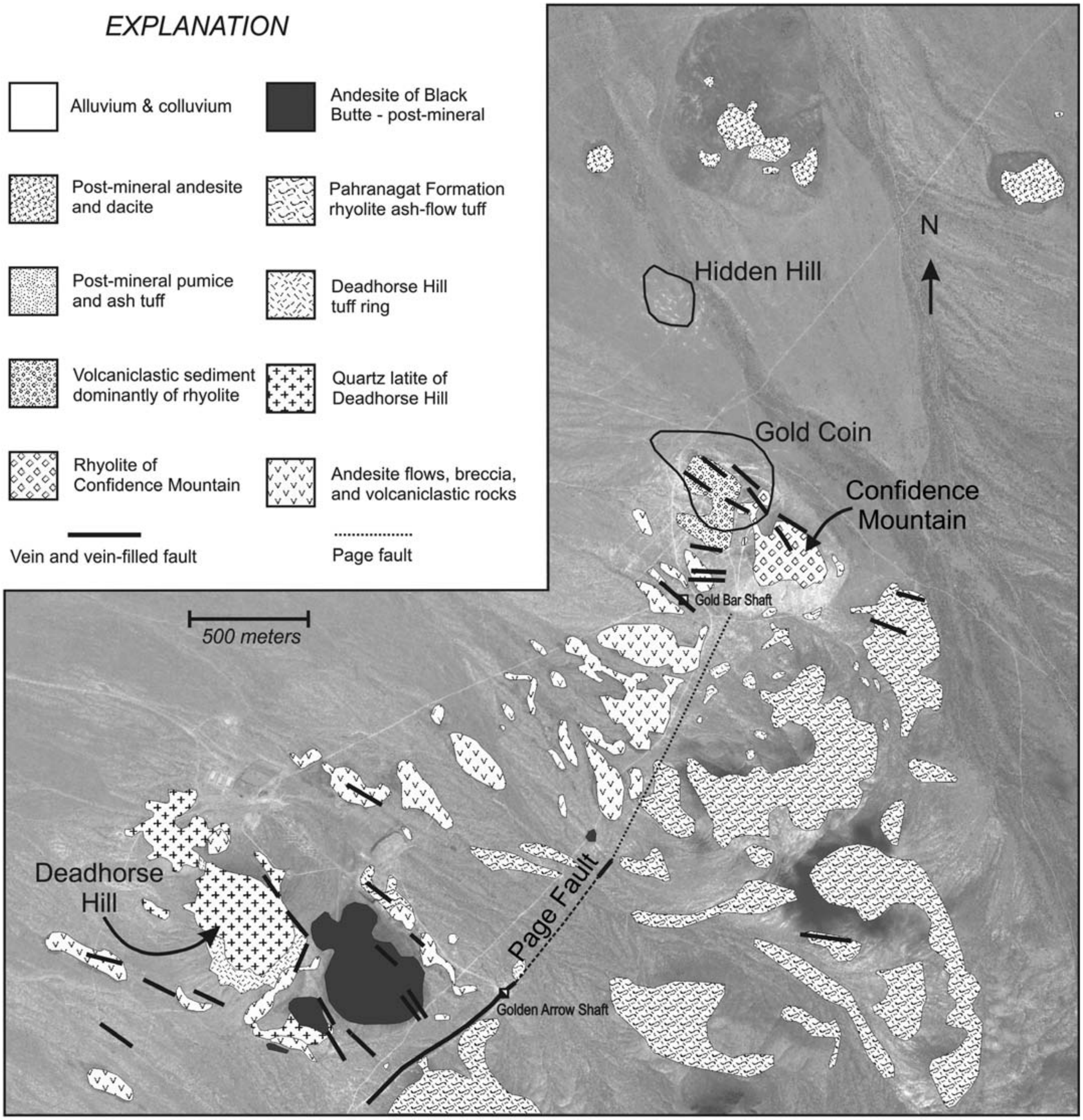

Figure 2. Generalized geological map of the Golden Arrow mineral district, Nevada. The locations of the Gold Coin and Hidden Hill resource deposits and prominent geographical features are indicated.

block of densely welded rhyolite ignimbrite, interpreted to be a collapse block along the caldera margin. Extending northwestward from Confidence Mountain is a volcanic depression filled with (5) rhyolite-dominant volcaniclastic sediment. The prominence known as (6) Deadhorse Hill is interpreted as a volcanic neck of coarse-grained quartz latite porphyry. Several younger post-mineral volcanic units and still younger alluvial deposits cover much of the district.

Lithologic Units

The following descriptions of rock units have been developed through surface mapping and logging of drill cuttings and core. The discussion proceeds generally from older to younger units.

Andesite. The oldest rocks exposed in the Golden Arrow district are andesite flows, volcanic breccia, pyroclastic rocks, and andesite-derived epiclastic sedimentary rocks. Andesite crops out to the southwest of Confidence Mountain and west of the Page fault. Andesite has been intersected in drilling at depth beneath both the Gold Coin and Hidden Hill gold deposits, underlying felsic volcaniclastic sediments and rhyolite ignimbrite. The andesite is inferred to rest upon Paleozoic sedimentary and metasedimentary rock units, as exposed elsewhere in the Kawich Range. Weak to moderate propylitic alteration of andesite is present throughout the district.

Confidence Mountain Rhyolite. The low hill known as Confidence Mountain is a coherent block of densely-welded rhyolite ignimbrite, which overlies andesite and both overlies and is overlain by volcaniclastic sediment. The rhyolite is a light-colored densely welded ignimbrite with distinctive glassy bipyramidal quartz and sanidine crystals in a glassy matrix. The Confidence Mountain ignimbrite block dips 50–60° to the northwest, in contrast to surrounding extrusive volcanic rocks, which are near-horizontal. The form of Confidence Mountain and character of the rhyolite are illustrated in Figure 3.

Volcaniclastic sedimentary rocks. Closely associated with the Confidence Mountain ignimbrite is a thick lens of volcaniclastic sedimentary rock. The volcaniclastic sedimentary rocks are dominantly of rhyolite parentage and vary from fine laminated mudstone to coarse angular sedimentary breccia. The presence of abundant bipyramidal quartz grains, locally constituting more than half of the rock volume, is distinctive. The unit is locally well-bedded, and sedimentary features such as graded bedding, cross-bedding, and soft-sediment deformation are common. The unit is locally densely cemented by chalcedony (Figure 4).

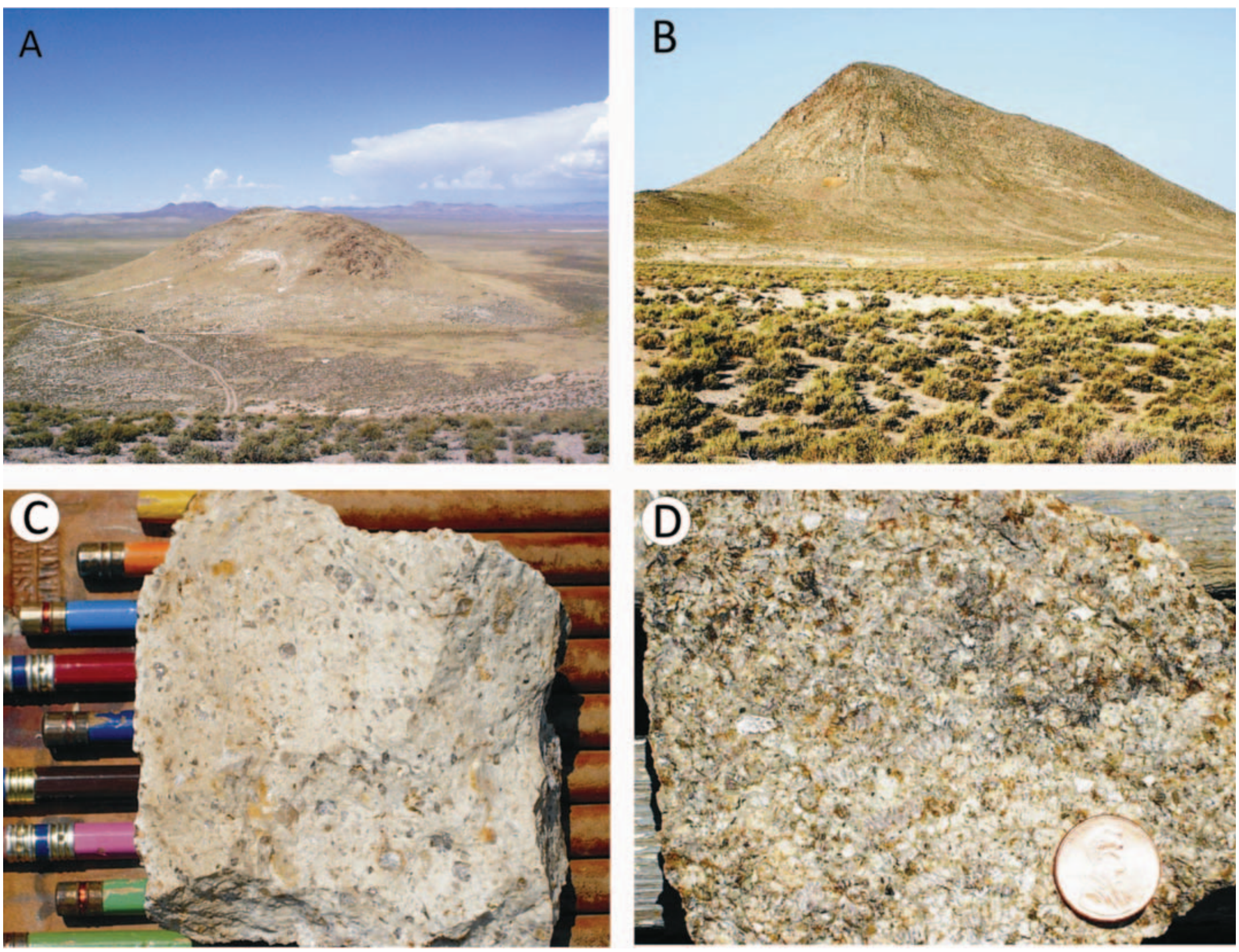

Figure 3. A) View of Confidence Mountain to the northwest. B) View of the Deadhorse Hill volcanic neck. C) Flow-banded rhyolite ignimbrite of Confidence Mountain. D) Quartz-latite porphyry of Deadhorse Hill.

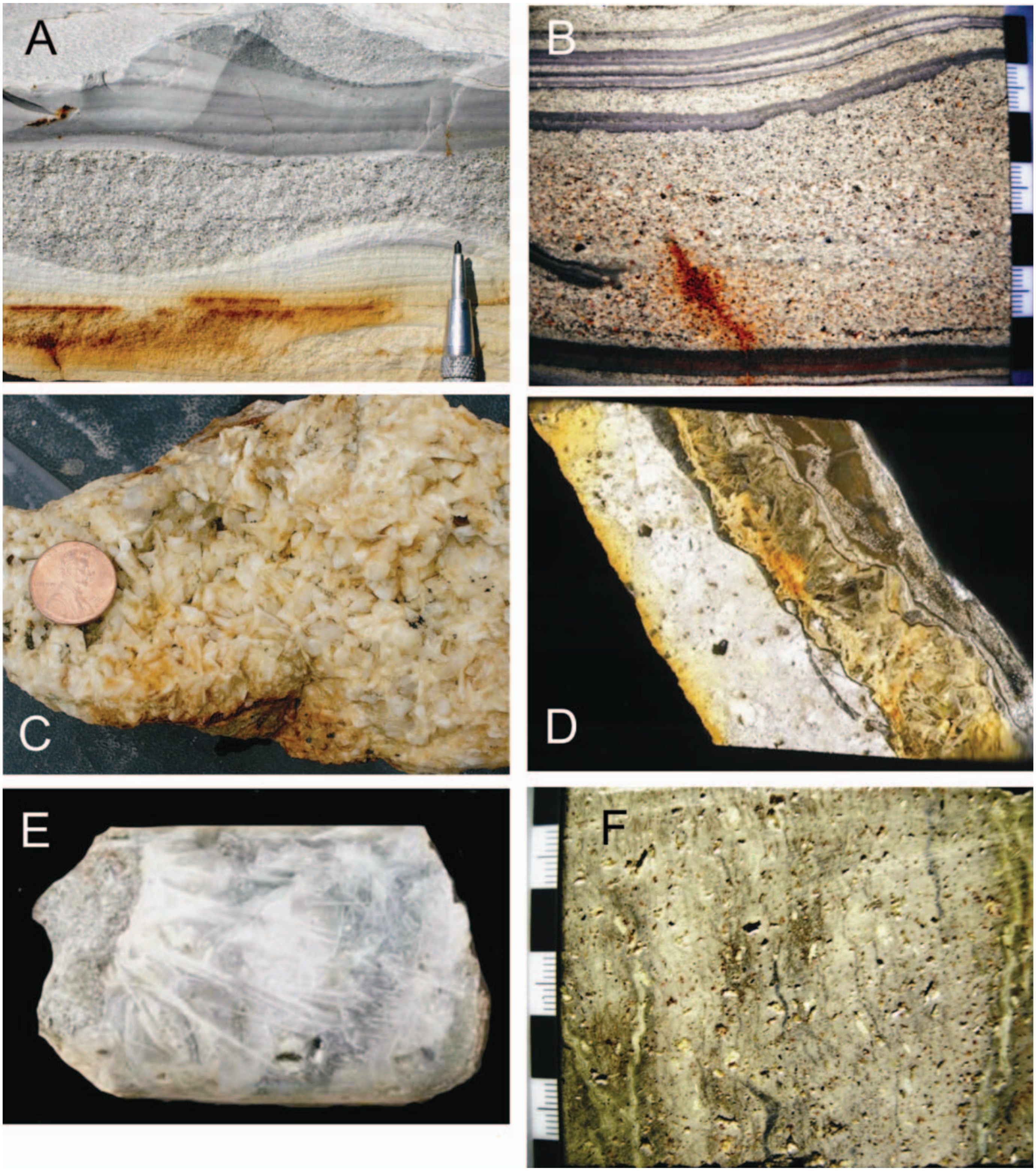

Figure 4. A) Volcaniclastic sediment from the Gold Coin deposit. Darker color through the center of the sample is due to chalcedony flooding. B) Coarse and fine-grained volcaniclastic sediment exhibiting syn-depositional brecciation. C) Adularia from epithermal vein within Page fault zone. D-E) Textures in epithermal quartz-adularia veins from the Golden Arrow district. F) Flow-banded latite vitrophyre dike from drill core in the Hidden Hill deposit.

The volcaniclastic sedimentary unit both underlies and laps over the ignimbrite of Confidence Mountain. Lithic clasts in the volcaniclastic sedimentary breccia are of Confidence Mountain rhyolite ignimbrite. From drilling, the unit is known to fill a basin or trough at least 250 meters deep extending northwestward from Confidence Mountain. The basin is mostly underlain by andesite.

The volcaniclastic sedimentary unit is interpreted to be maar or moat sediment, deposited within a water-filled volcanic depression, with sediment derived from the immediately adjacent Confidence Mountain ignimbrite block or similar units. The abundant, frequently stratabound, chalcedonic cement is evidence for silica-charged hot-spring activity within the caldera-margin setting. In addition, the unit is cut by phreatic breccia, evidence for a dynamic environment of deposition.

Latite dikes. A number of latite vitrophyre dikes or small intrusive bodies have been defined by drilling, although the unit is not known at the surface. This is a light-colored igneous rock with phenocrysts of biotite and lesser K-feldspar in a flow-banded glassy or slightly devitrified matrix (Figure 4). "Latite" has been a field term to distinguish this unit from the quartz-crystal-rich rhyolite ignimbrite of Confidence Mountain, although the "latite" is of rhyolite chemical composition. The unit intrudes both andesite and the volcaniclastic sedimentary unit. Peperite breccia, commonly pyrite-rich, is common at the intrusive contacts of latite into volcaniclastic sediments, suggesting that the latite vitrophyre intruded wet barely-consolidated volcaniclastic sediment.

Deadhorse alaskite. Deadhorse Hill is comprised of a coarse-grained leucocratic igneous rock with coarse phenocrysts of K-feldspar, plagioclase and quartz. The unit cores the prominent Deadhorse Hill and forms several radiating dikes. Deadhorse Hill is partly surrounded by a tuff ring and is interpreted to be a volcanic neck (Figure 3).

Rhyolite ash-flow tuff. The higher hills to the east of the Page fault are underlain by variably welded rhyolite ash-flow tuff. The Pahranagat Formation is a large-volume crystal-vitric-lithic rhyolite welded tuff sourced in the Kawich volcanic center. The welded tuff, or ignimbrite, contains crystals of sanidine, quartz, plagioclase and minor biotite and hornblende; clasts of rhyolite as well as of basement andesite and Paleozoic sedimentary rocks; and deformed clasts of pumice. The unit is moderately to densely welded. The Pahranagat Formation has been dated as 22.65 Ma ± 9000 years (Best et al., 1996).

Dacite. The small hills to the north and northeast of Confidence Mountain are capped by dark-colored, dense, unaltered dacite to andesite flows. These flows are underlain by a highly variable thickness of unwelded pumice-lithic-crystal tuff. The dacite flow units are strongly magnetic; an extreme low observed in the aeromagnetic survey over the unit suggests that at least some of the flows have reverse remnant magnetism. The unit is nowhere hydrothermally altered, even where overlying the altered and mineralized volcaniclastic sedimentary unit, and is thus interpreted to be post-mineral.

Alluvium and latest Tertiary basalt cover. Much of the property is covered by unconsolidated alluvium, colluvium and eolian material. This material consists of clay to boulder-sized clasts of all volcanic lithologies within the nearby Kawich Range. In the broad flat area between Confidence Mountain and Deadhorse Hill, the alluvial cover is quite thin, as evidenced by windows of outcrop within the shallow arroyos. The Hidden Hill zone is covered by about 35m of alluvium. The alluvium gradually thickens westward toward the center of Stone Cabin Valley but only rarely exceeds 75 meters in thickness in those parts of the Golden Arrow property that have been drilled. Post-mineral basalt locally overlies the older Tertiary rocks.

Structural Framework

The regional structural framework for the Golden Arrow property is defined by the generally north-trending normal fractures associated with the western margin of the Kawich caldera and generally northwest-trending faults of the Walker Lane.

The most prominent structural feature in the surface geology is the Page fault, extending in an arc northeastward across the property and apparently terminating at Confidence Mountain (Figure 2). Numerous historic shafts and declines explored and exploited veins filling the Page fault structure. Most of the early historic gold production from the Golden Arrow district was realized from these veins. The fault frequently places older andesite to the west against younger rhyolite ash-flow tuffs to the east. Kinematic indicators suggest that this is a tensional normal fault, down to the east, possibly related to collapse of the Kawich caldera.

In the area of Confidence Mountain are a swarm of northwest-striking vein-filled faults, from which gold production was realized during the early years of the district. These are apparently post-caldera faults, parallel to the trend of the Walker Lane and radial to the caldera margin.

Layering in the rhyolite ignimbrite of Confidence Mountain strikes northwestward and dips 50–60° northeastward, in contrast to the near-horizontal orientation of surrounding volcanic rocks. The Confidence Mountain block overlies caldera-margin andesite and appears to have been surrounded by volcaniclastic sediment. Megabreccia with block dimensions as great as 1000 meters is observed at other localities along caldera margin faults within the Kawich Range. Confidence Mountain is now interpreted to be a megabreccia block slumped from the caldera margin into moat volcaniclastic sediments.

The volcanic depression filled with rhyolitic volcaniclastic sediments extends in a northwest direction from Confidence Mountain, parallel to the Walker Lane.

Alteration

Lithologies within the Golden Arrow district exhibit a variety of alteration styles. The pre-caldera basement andesite was everywhere affected by regional propylitic alteration including the minerals epidote ± chlorite ± albite ± calcite.

The volcaniclastic sedimentary rocks exhibit variable to extreme alteration, as might be expected from deposition and alteration in an active caldera-margin hydrothermal setting. Intense chalcedonic silicification of hot-springs character is particularly striking in outcrops on the western flank of Confidence Mountain. In drill holes, silicification is locally so intense as to create a rock described in logging as porcellanite—a dense, extremely hard aggregate of fine crystalline quartz. Yet elsewhere this same volcaniclastic unit is altered to a bleached white residue of clay-quartz or clay-quartz-pyrite. The alteration mineral suites observed within the volcaniclastic sedimentary unit are typical of hot-springs hydrothermal systems, with varied alteration mineral assemblages formed above and below a fluctuating boiling water table. Gold mineralization within volcaniclastic sedimentary rock in the Hidden Hill zone is frequently associated with intense clay-pyrite alteration.

Gold-quartz veins along the Page fault and surrounding Deadhorse Hill are characterized by crystalline quartz and adularia with very restricted alteration selvages of silicification and sericite.

The later post-mineralization lithologies—the dacite flows and tuffs—are mainly fresh and unaltered. The Pahranagat Formation rhyolite ash-flow tuff and the quartz latite of Deadhorse Hill similarly exhibit little alteration. The question remains whether these units were post-mineralization or simply are not altered as currently exposed.

Supergene oxidation may extend to more than 200m depth along fault and fracture zones, but more generally extends to depths of 30–60m into bedrock in the Hidden Hill and Gold Coin mineral zones.

Geological Summary

Acknowledging that there is great complexity in the details, the geology of the Golden Arrow property can be summarized as follows. Basement rocks in the district include metamorphic rocks—quartzite, slate, phyllite and marble—of Paleozoic age; these do not crop out anywhere in the district. Paleozoic basement metamorphic rocks are overlain by a thick and heterogeneous sequence of Tertiary volcanic rocks associated with the evolving Kawich Range volcanic center. The earliest pre-caldera volcanic basement consists of andesite flows, volcanic breccia, and andesite epiclastic sedimentary rocks. The andesite basement is overlain by great thicknesses of rhyolite (lithic-crystal-pumice) welded ash-flow tuff or ignimbrite representing the main stage of volcanic activity—eruption and caldera collapse of the Kawich Range volcanic center. Intrusion and extrusion of rhyolite along the caldera-margin fault zones closely followed eruption of the voluminous ash-flow sheets; at Golden Arrow, these are represented by the Deadhorse Hill volcanic neck and latite dikes encountered at depth in the Gold Coin and Hidden Hill deposits. A caldera-margin structural depression filled largely with volcaniclastic detritus. The ignimbrite block of Confidence Mountain is interpreted to be a megabreccia block, slumped from the caldera wall into the water- and sediment-filled caldera-margin mote. Hydrothermal alteration and mineralization were intimately involved with this episode of structural collapse and felsic magmatism. Later stages of waning volcanic activity were characterized by eruption of post-mineral dacite to andesite tuffs and volcanic flows.

Gold Deposits

Currently known gold mineralization at Golden Arrow occurs primarily in three areas. Historic production was realized from veins developed within the Page fault and a number of northwest-striking faults immediately adjacent to Confidence Mountain. The Gold Coin resource zone crops out on the northwest flank of Confidence Mountain. The Hidden Hill resource zone, entirely covered by Quaternary alluvium, is situated about 550m north of the Gold Coin zone (Figure 2).

Known gold mineralization at Golden Arrow presents two very distinct styles of occurrence and associated mineral alteration suites. These two styles of mineralization are interpreted to have formed sequentially within an evolving hydrothermal system.

The quartz-adularia-gold veins exploited by the historic underground workings at Golden Arrow are hosted in both rhyolite and andesite lithologies. The veins fill brittle open fracture and fault zones. Narrow zones of quartz ± adularia ± sericite ± carbonate alteration surround quartz ± adulariaca ± lcite ± barite veins. The veins exhibit rhythmic banded textures, comb textures, and evidence of repeated brecciation and vein filling. Platy quartz psuedomorphs after calcite are common (Figure 4). Gold is confined to the veins and their immediate wallrock alteration selvages. Ore grades of several ounces of gold per ton from hand-selected ore were reported from historic mining operations.

The veins vary considerably in thickness both along strike and dip; thicker veins and greater gold values were reported to occur in tabular raking ore shoots. The textures and mineralogy of these veins are typical of low-sulfidation vein systems. How the veins vary in character with depth is not known.

In contrast to the restricted, relatively high-grade, quartz-adularia-gold veins, gold-silver mineralization in the Hidden Hill and Gold Coin deposits is more broadly disseminated, of lower grade, and exhibits distinctly different alteration and mineralization styles. Precious metal enrichments occur in andesite, volcaniclastic sediments, and the rhyolite ignimbrite.

- In Hidden Hill, gold mineralization is disseminated in peperite breccia zones with intense clay-pyrite alteration surrounding dikes of latite vitrophyre.
- In Hidden Hill, gold is also concentrated in nearly horizontal “hot-springs style” laminated-chalcedony flooding of the volcaniclastic sediment, especially along the lower contact of the volcaniclastic sediment with underlying andesite. Stratabound disseminated gold mineralization occurs within

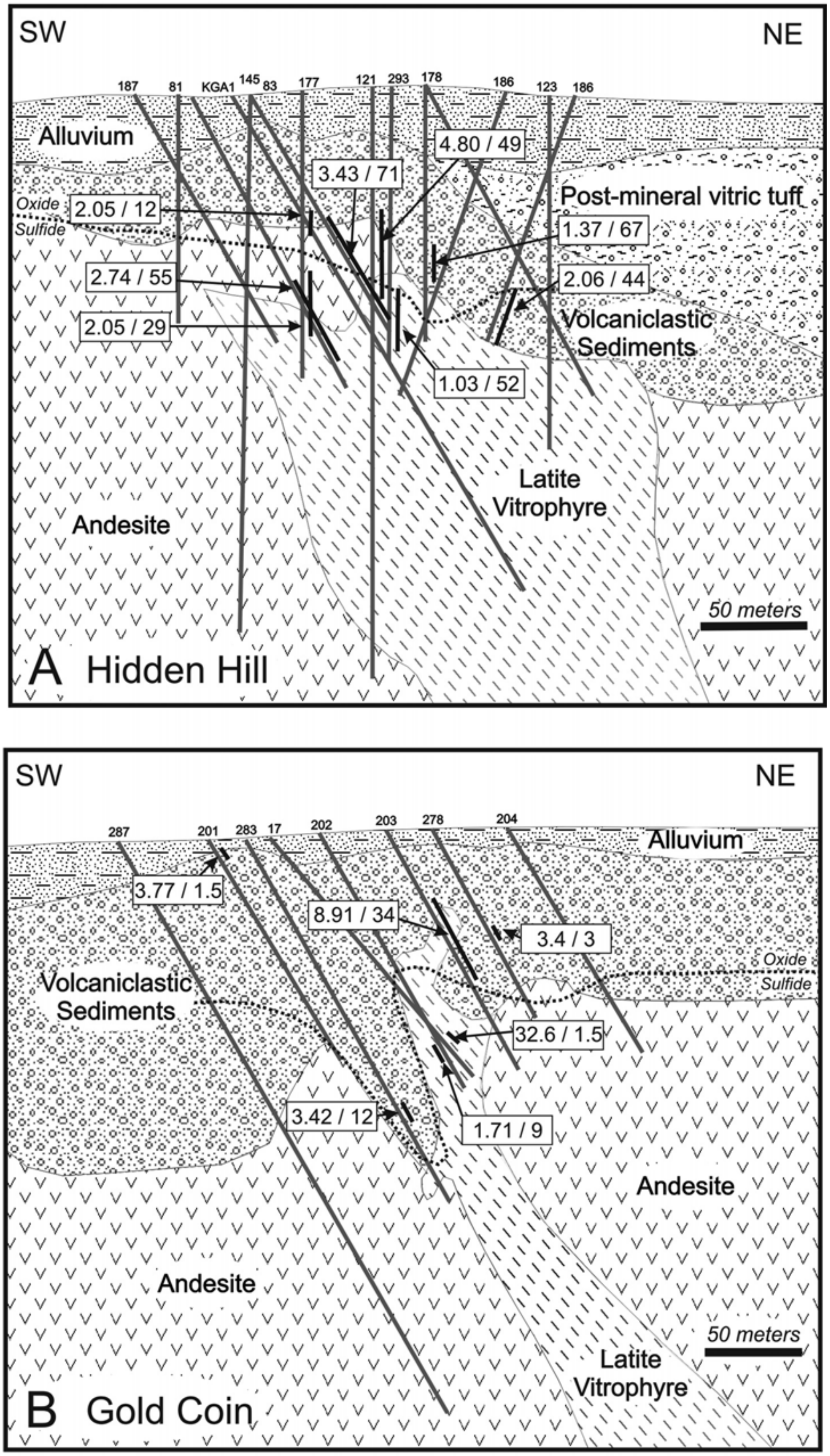

Figure 5. Representative geological cross-sections through the Hidden Hill and Gold Coin deposits, showing drill-hole gold intercepts. Intercepts are reported as grams/tonne gold / meter intercepts. Dotted line marks break between oxidized and sulfide-bearing material.

volcaniclastic sedimentary rocks capped by the overlying rhyolite ignimbrite in the Gold Coin zone.

- In Gold Coin, subhorizontal zones of gold enrichment occur with chalcedony-filling brittle fractures within the rhyolite ignimbrite.
- Higher-grade gold mineralization at depth within both the Hidden Hill and Gold Coin deposits is restricted to northwest-striking, southwest-dipping veins. The depth extent of these veins has not been determined.

There is evidence in drill core that the high-sulfidation hot-springs style alteration and mineralization overprint earlier low-sulfidation gold mineralization. These styles of mineralization are illustrated in representative geologic cross sections through the Hidden Hill and Gold Coin deposits (Figure 5).

In the Hidden Hill zone, there is a distinct spatial association and an inferred genetic association between the latite vitrophyre dikes, alteration and gold mineralization. The margins of the latite dikes are commonly peperite breccia, indicating intrusion into wet sediments. These breccias are typically intensely altered and are commonly gold-mineralized. Pipes of hydrothermal breccia or tuffisite within both the Hidden Hill and Gold Coin zones are evidence of a very dynamic environment of formation closely associated with igneous activity.

The Golden Arrow deposit is best described as consisting of low-sulfidation epithermal quartz-adularia-gold veins overprinted by hot-springs style, high-sulfidation epithermal alteration and precious metal mineralization.

The geological framework for gold mineralization within the Golden Arrow district is presented schematically within Figure 6. Although the illustration is a schematic cartoon, the relationships illustrated are constrained by surface mapping and drilling.

EXPLORATION EVIDENCE

The geological framework and character of gold mineralization within the Golden Arrow district have been defined and constrained by geological mapping and extensive exploration drilling. This work, combined with geochemical and geophysi-

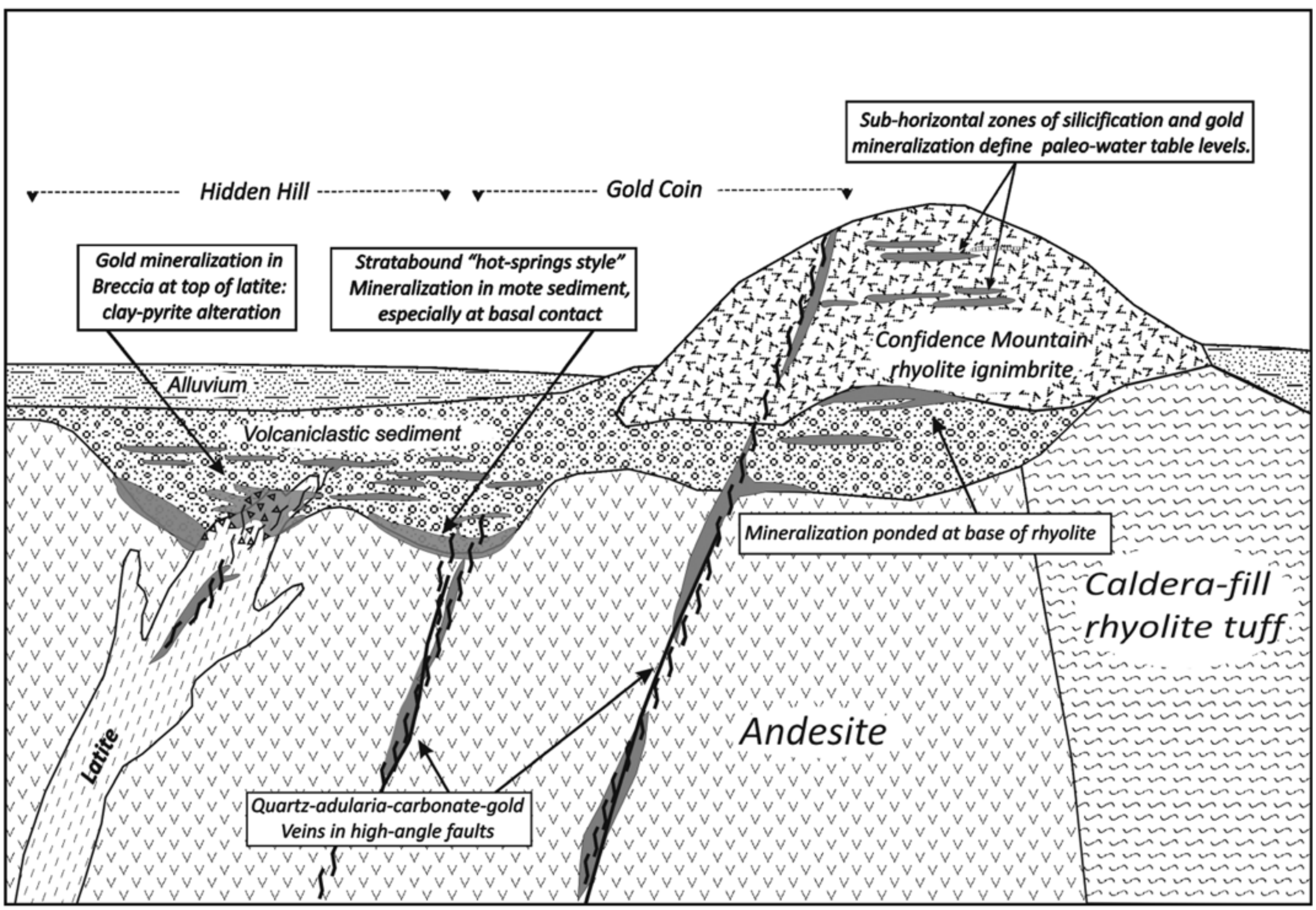

Figure 6. Schematic geological cross-section illustrating the varied styles of precious metal mineralization within the Hidden Hill and Gold Coin deposits, Golden Arrow district, Nevada. Although the illustration is schematic, the geometric and geological relationships illustrated are well constrained by field mapping and drilling.

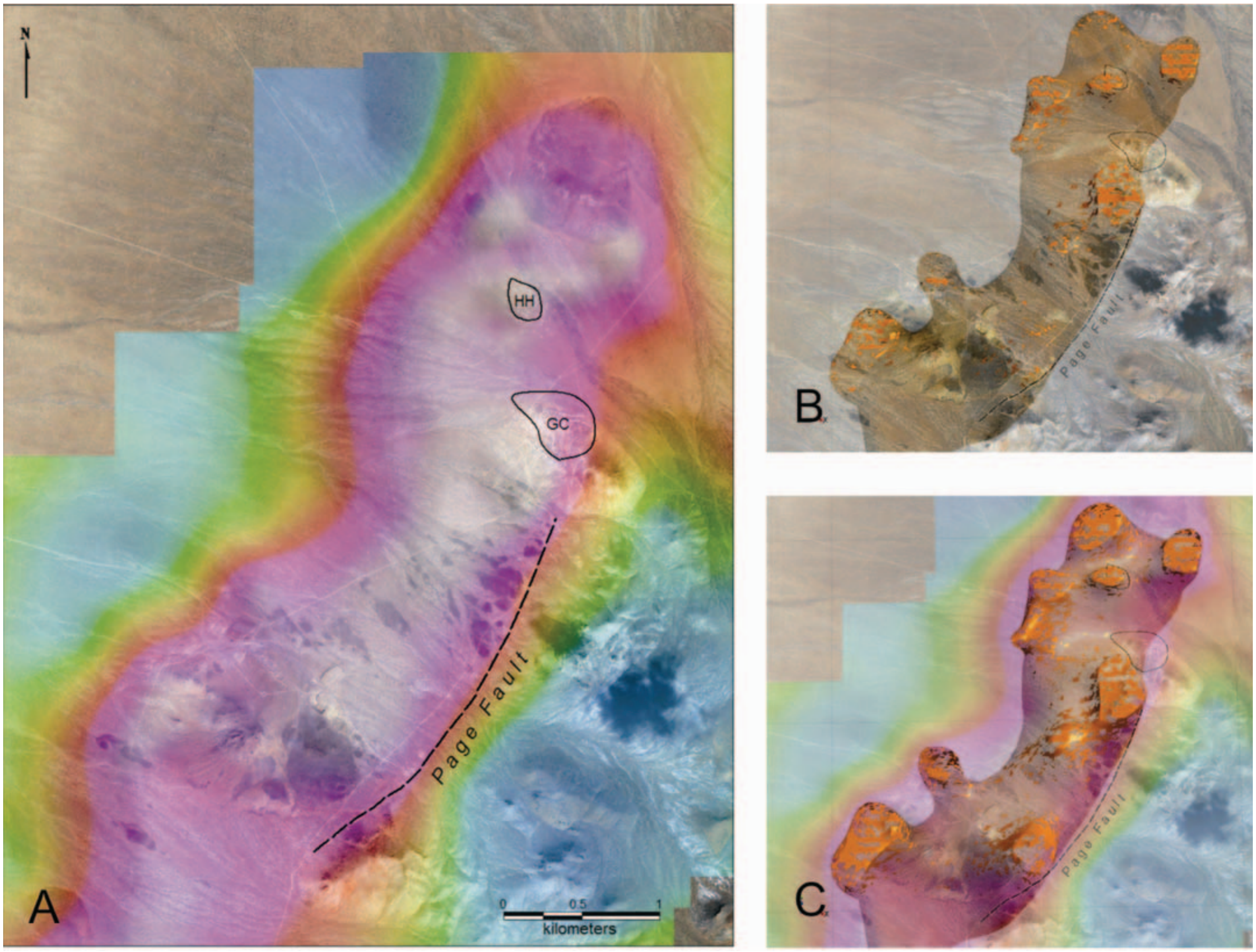

Figure 7. A) Color-contour map of complete Bouguer gravity anomaly over the Golden Arrow district. Warmer red colors indicate higher gravity values. The locations of the Hidden Hill and Gold Coin deposits are indicated. B) Modeled gravity data for the district, showing modeled high-density mass at depth. C) Combined map showing modeled high-density body at depth beneath surface gravity response.

cal investigations, provide guidance for continuing exploration for new centers of mineralization.

Geophysical Exploration Programs

Geophysical exploration surveys have been completed as a component of several of the Golden Arrow exploration programs. This work has included airborne and ground magnetic surveys, gravity surveys, induced polarization surveys, and airborne electromagnetic surveys, as reviewed in Ristorcelli and Christensen (2009).

Of the various geophysical surveys, gravity surveys appear to provide the most informative exploration guidance. Gravity measurements at the surface detect differences in the mass of the underlying material and are particularly useful for mapping the distribution of units of different density at depth. Figure 7 presents a complete Bouguer gravity image of the Golden Arrow property. The gravity data were collected by Kennecott Exploration in 1996 and were reprocessed by Wave Geophysics for Intor Resources Corporation in 2007. The residual gravity data were computed by applying a 5km wavelength, high-pass filter to the complete Bouguer anomaly data. The image is dominated by a distinct northeast-oriented elliptical gravity anomaly measuring approximately 5 km by 2 km. The arcuate eastern margin of this gravity high is coincident with the Page fault. Three-dimensional modeling of the gravity data indicates the anomaly to be caused by a large tuber-shaped mass of higher density material. This is interpreted to be a buried intrusive body with several apophyses extending upward in the vicinity of Deadhorse Hill, Confidence Mountain, Hidden Hill, Gold Coin and several other locations (Figure 7).

The spatial coincidence of the upward apophyses in the gravity model with the rhyolite and latite vitrophyre dikes and gold mineralization suggests that the cause of the gravity anomaly may be a buried felsic intrusive body, that the felsic dikes and domes were sourced from this body, and that gold mineralization is associated with these modeled upward extensions.

Geochemical Exploration Programs

Nearly all of the historical exploration programs have included collection and analysis of rock-chip and soil geochemical samples, and fortunately records for most of these programs are accessible, as reviewed in Ristorcelli and Christensen (2009).

While nearly every geologist who has visited the Golden Arrow project has collected select rock samples, systematic grid rock-chip sampling has not been completed over the district. Collection of select rock samples has, not surprisingly, been concentrated along the Page fault, near historic workings, and over the outcropping Gold Coin deposit. Samples containing the highest concentrations of gold and pathfinder elements have been collected along the outcropping Page fault. There have also been a number of geochemically anomalous rock samples collected to the east of the Page fault from a swarm of quartz-adularia veinlets in rhyolite ash-flow tuff, an area that has received less exploration attention and no drilling (Figure 8).

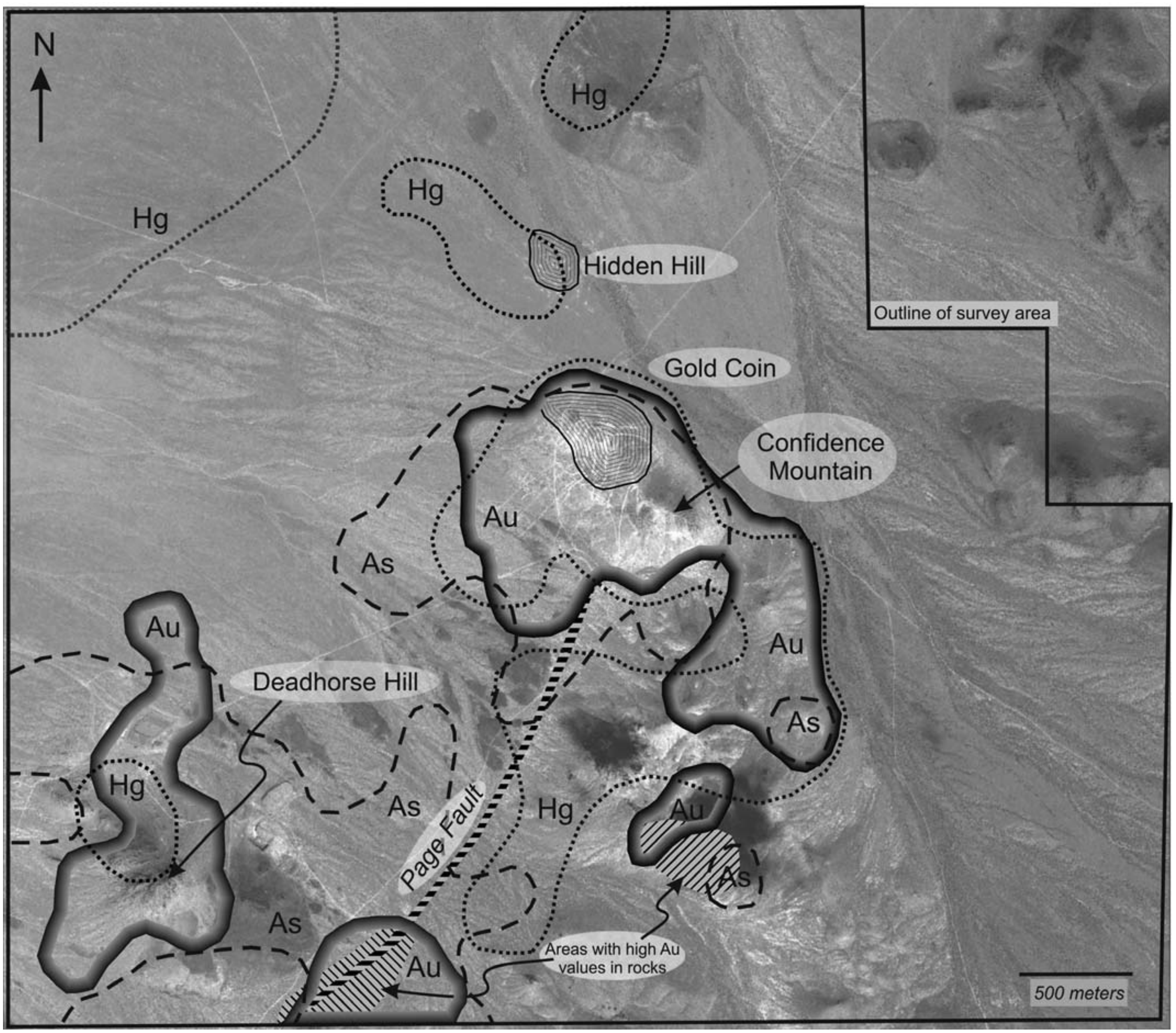

Figure 8. Interpretive map of the Golden Arrow district showing areas of anomalous concentrations of gold (Au), arsenic (As) and mercury (Hg) in soil geochemical samples. Outlined anomalous areas represent generally the upper quintile of samples. The locations of the Hidden Hill and Gold Coin gold-silver deposits are shown as well as the prominent geographic features Confidence Mountain and Deadhorse Hill.

Three systematic soil geochemical surveys have been completed on the property as summarized in Ristorcelli and Christensen (2009).

Factor analysis of available soil geochemistry defines three distinct soil geochemical associations (1670 samples):

(1) A factor comprised of the elements **Zn, Cu, Fe, Ni, K, Mg, Co, Cr, Bi and Sn**. distinguishes the dominant primary lithologies of andesite and basalt from rhyolite and rhyolite volcaniclastic rocks.
(2) A factor comprised of the elements **Au, Ag, As, Sb, Hg, Mo, and Pb** is characteristic of epithermal mineral systems known to exist in the district.
(3) A factor comprised of the elements **Ca, Mg, and Sr** factor characterizes the association of elements enriched in the caliche of desert soil.

Some of the general features revealed in the soil geochemistry are presented on Figure 8. Gold is most highly enriched over the extent of the rhyolite ignimbrite block of Confidence Mountain, extending southward over an area with historic mine workings, and also extending to the southeast, over an area of rhyolite ash-flow-tuff that has received little exploration attention. Gold is also concentrated over the south end of the Page fault in the area of the Golden Arrow mine and numerous other historical mine workings. Gold is concentrated in soils over and extending northward from the volcanic neck of Deadhorse Hill, an area not tested by exploration drilling.

Arsenic appears to be the most reliable geochemical pathfinder element for gold in rocks and soil. Arsenic is concentrated in soil, with gold, over the extent of Confidence Mountain with some enrichment extending to the southeast of Confidence Mountain. Arsenic is more broadly enriched in a large area surrounding Deadhorse Hill, extending eastward to the southern end of the Page Fault.

There are small areas of gold and arsenic enrichment in soils about 500 meters to the east of the Page fault, in an area of poorly- to moderately-welded ash-flow tuff with but minor mapped alteration. It is from this area that some of the better rock-chip samples have been collected. This discontinuous gold and arsenic enrichment in rock and soil may be evidence of deeper confined mineralization.

Mercury is a fickle element in soil geochemical surveys, and such is the case here. The pattern of mercury enrichment follows that of gold over the extent of the Confidence Mountain block, extending to the east over the ash-flow tuff and extending southward along the eastern side of the Page fault. The area of mercury enrichment over the quartz latite of Deadhorse Hill is more tightly constrained than that of gold. There is some enrichment of mercury over the Hidden Hill deposit and in untested areas to the north and west.

Exploration Drilling

It is estimated that more than 400 hammer, air-track, RC, and diamond drill holes exceeding 46,000 meters have been drilled to explore for and evaluate gold-silver mineralization on the Golden Arrow property. Exploration records are available for 324 drill holes (15 diamond core holes and 309 reverse-circulation percussion drill holes) totaling 51,378 meters. Drill core and cuttings samples are available for most of these holes. All of these were relogged by Intor geologists during 2007-2008 to develop a consistent down-hole lithology and alteration database for deposit resource modeling and estimation, as illustrated in Figures 5 and 6.

RESOURCE ESTIMATION

A mineral resource estimate for the Golden Arrow property was completed by Mine Development Associates of Reno, Nevada, in 2008 (Ristorcelli and Christensen, 2008) and updated in 2009 to include additional drilling completed in 2008 (Ristorcelli and Christensen, 2009).

The 2009 deposit geological model and mineral resource estimate was based on a total of 28,864 gold assays and 24,297 silver assays from the 324 drill-hole database. The average spacing of holes is 39 meters in the Gold Coin zone and 30 meters in the Hidden Hill zone. Modeled blocks were constrained by geological sections including lithological and metallurgical zones. Zones of gold mineralization disseminated within horizontal or near-horizontal bodies were modeled separately from gold mineralization controlled by underlying northwest-striking high-angle veins. Block grades were estimated by inverse-distance geostatistical estimation using MineSight« geostatistical modeling software.

The estimate contains the resources summarized in Table 2.

Of this mineral resource, 70% is contained in the Gold Coin zone and 30% in the Hidden Hill zone; 42% is oxidized material and 58% is unoxidized. The Ag/Au ratio in the total measured and indicated resource estimate is 13.5.

Table 2. 2009 MINERAL RESOURCE ESTIMATE FOR THE GOLDEN ARROW PROPERTY.

Classification	Tonnes	Au, g/t	Au, oz	Ag, g/t	Ag, oz
Measured	1,678,000	0.96	52,400	14.74	796,000
Indicated	10,322,000	0.82	244,100	10.66	3,212,000
Measures and Indicated	12,172,000	0.82	296,500	11.29	4,008,000
Inferred	3,790,000	0.04	50,400	11.29	1,249,000

EXPLORATION TARGETS

From the exploration record, a number of exploration target areas have been identified (Ristorcelli and Christensen, 2009).

(1) The Confidence Mountain rhyolite ignimbrite block is situated at the intersection of the north-northeast-striking Page fault and a northwest-trending structural zone prominently identified in geophysical surveys. The Gold Coin deposit extends northwestward from this structural intersection, yet there has been very little exploration southeastward from Confidence Mountain beneath cover. Geophysical resistivity trends, gold and pathfinder-element enrichments in soil geochemistry all suggest exploration potential to the southeast of Confidence Mountain.

(2) Historic gold production within the Golden Arrow district was realized from bonanza quartz-adularia-gold veins within the Page fault zone. The Page fault extends approximately two kilometers southwestward from Confidence Mountain to a cluster of historic shafts, including the Golden Arrow shaft. For most of this distance, the fault is concealed by post-mineral cover–cover too thick for the old-time prospectors to explore through. Both gravity and magnetic geophysical data map this fault at depth. Historic production was limited to the upper 150 meters of the vein above the water table; the vein has not been drill-tested at depth. The entire Page fault zone presents an attractive exploration target.

(3) High-grade veins were historically exploited from a swarm of northwest-trending veins immediately to the southwest of Confidence Mountain. These veins have received little modern exploration. Precision drill targeting of these bonanza vein targets can be improved with high-resolution ground electrical geophysical surveys.

(4) The pediment area to the west of the Page fault between Confidence Mountain and Deadhorse Hill deserves exploration attention. Some of the highest gold grades in the two known deposits occur in andesite; the pediment to the west of the Page fault is underlain by andesite.

(5) Geophysical data suggest that the mineralized Page fault traces the margin of an intrusive body and that the Gold Coin and Hidden Hill deposits are situated above upward apophyses this same body (Figure 7). The western margins of the interpreted intrusion, as well as several other modeled upward extensions, lie hidden beneath the pediment cover, have never been drilled, and represent compelling excellent targets.

(6) The quartz latite of Deadhorse Hill, while itself little altered or mineralized, is surrounded by an aureole of anomalous gold and pathfinder geochemistry. Much of the surrounding area zone is covered by post-mineral andesite and colluvium.

Although known for more than a century, the Golden Arrow district remains an attractive target for discovery of significant additional gold and silver resources.

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