Geologic and Exploration Update, Keystone Project, Eureka County, Nevada

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ABSTRACT

Keystone is a gold and silver exploration project located along the western edge of the Battle Mountain-Eureka gold belt, in the northern Simpson Park Mountains, Roberts Mining District, Eureka County, Nevada. Historic prospects and the Keystone mine were developed during the 1870's, and sporadic production of silver, lead, zinc and copper from the Keystone Mine continued through 1962. Polymetallic skarn deposits were exploited at the Keystone Mine, characterized by galena-sphalerite-chalcopyrite-pyrite-pyrrhotite pods hosted in garnet-pyroxene skarns developed in Devonian Wenban limestone adjacent to the Eocene Walti quartz monzonite intrusion.

Modern exploration for Carlin-style gold mineralization at Keystone began in the late 1960's and has been semi-continuous since then. Multiple companies have been involved in exploration for gold deposits at Keystone, including Newmont Mining, Uranerz, Coral Resources, Nevada Pacific, Placer Dome, and several others. These companies explored several smaller, separate but contiguous claim packages within the present project area. Between 2015–2017, Dave Mathewson and US Gold Corp consolidated the entire Keystone district, with 20 square miles of contiguous mining claims, facilitating model-driven, district-scale exploration of the Keystone project.

Between 2016–2019, extensive geological, geophysical and geochemical work was completed, including the first detailed district-scale geologic mapping in the area and completion of a Master's thesis dating the various igneous rocks and associated alteration present at Keystone. Geologic mapping, completed by Tom Chapin in 2018, was supported by extensive biostratigraphic dating, whole rock analyses and thin section petrography, making the stratigraphic picture and potential mineral deposit targeting clearer. A Master's thesis, completed in 2018 by Gabriel Aliaga, demonstrated Keystone is centered about a long-lived, multi-phase, Eocene, magmatic system, active from 36–34 Ma.

District-wide, detailed, gravity surveys were completed to help define large structures and potential alteration under cover throughout the Keystone project. In addition, extensive district-wide rock, soil, stream-sediment and altered-cobble surveys have been completed. Target specific geologic-alteration mapping and rock-chip sampling is ongoing, with a focus on identifying and defining the active mineralizing structural zones-conduits and where they may form potentially economic mineral deposits.

Historic drilling at Keystone totals 146 holes, mostly shallow RC holes. Few holes deeper than 1000 feet have been drilled before US Gold Corp began drilling in 2016. Core drilling in several areas of the project in 2016 provided the first core and deep stratigraphic look at most of Keystone. The host rock characteristics observed in

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these core holes were then combined with extensive surface geochemical, geological and geophysical data to develop the 2017 and 2018 RC drilling programs. These RC drilling programs, totaling 31 holes, were limited under BLM Notices (NOI's) until late 2018, when a district wide Plan of Operations (PoO) was approved. With the PoO in place, and the newly generated, extensive, surface and sub-surface data in hand, 2019 exploration drilling was target specific and discovery oriented, pursuing Carlin-type and gold skarn targets. Gold assays from the 2019 program were the best to date at Keystone, further illustrating good potential to host multiple large gold and/or polymetallic deposits.

Key Words: Exploration, Gold, Keystone, Carlin-type, Eocene, Wenban

INTRODUCTION

The Keystone project is a primarily gold exploration project located along the western edge of the Battle Mountain-Eureka gold belt, at the north end of the Simpson Park Mountains, Roberts Mining District, Eureka County, Nevada. Approximately 20 square miles of contiguous, unpatented mining claims comprise the Keystone project, encompassing the entire Keystone Window, a domal exposure of Lower Plate Devonian carbonate rocks through Upper Plate Cambrian to Devonian rocks. Access is gained from several directions: north along the Grass Valley road just west of Austin, south into Grass Valley from Crescent Valley and the Cortez Gold Mines area, northwest from the Three-Bars road northwest of Eureka, and west on the JD Ranch road from SR 278 between Carlin and Eureka (Figure 1).

Historic mining in the Roberts Mining District was limited to the Keystone Mine, located within and at the northern end of the Keystone project. Discovered in 1870, the mine produced a

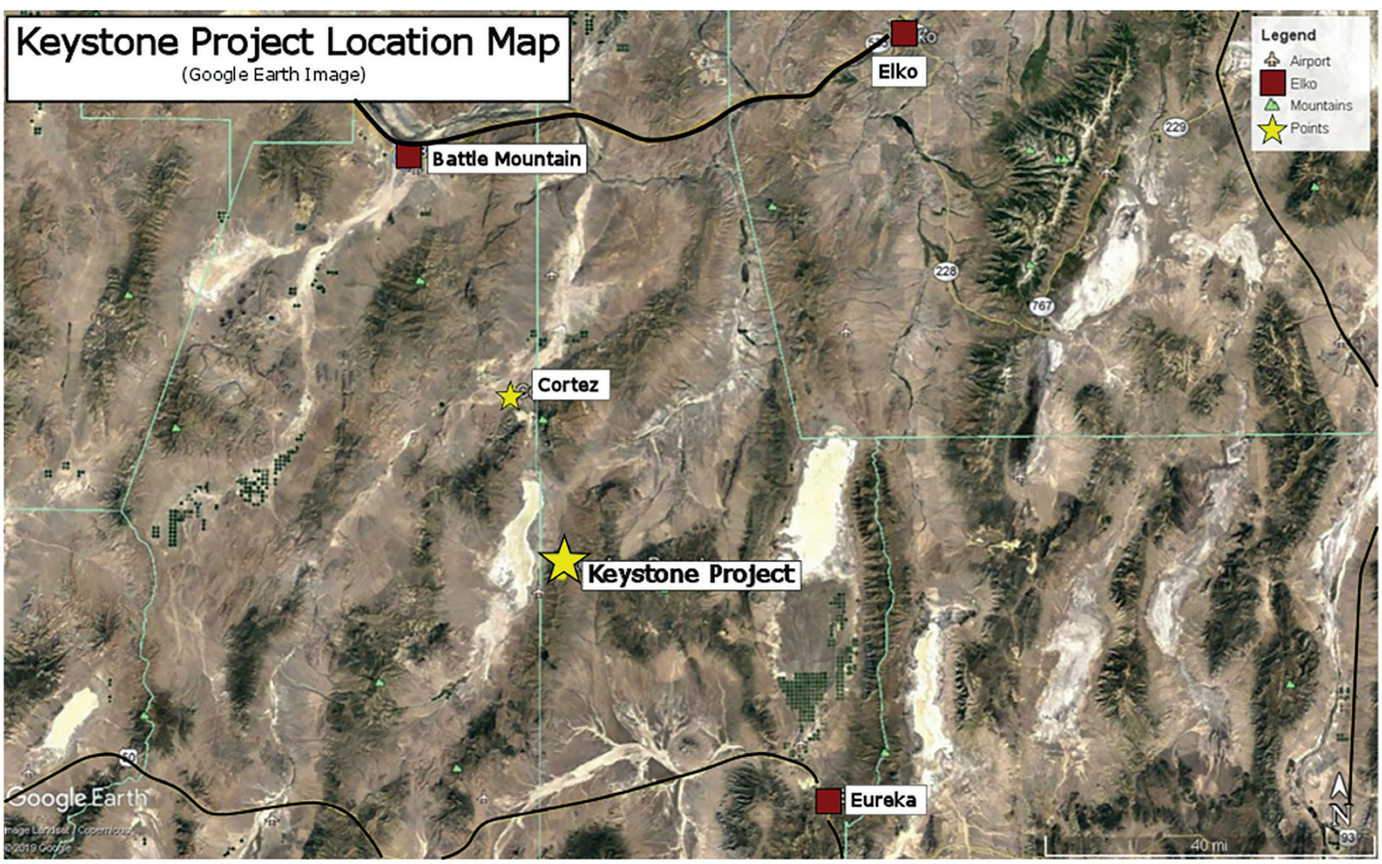

Figure 1. Keystone relative to major northern Nevada towns and the Cortez district.

small amount of silver-lead-zinc and copper to 1962 from polymetallic skarn deposits developed along the northern contact of the Eocene Walti pluton. No historic gold production is known from the Keystone project, though recent rock chip sampling demonstrates anomalous gold is present in many old prospect pits throughout the project area.

Modern-era gold exploration of the Keystone Window, specifically for Carlin-type gold deposits, began around 1967 with Newmont Exploration doing some drilling along the northwest flank of the project area. Between 1967–2015 multiple companies held various small but contiguous land positions within the Keystone project area, which limited district-scale exploration work and geologic understanding. Geologic mapping, rock chip and soil sampling, and mostly shallow reverse-circulation (RC) drilling was carried out on the various claim blocks. Between 2015–2017 Dave Mathewson and US Gold Corp. consolidated the entire project area around the Keystone Window, enabling district-scale and model driven exploration efforts, leading to the identification of the most continuous, strong gold mineralization ever encountered to date at Keystone in 2019.

REGIONAL GEOLOGIC SETTING

The Keystone project is located along the western edge of the northwest-trending Battle Mountain-Eureka gold belt, between the prolific Cortez district and the recently reactivated Gold Bar district and to the west of the Tonkin Springs mine. A strong northwest structural fabric parallel with the Battle Mountain-Eureka gold belt is clear in aerial photography, topography and gravity maps. It spans from the Keystone project to the middle of the Roberts Mountains and the Northern Nevada Rift, which forms the eastern margin of the Battle Mountain-Eureka gold belt in the region (Figure 2).

The $^{87}Sr/^{86}Sr$ 0.706 line passes through the region indicating the approximate position of the Precambrian continental margin and representing a postulated source for gold and other metals in the region and elsewhere in northern Nevada (Figure 3) (Mathewson, 2018, personal communication). Early Cambrian rifting of North America formed the beginnings of the Pacific Ocean, where deep water, submarine volcanic, siliciclastic and carbonate rocks were deposited to the west of North America from the Cambrian through Devonian, while thick, mostly carbonate sequences were deposited along the continental margin during the Cambrian to Late Devonian (Chapin, 2017). The Late Devonian-Early Mississippian Antler Orogeny formed the Roberts Mountains Thrust that carried the Cambrian to Devonian "Upper Plate", mostly siliceous rocks, over the Cambrian to Mississippian "Lower Plate" carbonate platform, eastward across northern Nevada and western North America.

Deposition of clastic and carbonate rocks continued from the Mississippian through Late Permian-Early Triassic, when the Sonoma Orogeny thrust Pennsylvanian-Permian rocks along the Golconda Thrust over Triassic and Paleozoic rocks elsewhere in northern Nevada. Jurassic sedimentary and volcanic rocks were deposited to the northeast of the Cortez district, and Mesozoic intrusions were emplaced in the region, the most notable being the Jurassic Mill Canyon stock at Cortez (Roberts and others, 1967).

Beginning in the Early Eocene, a southwestward sweep of magmatic activity progressed across the Great Basin from 40–34 Ma, the time frame of Carlin-type gold deposition within the region (Muntean and others, 2011). Around 34 Ma the ignimbrite flare-up began, forming large calderas and ash-flow sheets beginning in the now Cortez and Battle Mountain areas with the deposition of the Late Eocene Caetano Tuff and Tuff of Cove Mine, and continuing southwestward through the Oligocene to the Walker Lane province (Henry and Ressel, 2000). During the Late Miocene, the Northern Nevada Rift opened along the eastern edge of the Battle Mountain-Eureka gold belt and deposited bimodal, basalt dominated volcanic rocks associated with low-sulfidation epithermal gold-silver deposits.

The present Basin and Range topography in the region was formed by mid-Miocene to Quaternary extension. Basins in the region, such as Crescent Valley and Grass Valley, are deep, gravel-filled basins bounded by moderately-dipping normal faults, some of which may be older, reactivated faults. These faults have localized geothermal activity in several areas throughout the region, including at Keystone. Mesozoic-Cenozoic intrusive related doming has been dissected by Basin and Range faulting, facilitating further exposure through erosion of the Cortez and Keystone Windows and mineral deposits present within them.

KEYSTONE DISTRICT GEOLOGY

District-scale geologic understanding at Keystone was limited before 2016, largely due to the fragmented land status and the limited understanding of regional geology in general. Recent geologic advancements in the Cortez District to the north of Keystone have been valuable in developing a better understanding of the geology at Keystone. Detailed district-scale geologic mapping, geochemical, biostratigraphic and petrographic studies completed by Tom Chapin at Keystone between 2016 and 2019 shows the geology at Cortez and Keystone is similar. Gabriel Aliaga completed a Master's thesis in 2018 detailing the igneous geology of Keystone and related alteration, including isotopic age dating. This work shows Keystone is cored by a multi-phase, late Eocene magmatic system which has intruded and altered a thick sequence of Silurian-Devonian carbonate rocks and Cambrian-Devonian Upper Plate rocks. Eocene volcanic rocks flank the Keystone project and cover both Paleozoic sedimentary rocks and Eocene intrusive rocks. Structural fabrics at Keystone are nearly identical to those observed by the authors in the Cortez and Carlin gold districts, and coupled with similar, favorable stratigraphy, exert a strong control on alteration and known gold mineralization at Keystone. A simplified geologic map generated by Tom Chapin is attached as Figure 4.

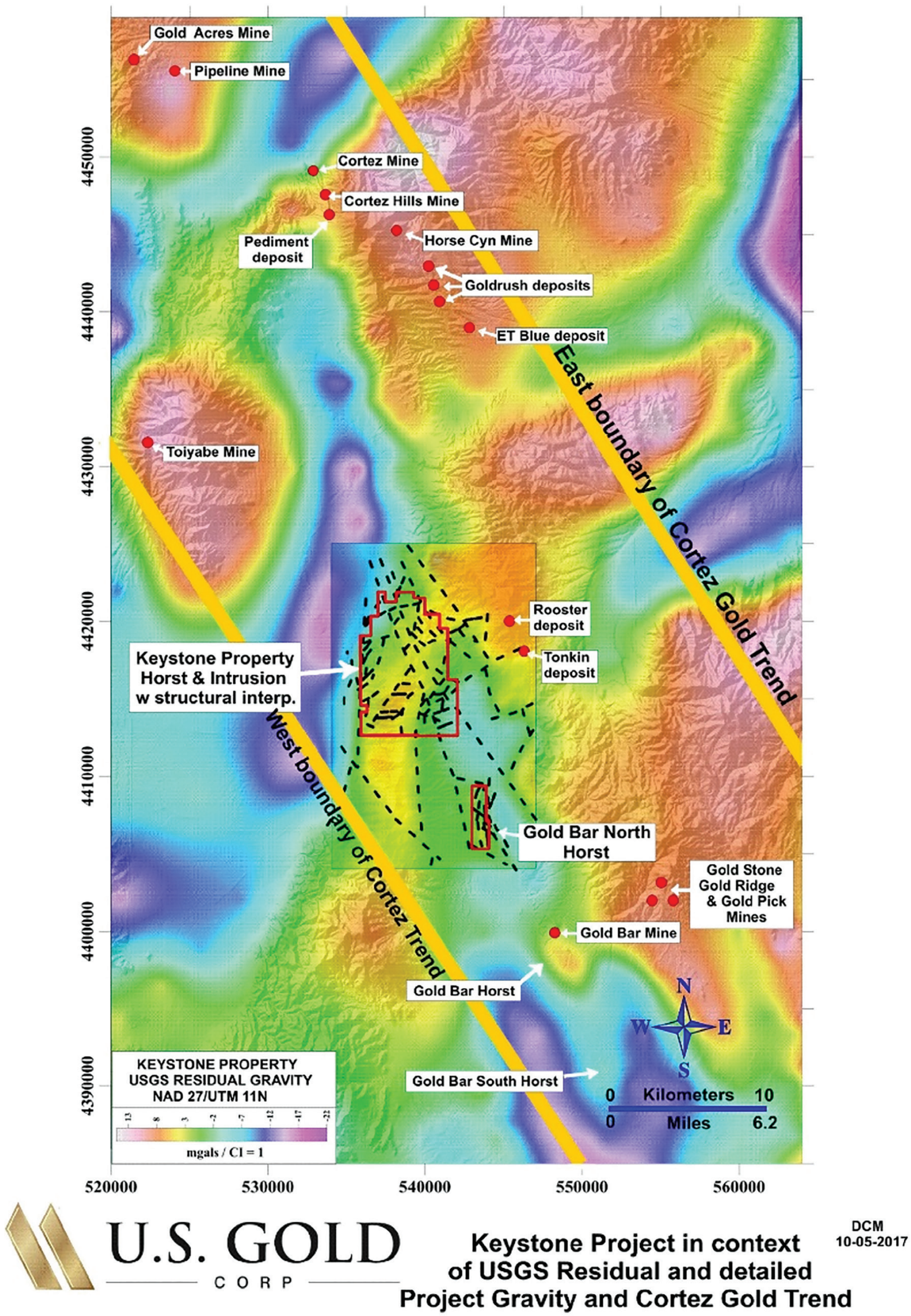

Figure 2. Keystone is located along the west edge of the Battle Mountain-Eureka gold belt, which is illustrated well as a northwest trending fabric in the regional gravity data.

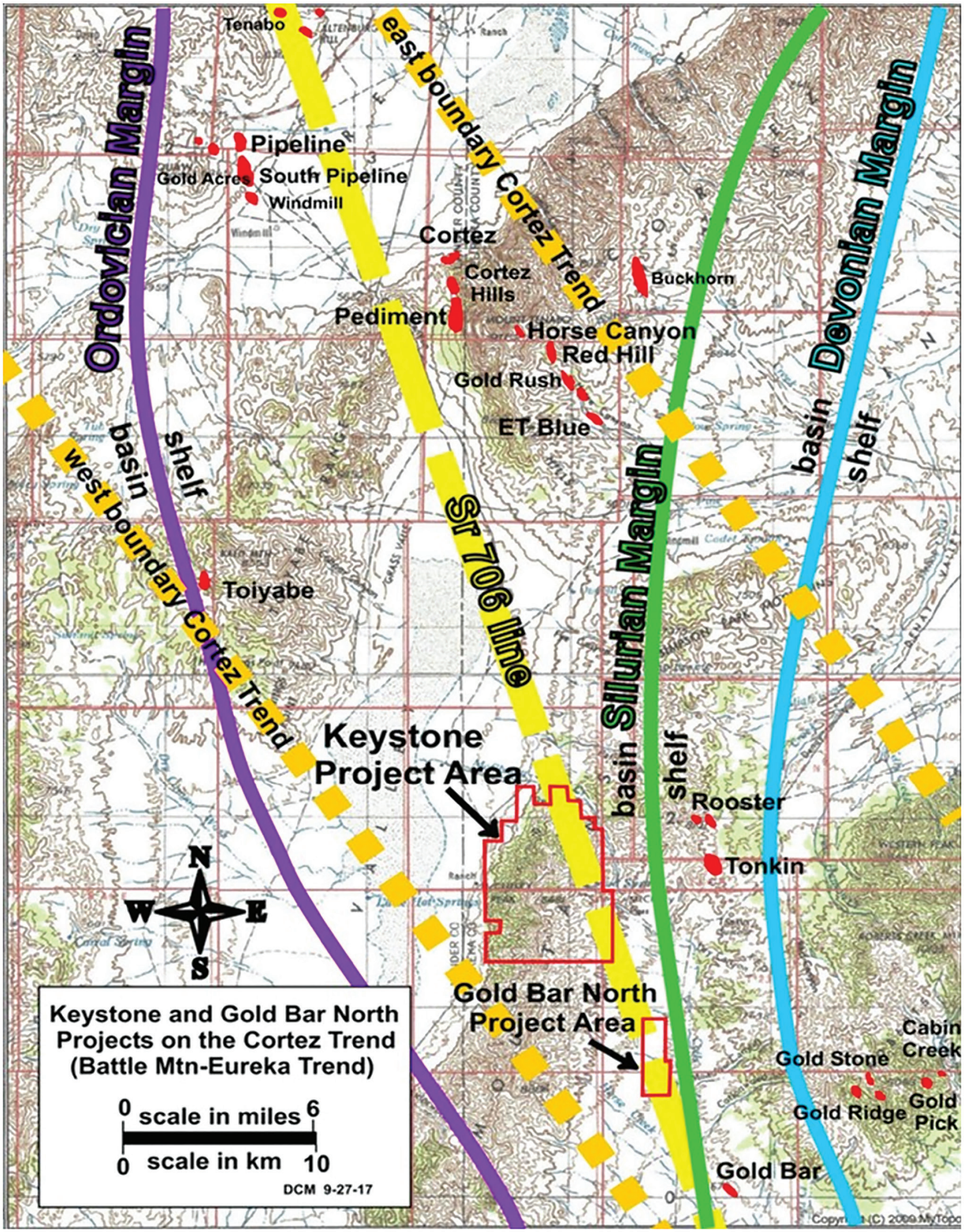

Figure 3. Keystone is located on the $^{87}Sr/^{86}Sr$ 0.706 line, representing the Precambrian continental margin and a postulated source of gold in the region.

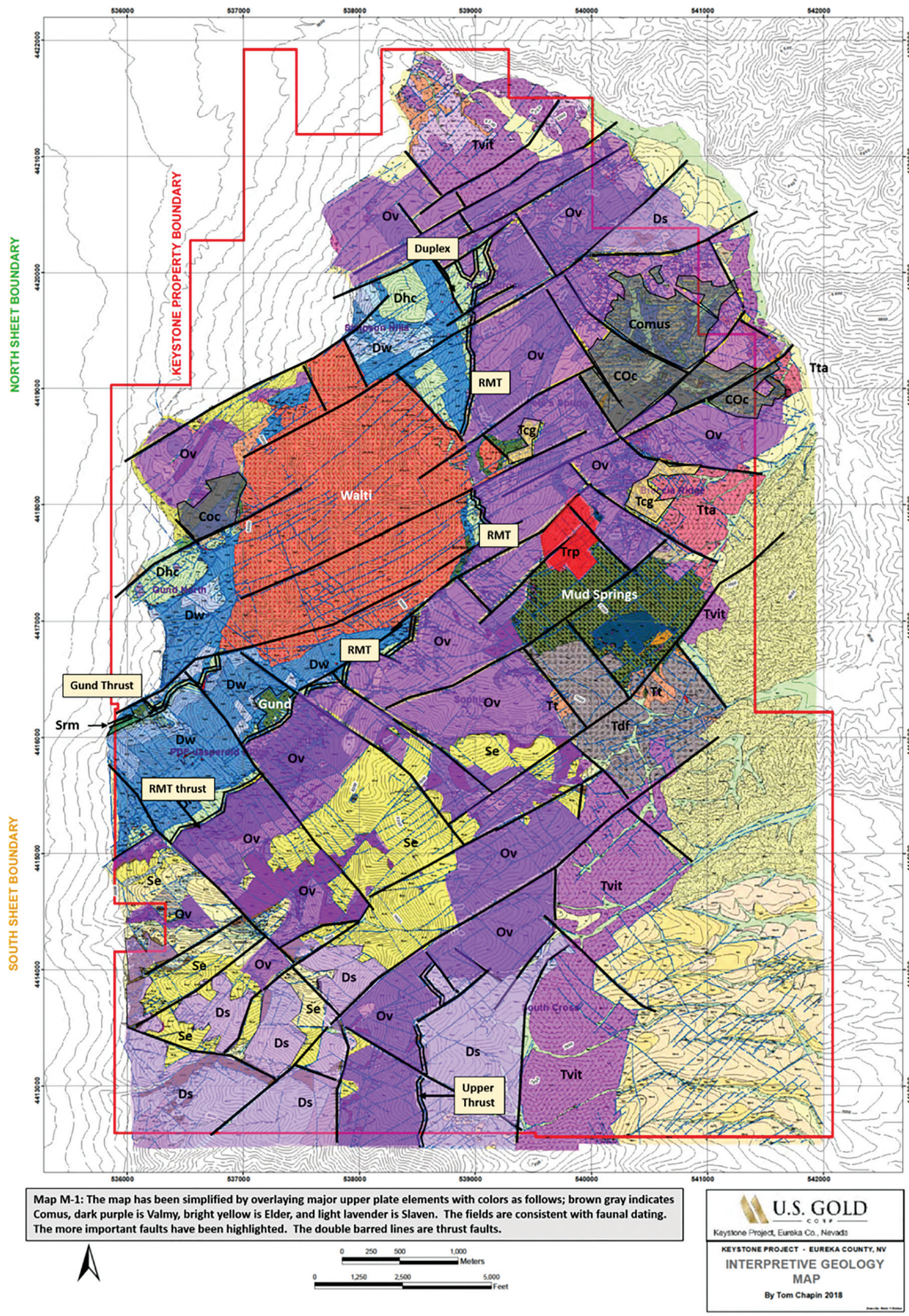

Figure 4. Major surface stratigraphic and structural geology of Keystone. Note the dominant northeast and northwest structural fabric.

Further descriptions of geology, alteration and mineralization of Keystone will reference several different target areas, as defined by US Gold Corp., and are identified in Figure 5.

Stratigraphy

Sedimentary rocks at Keystone are dominated by siliceous rocks of Cambrian to Devonian age within the Upper Plate of the Roberts Mountains allochthon. A series of thrust sheets have emplaced Upper Plate rocks in apparent time normal arrangement within the allochthon at Keystone, with the Cambrian-Ordovician Comus Formation at the base, overlain sequentially by the Ordovician Valmy, the Silurian Elder, and at the top, the Devonian Slaven Formations. The Lower Plate, dominantly carbonate rocks of Silurian-Devonian and possibly Mississippian age, is exposed as a window in the allochthon and was penetrated by deep holes drilled by US Gold Corp. A simplified stratigraphic section and the stratigraphic position of US Gold's 2019 drilling are shown in Figure 6.

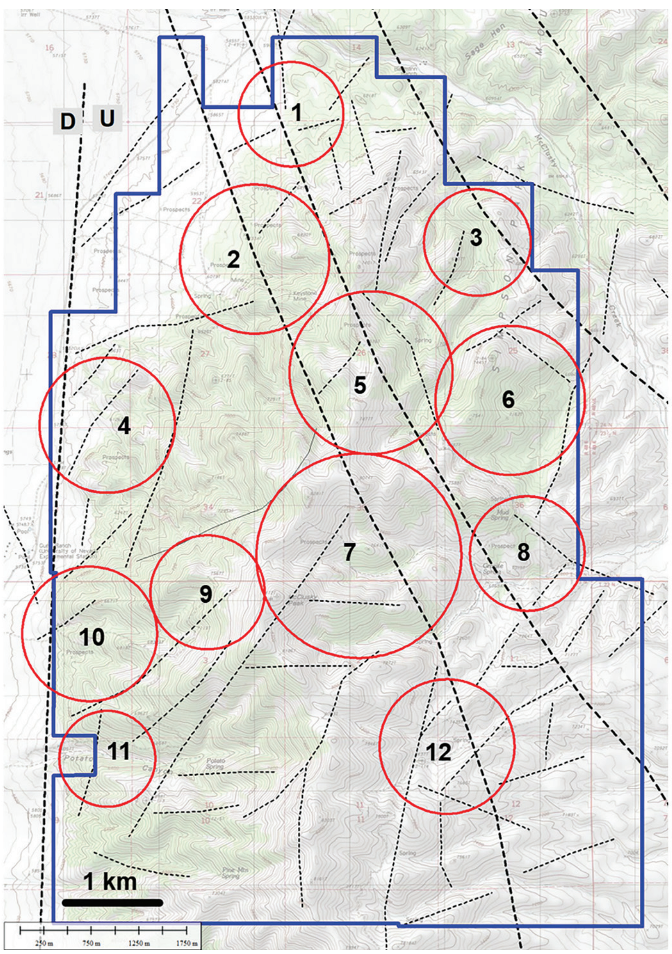

Figure 5. Keystone Target Areas. 1: North Cross-Junction, 2:Simpson Hills-Keystone Skarn, 3: Greenstone Gulch, 4: Gund North-Gund Hills, 5: Nina Skarn-Mineral Basin, 6: Breccia Ridge, 7: Sophia, 8: Mud Springs, 9: McClusky West, 10: PDF-Jasperoid Ridge, 11: Potato Canyon, 12: South Cross.

Lower Plate Stratigraphy

The deepest exposed Lower Plate rocks at Keystone are assigned to the Silurian-Devonian Roberts Mountains Formation (Roberts). A small area on the southwest flank of the Walti pluton provides the only exposure of the Roberts at Keystone, where it is mostly hornfels-altered. Less than 100 feet are exposed, but the top 500 feet is typically a black, plane-laminated silty limestone with quartz silt and some black phosphate lenses at the top (Chapin, 2017). None of the historic or recent drilling has penetrated Roberts; recent work has shown drill-holes thought to have pentrated Roberts encountered the Devonian Wenban Formation unit 5 or Comus Formation, instead. Elsewhere within the Battle Mountain-Eureka gold belt and along the Carlin gold belt, the upper Roberts (Lower Popovich Formation at Goldstrike) is very receptive to alteration and gold mineralization. Based upon exposures to the north at Cortez, drilling at depth below the Roberts at Keystone will likely encounter Ordovician Hanson Creek Dolomite, Ordovician Eureka Quartzite, and Cambrian Hamburg Dolomite (Jackson and others, 2010).

Conformably above the Roberts is a ~2,200–2,600-foot thick sequence of slope carbonates assigned to the Devonian Wenban Formation (Wenban). The Wenban is subdivided into eight units based upon lithologic and lithogeochemical characteristics, with Wenban unit 1 at the base and Wenban unit 8 at the top. There is some variability in unit thicknesses encountered in drilling, probably due to faulting, especially within Wenban unit 8. At the southwest side of the property, the Wenban and Roberts are thrust over the Horse Canyon Formation and Wenban along the Gund Thrust. It is certainly possible that the entire Keystone window is a thrust slice. Unit descriptions below will progress from bottom, up in time sequence. All descriptions below are a combination of the authors' observations, with much taken from the 2017 mapping report by Tom Chapin.

Starting at the bottom, Wenban unit 1 is ~10 feet thick and is characterized by 1–2 m thick carbonate debris flows. Conodonts collected from this unit yielded Lochkovian-Early Pragian ages (Early Devonian; 416–407 Ma). This unit sits conformably upon the Roberts at Keystone. Wenban unit 2 is ~30 feet thick and is characterized by thin, platy black silty mudstone. Wenban unit 3 is ~500 feet thick and is characterized by rhythmically bedded, light and dark-banded turbidites and mudstone, commonly bioturbated with sparse fossils. It is difficult at Keystone to distinguish between unit 3 and unit 4. Wenban unit 4 is ~1,000 feet thick and consists of thinner plane-bedded, smooth-weathering gray turbidites and mudstones which are commonly fossiliferous, including large trilobites, brachiopods and crinoids. A few crinoid-rich packstone beds are present, especially at the top. Where recrystallized or altered to marble, as seen in drill-holes, this unit commonly displays a light-dark "salt-and-pepper" speckled look. A conodont age from the bottom of the unit gave a Lochkovian-Early Pragian date (Early Devonian; 416–407 Ma).

Wenban unit 5, a regionally important unit in terms of fa-

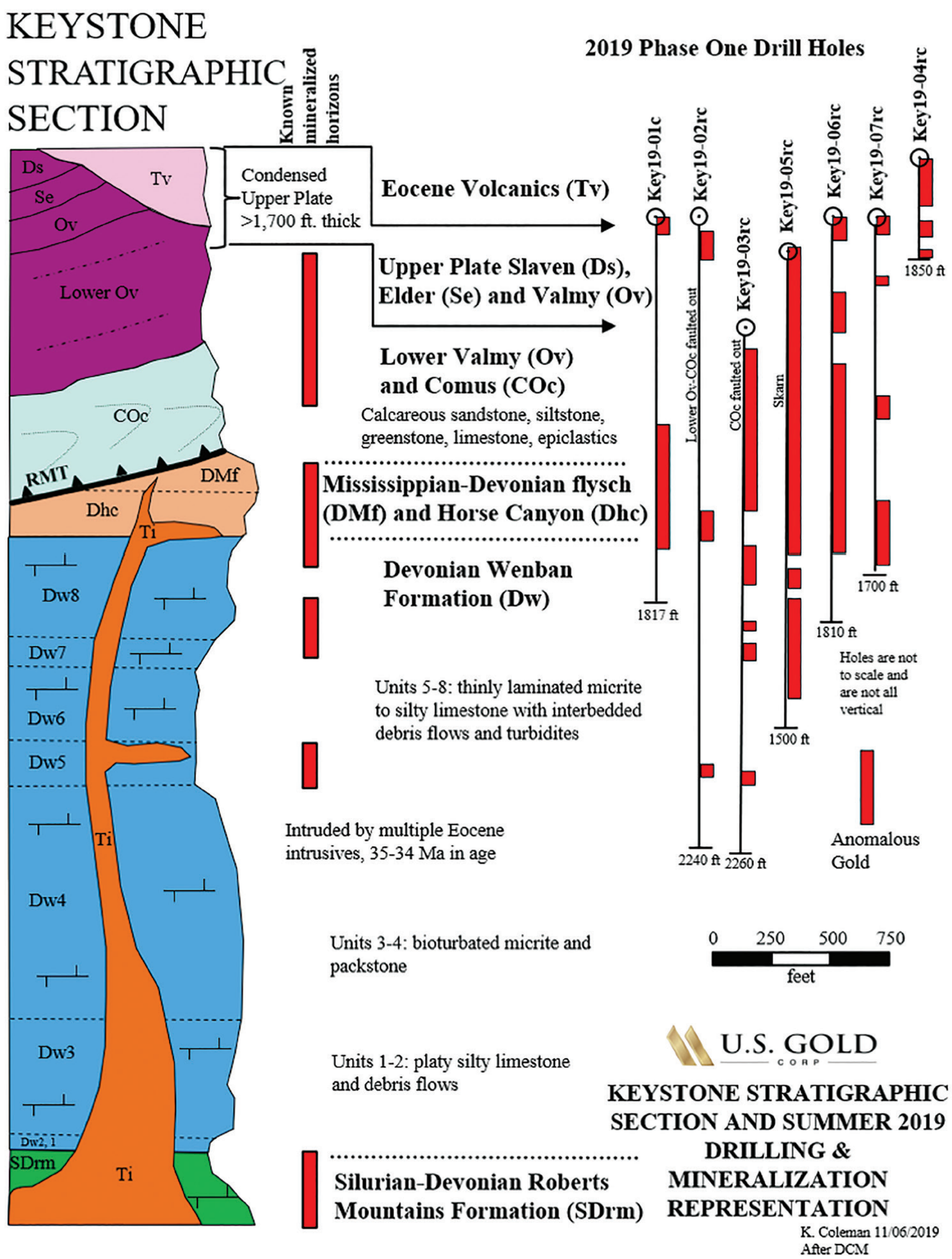

Figure 6. Simplified stratigraphy based upon surface mapping and drilling.

vorability for gold deposition, is ~200 feet thick at Keystone, based upon surface mapping and drill-hole intersections. Unit 5 is characterized by thin beds of pinkish-weathering platy, silty micrite and 20-30 cm thick bioclastic debris flows. Tentaculites are common in surface exposures. Conodonts collected at the base of unit 5 yielded an Emsian age (Early-Mid Devonian; 407–397 Ma). Everywhere encountered in drilling, unit 5 is variably anomalous in gold and pathfinder elements, altered to skarn-hornfels or is black, strongly decalcified and partly brecciated with a coarse, white calcite matrix. Unit 5 is also more geochemically anomalous than units 4 or 6, especially in V, P and Zn. Wenban unit 5 is an important host rock for much of the gold mineralization within the Goldrush deposit to the north of Keystone at Cortez and is a primary target horizon at Keystone.

Wenban unit 6 is ~300 feet thick and is characterized by thin, 10 cm beds of micrite and turbidites rich in terrigenous material. Tentaculites fossils are common, and the unit weathers similar to unit 5, making them both hard to differentiate in outcrop. However, as stated in the last paragraph, unit 5 is more geochemically anomalous than the surrounding units. Conodonts collected from unit 6 yielded a Mid-Frasnian age (Mid-Upper Devonian; 385–374 Ma). Wenban unit 7 is ~60 feet thick and is characterized by massive, soft-sediment deformed mudstone. In drill-holes, this unit displays a common plumose fracture pattern. Wenban unit 8 is highly variable in thickness, from ~40 to over 200 feet, though ~500 feet of interpreted Wenban unit 8 was encountered in one drill-hole. From drill-hole evidence, faulting and folding has likely repeated or thickened unit 8. The unit is characterized by thick bedded, gray to black carbonate mudstone, turbidites, debris flows and fossiliferous packstone. The upper-most 200–300 feet, directly below the Devonian Horse Canyon Formation (Horse Canyon) is favorable for Carlin-type alteration and gold mineralization, as evidenced by outcrop and drilling. The top of unit 8 is a black, hackly weathering mudstone where not altered.

Conformably above the Wenban is the Horse Canyon a 100–200-foot thick sequence of variably calcareous siltstone and siliceous mudstone. In outcrop, the unit is pink to orange, thin, plane-laminated, platy weathering, with common pin-stripe textures (light-dark red) and some interbedded black siliceous mudstone (mostly near the bottom), forming what is called IB. In drill-holes where it is not oxidized, the pin-stripe texture is manifested as pin-stripe pyrite. Actual thickness in drill-holes and outcrop is highly variable due to faulting or collapse brecciation in many cases. Conodonts collected from the Horse Canyon yielded Late Frasnian dates (Late Devonian; 376–359 Ma). Horse Canyon is very susceptible to alteration and mineralization, commonly being hornfels-skarn-altered, or variably decalcified and silicified. Collapse breccia is commonly developed within the unit throughout the Keystone project, with open voids up to 20 feet across having been encountered in drilling. The Horse Canyon-Wenban contact is an important gold-mineralized horizon at Keystone and Cortez to the north.

Conformably above the Horse Canyon but not present everywhere, and only identified in a few drill-holes, is the postulated Late Devonian or Mississippian flysch, which may be equivalent to the Blue Hill unit seen at Cortez. Age is uncertain due to the lack of fossil preservation in the unit's depositional environment. The unit resembles Upper Plate siliciclastic rocks, but lacks the penetrative fabrics commonly seen in Upper Plate rocks and consists mostly of angular quartz sandstone, siltstone and black mudstone. Actual thickness of the unit is unknown due to it being thrusted out in many areas of Keystone, but it is estimated to be ~200–500 feet thick. At Gold Bar, southeast of Keystone, the Horse Canyon grades conformably into the Mississippian Webb Formation, which is a flysch (Chapin, 2020, personal communication).

Upper Plate Stratigraphy

The strongly folded Cambrian-Ordovician Comus Formation (Comus) lies above the Roberts Mountains thrust. The Comus is not always present, but where encountered the thickness ranges between 500–1000 feet. Many drill-hole intercepts show approximately 600 feet of Comus. At Keystone, the Comus is comprised of a variably folded, laterally discontinuous sequence of greenstone, mafic epiclastics, silty limestone, carbonate and greenstone debris flows and calcareous siltstone. Conodont analyses yielded Trempealeauan-Ibexian ages (Latest Cambrian-Earliest Ordovician; 492.5–485 Ma) (Chapin, 2019). Conodonts were obtained from conformable, in-place limestone beds which surround greenstone debris flows. The absence of any younger fossils coupled with the stratabound nature of the debris flows suggests the debris flows are not likely younger, reworked flows. The Comus has been demonstrated by drilling to be a very receptive host rock for alteration and gold mineralization at Keystone, as it is to the northwest at the Twin Creeks and Turquoise Ridge mines. The Comus at Keystone is also lithologically similar to the Cambrian Hales Formation, the primary host rock of Carlin-type gold mineralization at the Tonkin Springs mine located directly east of Keystone (Noble, 2008). Figure 7 illustrates the Comus Formation in drill core.

The Comus seems to grade upward into the overlying Ordovician Valmy Formation's lower unit (Lower Valmy) but it is unclear if the contact is conformable or structural. The Lower Valmy as mapped at Keystone is ~300–600 feet thick, though some drill-holes show around 600 feet, and consists of a coarsening-upward sequence of greenstone, mafic epiclastics, limestone, carbonate clast clastics and calcareous quartz sandstone. The top is capped by a thin bed of quartzite typical of the Valmy (Chapin, 2019). Conodont analyses by Chapin yielded Early-Middle Ordovician ages, and $^{40}Ar/^{39}Ar$ dating of greenstone by Aliaga (2018) yielded a 466.1 Ma age, also Early-Middle Ordovician. The Lower Valmy has been shown by drilling to be a receptive host rock for alteration and gold mineralization at Keystone.

Above the Comus and Lower Valmy are at least three mappable units of variably siliceous-siliciclastic rocks and lesser carbonates and greenstone at least 1,400 feet thick, all of which are assigned to the Ordovician Valmy Formation (Valmy). These units are capped by the thin and distinctive Silurian Cherry Springs chert, which forms the contact between the Valmy and the Silurian Elder Formation. Thrust duplexes have significantly increased the overall thickness of the Valmy in places, as evidenced by drill-hole data.

The first and lowest Valmy unit consists of a ~300-foot thick, coarsening upward sequence of non-calcareous shale, siltstone, varved arkosic sandstone and a thin orthoquartzite bed at the top. This unit has been faulted out in some drill-holes. The next highest or middle unit consists of a variable sequence of chert, siliceous mudstone, siltstone, shale, limestone, greenstone and quartzite. A prominent greenstone bed is present at the top of the middle cycle. Radiolaria obtained from chert within this cycle gave Late Darwillian to Katian ages (Upper Ordovician; 468–445 Ma), and conodonts obtained from limestone yielded Mid Ordovician-Early Silurian ages (Chapin, 2019). The upper unit consists of ~600 feet of plane bedded, polymict sandstone and siltstone with lesser chert and chert-like siliceous argillite beds.

At the top of the Valmy is the Cherry Springs Member, a 20–60-foot thick sequence of commonly bright green chert, boudinaged white chert and black, chert-like siliceous argillite. Radiolaria obtained from chert within the Cherry Springs Mem-

Figure 7. Cambrian-Ordovician Comus Formation limestone and calcareous siltstone. Note tight folding and rhythmic bedding of silty versus muddy beds, very favorable characteristics for Carlin-style alteration and gold deposition.

ber yielded Llandovery ages (Early Silurian; 443–433 Ma). The bright green chert has been used across northern Nevada to map the top of the Valmy Formation.

Above the Valmy is a sequence of siliciclastic rocks assigned to the Silurian Elder Formation (Elder). The nature of the contact and the actual thickness of the Elder is uncertain. Mapped thickness is estimated at ~200 feet, though extensive faulting has largely made good stratigraphy measurements difficult. The Elder consists of a sequence of yellow weathering, plane bedded, fine quartz sandstone and siltstone, turbidites and mudstone which can be weakly calcareous and shows common detrital white mica. Due to the siliciclastic nature of the Elder, age dating is difficult. Rocks mapped as Elder at Keystone have been assigned a Silurian age due to being confined between the easily dated Cherry Springs Member and Devonian Slaven Chert.

Above the Elder in probable structural contact is a thick package of strongly folded chert, chert-like siliceous argillite, shale, and bedded barite, all assigned to the Devonian Slaven Formation (Slaven). Radiolaria obtained from chert assigned to the Slaven yielded Early Devonian to Carboniferous age dates, though the authors think the Slaven is no younger than Famennian (Latest Devonian; 358 Ma) in age (Chapin, 2019). Thrusts internal to the Slaven are mapped at Keystone, which have thickened the Slaven in many places.

Three mappable units or members are present within the Slaven, all of them dominantly chert. The lower member is ~150 feet thick and is characterized by highly folded gray chert that weathers to white-or honey color, abundant black, shiny siliceous argillite and a 1m thick basal chalcedony replaced algal mat. Radiolaria dates from the lower member chert are Early Devonian. The middle member is ~350 feet thick and is comprised of less folded khaki-brown-black-white chert, shale and black siliceous argillite beds (Chapin, 2019). The upper member is ~100 feet thick and is characterized by strongly to weakly folded thin black-green-white chert, shale, fine quartz siltstone and bedded barite. Gossan outcrops scattered throughout the Devonian Slaven at Keystone were likely SEDEX massive sulfide beds related to the bedded barite deposits, similar to those that can be seen at the Clipper Barite mine in the Shoshone Range to the northwest of Keystone. Radiolaria from the upper member gave mostly Famennian (Late Devonian) dates.

Tertiary Conglomerate

On the east side of the Keystone project, in the area of Breccia Ridge and Mineral Basin, several large exposures of water-worn (rounded clasts), Upper Plate derived siliceous pebble conglomerate are present. These exposures have been mapped as Tertiary conglomerate and included with the dated Tertiary basal angular clast volcanic breccia mapped in the same area that is described later in this paper. Aliaga (2018) describes intrusive clasts within the rounded pebble conglomerate. Since the clasts were not dated, the clasts could be derived from older intrusions elsewhere, and not from the Eocene intrusions at Keystone.

The conglomerate resembles the poorly dated Pennsylvanian-Permian Brock Canyon Formation found north of Keystone in the Cortez Mountains. The conglomerate at Keystone is variably altered, partly mineralized, and rests upon the Valmy Formation and Eocene intrusions. If the conglomerate is conformable to the intrusions, then it must be younger than the intrusions. However, in Mineral Basin, newly constructed drill roads expose the base of the conglomerate, which displays an altered, shallow dipping shear-breccia zone that separates it from Valmy chert and mudstone, suggesting the contact is structural. Gilluly and Gates mapped the Brock Canyon Formation in the Simpson Park Mountains in 1965, south of Keystone. In the Cortez Mountains, the basal contact of the Brock Canyon Formation is everywhere seen a thrust fault (Western Cordillera website, 2006). Since the conglomerate outcrops at Breccia Ridge are cut by several weakly gold-anomalous, silica-FeOx-barite mineralized faults, and if the mineralization is related to the Eocene intrusive event, then the conglomerate must at least be Eocene.

Tertiary and Quaternary Alluvium

Aliaga (2018) had a good summary of the Tertiary and younger alluvium at Keystone, quoted below.

> *"On the eastern side of the study area are older, possibly Tertiary, weakly consolidated gravels comprised of upper plate siliceous rocks, igneous rocks resembling the Mud Springs pluton, andesite lava, rhyolite tuff and conglomerates. This older alluvium is incised by modern drainages at the headwaters of McClusky Creek. One drainage exposes andesite lava of McClusky Creek beneath the old alluvium. The northern and western parts of the study area are covered by Quaternary alluvial fans and alluvium that lead into the Grass Valley alkali flats west of the study area."*

Structure

Faulting

The most extensive fault present at Keystone is the Roberts Mountains Thrust (RMT), which is characterized in outcrop and drill-holes by 20–40 feet of sheared, brecciated, and commonly silicified rock. Slicks are common in RC chips and core, some intervals being composed of lens-shaped chips entirely slicked on all sides, termed "slick chip breccia". Where highly altered, the base of the thrust is determined by the change from highly strained rocks to little or non-strained rocks or by using trace element geochemistry.

Across the property, strong northeast and northwest trending fault-fracture fabrics were mapped and can be seen as topographic linears and in geophysical data. Two major northwest trending structures are interpreted to cut through the middle of the Keystone project and appear to both cut and be offset by conjugate northeast-trending structures that extend from the Jasperoid Ridge area at the southwest end of the project to Greenstone Gulch at the northeast end. Nearly all known gold mineralization and strong surface geochemistry at Keystone is coincident with these structural zones and their intersections. Figure 8 shows the interpreted structural fabric based upon horizontal gradient and residual gravity arsenic soil geochemistry, which shows how well the geochemistry coincides with the major interpreted and mapped northwest and northeast trending structural zones.

Many of the strong northwest- and northeast-trending fault sets are filled with variably altered and mineralized dikes that range in composition from mafic to acidic, especially in the Sophia, Mineral Basin, Greenstone Gulch and Breccia Ridge areas. Further details concerning these dikes will be addressed later in the igneous geology portion of this paper. At Sophia, altered feldspar porphyry dikes and gold-bearing pebble dikes (convective breccias) follow the same broad northwest trending structural set.

Besides the RMT, other thrusts or shallow dipping faults have been mapped and encountered in drilling. Many of these have localized gold mineralization within the target areas of Sophia and Tip Top. These faults strike northeast, northwest and west-northwest, based upon actual measurements or three-point problem calculations from drilling. The shallow dipping faults and their intersections with steeper faults are favorable loci for gold mineralization at Keystone and Cortez.

The Gund Thrust, located at the southwest side of the Keystone project, is partly filled by diorite. This northeast-striking, southeast-dipping thrust places Roberts and Wenban over the

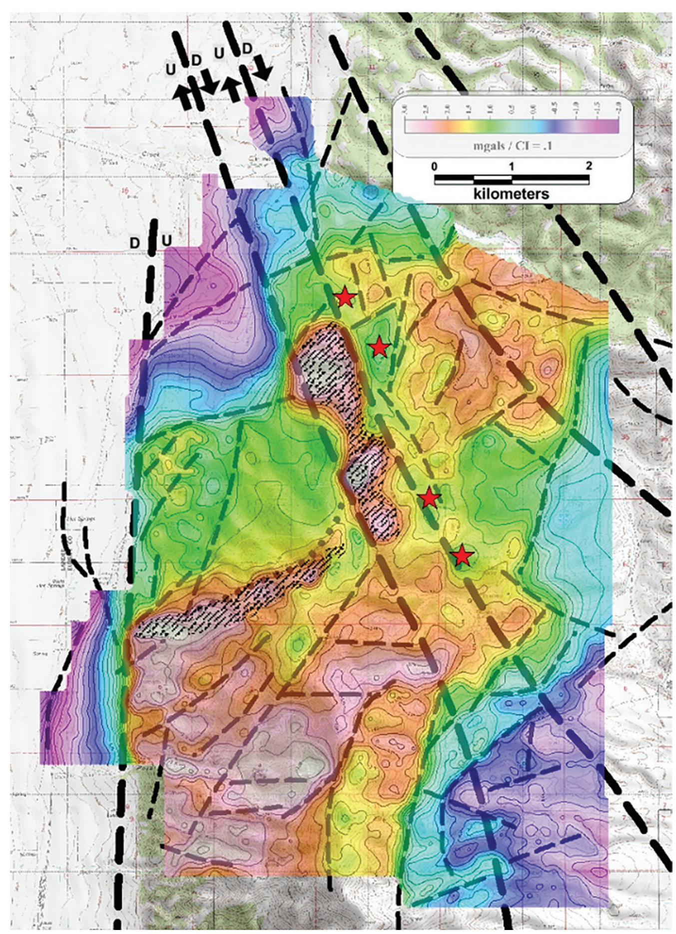

Figure 8. Arsenic in soils at 50 ppm correlates well with interpreted (and mapped) northwest- and northeast-striking fault-fracture systems, and their intersection zones.

top of a small sliver of Upper Plate rocks which overlie the normal stratigraphic section of Horse Canyon followed by Wenban and presumably the Roberts, thereby repeating the section (Chapin, 2017).

In the Tip Top area, two shallow dipping structures were defined by drilling. To date, drilling has defined a deeper, east-northeast-striking, southeast-dipping shear zone with over 1 km of down-dip lateral extent. It is named the Zn-V shear due to consistently containing > 1000 ppm zinc and vanadium everywhere encountered in drill-holes. In core, the shear zone is a 20–40-foot wide zone of carbon slick planes and slick chip breccia. This structure forms the lower boundary of known gold mineralization and Carlin-type alteration at Tip Top. Above this structure, and variably cutting through the Horse Canyon and Wenban is a northwest-striking, shallow southwest-dipping fault which localizes moderate to strong dolomitization and gold in both outcrop and drill-holes, with drill-hole intercepts along the plane showing > 4 gpt Au. This structure or one parallel to and below it may be partly responsible for the thick intervals of Wenban unit 8 encountered in drilling at Tip Top. Both structures are illustrated in Figure 9, a hypothetical target cross section.

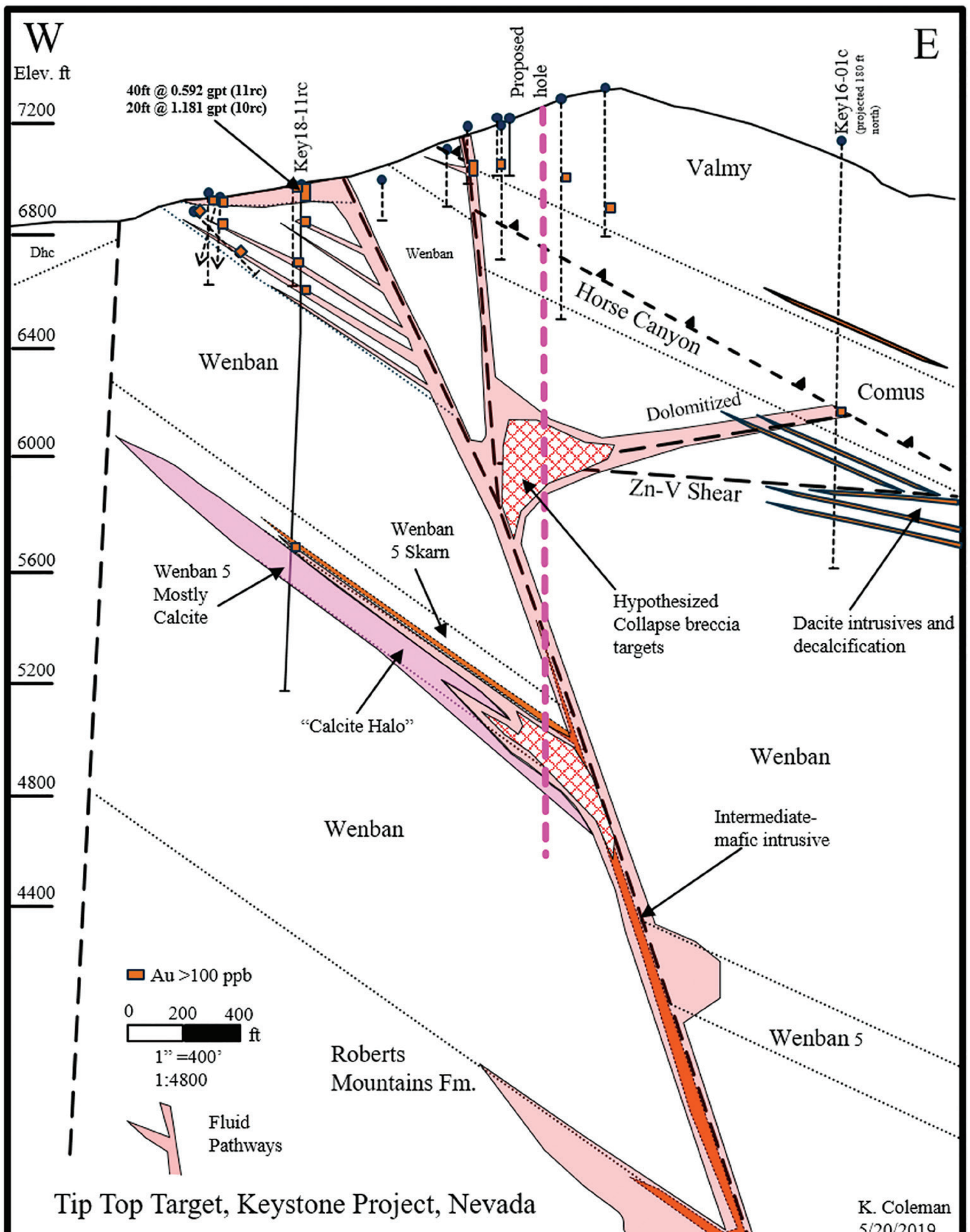

Figure 9. Target cross section for Tip Top, illustrating shallow dipping structures identified through drilling, especially the Zn-V shear, which forms a lower boundary to known drill defined Carlin-style alteration and mineralization.

A core hole drilled in the North Cross target area, Key16-05c, encountered Comus below a broad fault zone, with dated Wenban limestone above it and Upper Plate rocks further up the hole. An orientation cannot be deduced from one hole, but the implications are that at least some of the Lower Plate rocks at Keystone may in fact be allochthonous. In the Cortez district to the north, the Pipeline and Gold Acres deposits have been shown to be hosted in allochthonous Wenban and Roberts Mountains Formations (Leonardson, 2010).

Post-mineral northeast and north-south striking faults are present throughout the Keystone project. To the west, Keystone and the Simpson Park Mountains are bound by several down-to-the-west north-south trending range-front faults. Active geothermal springs are located along them that deposited thick travertine-calcite veins or "walls" along the scarps in several areas. These faults are thought to represent the southward extension of the Cortez Fault to the north. Refer to Figure 4 for a good idea of the major faulting-structure at Keystone.

Folding

Tight folding within the Upper Plate is commonly observed in all formations but is most pronounced in the Comus and Slaven Formations. Though the folding is quite clear in outcrops and core, in recessive areas only the steep limbs crop out. Much of this folding was likely generated during emplacement of the Roberts Mountains allochthon.

The emplacement of the Eocene Walti pluton formed a broad west-northwest trending dome. The surrounding strata are tilted and folded along the margins of the intrusion and particularly tight folds are found on the northwest margin of the pluton, coincident with the northwest striking faults identified in the geophysical data. In addition, local drag folds are present throughout the Keystone project, but are especially pronounced in Lower Plate rocks at the northern end of the project.

Igneous Geology

Igneous rocks present at Keystone are of diverse compositions and are either Paleozoic or Eocene in age, based upon historic work and recent work completed by Aliaga (2018). Aliaga's work classified and dated many of the igneous rocks, both extrusive and intrusive in nature. Of most importance are the age dates obtained which demonstrate that a long-lived, multi-phase, Eocene, magmatic system was active at Keystone for ~1.5 million years. Table 1 provides a list of age dates from various intrusive and extrusive phases at Keystone, along with a couple of illite alteration dates.

Paleozoic Mafic Igneous Rocks

Paleozoic mafic igneous rocks are confined to the Cambrian-Ordovician Comus and Ordovician Valmy Formations, and are characterized by basalt-greenstone flows, flow breccias, mafic dikes and sills, hyaloclastites and epiclastic sedimentary rocks. Compositionally, these rocks vary from basalt to picrite, and some contain abundant biotite. Whole-rock data analyses mark these as the only mafic igneous rocks found at Keystone and in the ocean island basalt (OIB) category (Figure 10). Biotite from basalt of the Valmy Formation yielded an $^{40}Ar/^{39}Ar$ age of 466.1 ± 0.7 Ma, making it Ordovician and unrelated to continental-arc magmatism in the Eocene (Table 1).

Eocene Intrusive Rocks

Eocene intrusive rocks are abundant at Keystone and are variably felsic to intermediate in composition, falling in the high K calc-alkaline to shoshonite magma series (Aliaga, 2018). The three largest exposed intrusions, the Walti, Mudsprings, and Gund plutons, all display variably mineralized contact metamorphic aureoles. Many dikes of variable composition are present, which follow the dominant northwest and northeast structural fabrics at Keystone. These dikes are variably altered and are spatially associated with stronger surface geochemical anomalies. Illite alteration from several of these dikes has been dated at 35.7–35.5 Ma (Table 1). Descriptions of the various Eocene intrusive phases below are generally organized by age, beginning with the oldest.

Mud Springs diorite (Tmd) in the eastern part of the project intrudes Upper Plate rocks and is characterized as an elongate west-northwest to east-west trending, sill-like intrusive with many large xenoliths of Upper Plate rocks, pegmatitic bodies, and local miarolitic cavities. Nearly all exposures of Mud Springs diorite display propylitic to weak argillic alteration, and in general, alteration in the Paleozoic wall-rocks is strongest surrounding the Mud Springs intrusive. The Mud Springs intrusive does not have a clear or strong magnetic signature in air mag surveys, though it could be overwhelmed by the larger, more magnetic Walti pluton response to its west.

Gund diorite (Tgd) is present in the southwest quarter of the Keystone project and is characterized by a small ovoid, lopolithic intrusion and sills along a thrust cutting Lower Plate rocks. Narrow contact metamorphic aureoles are developed in the wall-rocks, along with endoskarn development, though with no noted metallic mineralization.

A rhyolite porphyry (Trp) occurs as a north-south elongate, steep-sided plug which cuts both Upper Plate rocks and the Mud Springs diorite. Most exposures are variably bleached-sericitized and/or silicified. Flow-banding is notably absent and vertical jointing is strong. The rhyolite porphyry at Keystone is very similar in age (35.43 Ma) and composition to pyrite-realgar-mineralized quartz porphyry dikes at Cortez Hills, which were dated at 35.37 Ma (Arbonies, and others, 2010).

The Walti pluton forms the largest intrusion exposed at Keystone and formed a dome in both Lower and Upper Plate Paleozoic rocks. There is a ~25 km^2 air mag response to the Walti intrusion which continues underneath cover to the west. Compositionally, the rock varies between quartz monzonite and granodiorite, and has a diorite phase as patches surrounding the main pluton as well as enclaves within the quartz monzonite. Alteration is variable but pervasive throughout the Walti

Table 1. AGE DATES FROM KEYSTONE IGNEOUS ROCKS AND ILLITE ALTERATION (MODIFIED FROM ALIAGA, 2018).

Sample-Unit	*Location, Type*	*Age (Ma)*	*±2σ*	*Method*	*Method*	*Mineral*	*Comment*
Tmd	**Mud Springs diorite**						
KS003	E margin of pluton	35.87	0.06	$^{40}Ar/^{39}Ar$	Single crystal step-heating	plagioclase	2 age clusters, considered older
Tgd	**Gund diorite**						
KS114A	W sill	35.82	0.08	$^{40}Ar/^{39}Ar$	Bulk grain step-heating	hornblende	
Trp	**Rhyolite porphyry**						
KS044	E margin, altered, qtz veins	36.71	0.33	U-Pb	LA-ICP-MS	zircon	
KS098	center of stock	35.43	0.06	$^{40}Ar/^{39}Ar$	Single crystal fusion	sanidine	
Twq	**Walti quartz monzonite**						
KS014	W margin of pluton	35.05	0.41	U-Pb	LA-ICP-MS	zircon	
KS137	drill core @530m, N margin	35.52	0.14	$^{40}Ar/^{39}Ar$	Bulk grain step-heating	biotite	
Twd	**Walti diorite**						
KS041	NE margin of pluton	35.51	0.19	$^{40}Ar/^{39}Ar$	Single crystal step-heating	plagioclase	
KS086	SE margin of pluton	35.58	0.06	$^{40}Ar/^{39}Ar$	Single crystal step-heating	plagioclase	
KS093	E margin of pluton	35.24	0.22	$^{40}Ar/^{39}Ar$	Single crystal step-heating	plagioclase	
Twp	**Walti intermediate porphyry dikes**						
KS126	dike cutting Mud Springs diorite, altered	34.96	0.38	U-Pb	LA-ICP-MS	zircon	
KS095	dike cutting RMA, E of Walti	35.68	0.04	$^{40}Ar/^{39}Ar$	Bulk grain step-heating	hornblende	
Tta	**Trachyandesite dikes**						
KS025	altered dike, W of Walti	34.69	0.39	U-Pb	LA-ICP-MS	zircon	
Tvc	**Aphyric rhyolite + volcaniclastics**						
KS050	NE of Mud Springs, flow banded	35.6	0.38	U-Pb	LA-ICP-MS	zircon	
Ta	**McClusky Creek andesite**						
KS144	far SE end of study area, lava	35.99	0.04	$^{40}Ar/^{39}Ar$	Bulk grain step-heating	hornblende	
KS135	E of Mud Springs, lava	35.85	0.08	$^{40}Ar/^{39}Ar$	Bulk grain step-heating	hornblende	
Tda	**Dacite agglomerate**						
KS051	E of Mud Springs pluton	34.68	0.54	U-Pb	LA-ICP-MS	zircon	
Tcg	**Tertiary conglomerate-basal volcanic breccia**						
KS048	N of Mud Springs pluton	35.62	0.32	U-Pb	LA-ICP-MS	zircon	max depositional age
Ovb	**Valmy basalt**						
KS143	W of Walti pluton	466.1	0.7	$^{40}Ar/^{39}Ar$	Bulk grain step-heating	biotite	
Alteration age dates							
Ta	**McClusky Creek andesite**						
KS139	drill core @332m, NE of Walti	35.54	0.06	$^{40}Ar/^{39}Ar$	Bulk grain step-heating	illite	
KS019	altered dike, N of rhyolite porphyry	35.71	0.12	$^{40}Ar/^{39}Ar$	Bulk grain step-heating	illite	

[1]*Granodiorite*
[2]*Quartz monzonite porphyry*
[3]*Granodiorite porphyry*
[4]*Weight norms calculated from CIPW spreadsheet from M. N. Ducea, pers. commun., 2020; calculation steps after Johannsen, 1931*

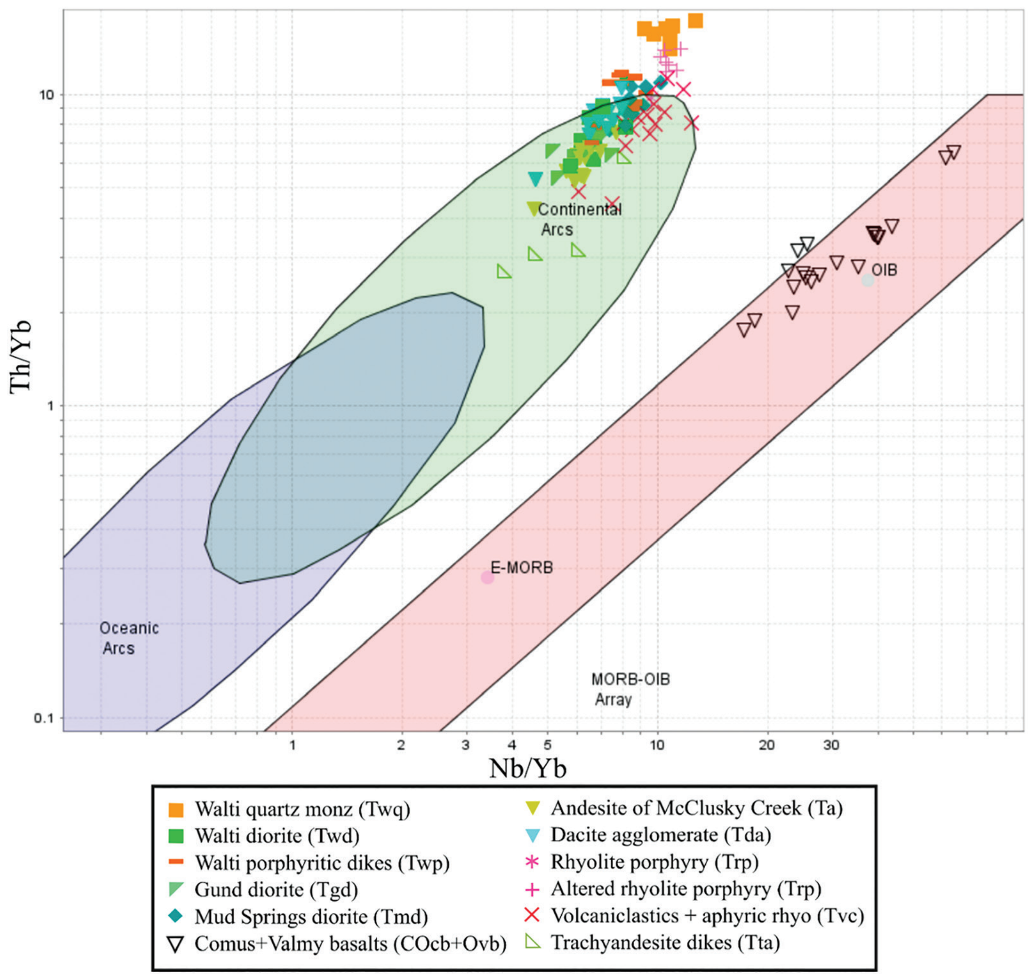

Figure 10. Pearce Element Ratio diagram, illustrating the ocean island basalt (OIB) classification of the Comus and Valmy greenstones, consistent with their lithologic characteristics and those of the enclosing sedimentary rocks.

intrusion and is dominantly propylitic. Argillic, silicification, sodic-calcic and endoskarn alteration are observed in localized areas of the Walti intrusion. Where endoskarn is present, local base metal sulfide concentrations are present. Base metal-rich exoskarn is commonly seen in direct contact with diorite of the Walti intrusion, in particular along the northern margin of the pluton where there are historic workings of the Keystone Mine. Intermediate porphyritic dikes extend from the Walti intrusion and cut Upper Plate rocks to the east and the Mud Springs pluton, and in many cases are associated with argillic alteration (Aliaga, 2018).

Eocene Extrusive Rocks

Eocene volcanic rocks are largely present as a mantle surrounding the Keystone Window on the north and east, and as scattered patches within the window. Age dates given in Table 1 show the volcanic rocks are essentially coeval with intrusive activity at Keystone, and most intrusive and extrusive igneous rocks share similar geochemical compositions. In general, volcanic rocks at Keystone are rhyolite, andesite or dacite in composition and are mostly lavas, but some are also tuffs or volcaniclastics. Importantly, these volcanic rocks provide an exposed Eocene paleosurface, with exploration implications discussed later in this paper. Descriptions of the various Eocene extrusive rocks below are generally organized by age. Figure 11 provides a compositional classification diagram for intrusive and volcanic rocks, for comparison.

Aphyric rhyolite and volcaniclastics (including the basal breccia/Tertiary conglomerate) are present mostly on the east side of the Keystone project, in the Breccia Ridge target area. A few scattered, fault bounded exposures are also present in the northwest quarter of Keystone, where volcaniclastics dominate. At Breccia Ridge, aphyric rhyolite lavas with flow-banding are present overlying a basal, bedded volcaniclastic breccia mapped as Tertiary conglomerate. The groundmass is typically clay-altered to silicified, and nearly all outcrops appear light tan to white or bleached, with scattered FeOx staining and quartz veinlets.

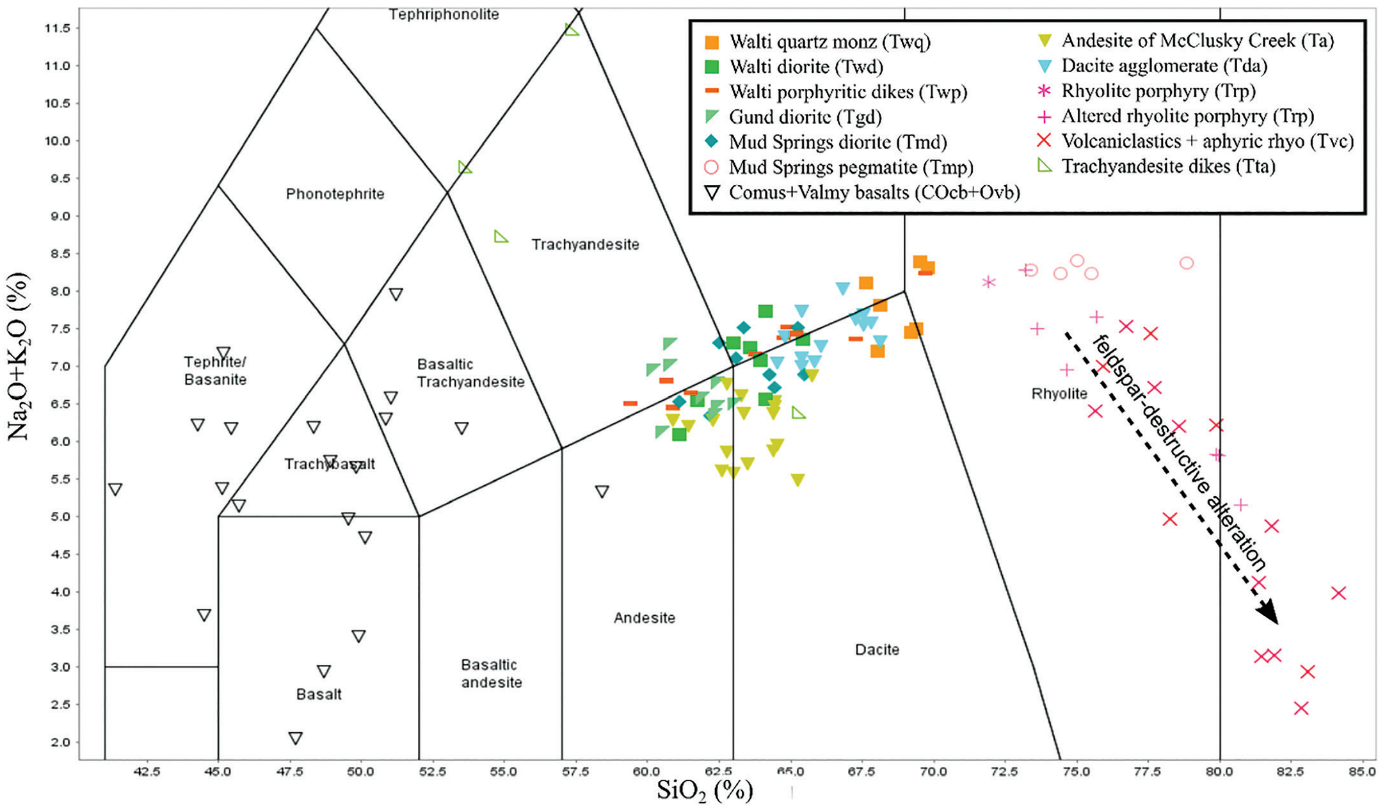

Figure 11. Classification diagram for intrusive and extrusive igneous rocks, illustrating the intermediate dominant nature of igneous rocks at Keystone.

Volcaniclastics and the basal breccia are well exposed at Keystone, especially at Breccia Ridge where the breccia is moderately bedded, highly altered and rests upon Upper Plate siliceous rocks. The breccia is polymict, with angular to subangular clasts of Upper Plate siliciclastic rocks and abundant altered tuffaceous material. Zircons recovered from this breccia yielded a maximum age of 35.62 Ma (Aliaga, 2018). Alteration is very strong and low-grade gold-silver mineralization is present in the aphyric rhyolite and basal breccia. Figures 12 and 13 below show the breccia outcrops and hand samples, respectively.

McClusky Creek Andesite is the most abundant extrusive igneous rock at Keystone and is present along the north and east sides of the project, and well outside as well. The andesite is characterized as lava flows, tuffs, and dikes that cut Upper Plate rocks. In outcrop, the andesite is light gray to maroon-brown in color, and some displays flow-banding, vesicular textures or compaction foliation. Andesite lavas are generally fresh where seen, while the tuffs and dikes are variably altered and typically weather recessively. Alteration is commonly strongly argillic to sericitic, with variable silicification and sulfidation, which has overprinted propylitic alteration. Recent exploration road exposures and drill-hole intercepts demonstrate this alteration is weakly-gold bearing in the north part of the Keystone project.

Dacite Agglomerate is mostly confined to the area surrounding the eastern half of the Mud Springs intrusive and is characterized by tan to reddish-weathering, variably altered lavas and breccias deposited upon the Mud Springs diorite and Upper Plate rocks. Propylitic alteration is common, and local quartz-sericite-pyrite alteration is observed.

Alteration and Mineralization

Skarn-Hornfels and Marble

Contact metamorphic alteration is common at Keystone surrounding the three major intrusions exposed, with some minor endoskarn. In general, massive or thick carbonate rocks form marble. Skarn minerals are more localized and are generally found directly adjacent to the intrusions, along structures and at the marble front. On the other hand, silty limestones, calcareous siliciclastic rocks and greenstones (both Upper Plate and Lower Plate) have largely been altered to skarn and hornfels. Non-reactive siliciclastic rocks form hornfels, usually imparting a change in hardness and texture to the rock, and less so in color.

Directly adjacent to the intrusions, especially the Walti pluton, the clay and silt bearing units form calc-silicates, including diopside, tremolite, idocrase and talc, with some phlogopite and rutile. These minerals impart a dark speckled "salt-and-pepper" look to otherwise grainy-textured calcite-rich marble. Marble grades distally away from the intrusions into recrystallized

Figure 12. Bedded Tertiary breccia in the Breccia Ridge target area. This unit underlies a rhyolite and is variably altered. The unconformable contact with Upper Plate rocks is to the left, outside the view of this picture. Anomalous Au-As-Sb-Hg is present in many outcrop rock chip samples, from veins or faults cutting the breccia.

limestone or structurally controlled skarn, which can be gold bearing as evidenced by recent drilling.

Around the eastern half and at the top of the Mud Springs intrusion there are many bleached, variably brecciated marble exposures of almost pure calcite. These outcrops could represent xenoliths or roof pendants of limestone within the Mud Springs intrusion, or surficial calcite deposits deposited at the Eocene paleosurface. The intensity of the recrystallization along with later hydrothermal alteration and brecciation precludes a clear answer.

At the Keystone Mine and several other areas around the north and northwest contacts of the Walti pluton, base metal rich skarn is well developed in association with the Walti diorite phase (Chapin, 2019). This skarn is directly adjacent to the contact and along several dikes that emanate from the pluton. Mineralogically, the skarn is characterized by fine to coarse grained garnet, amphibole (actinolite), epidote, calcite and quartz. Endoskarn developed within the intrusion consists of garnet, hedenbergite, epidote, plagioclase, orthoclase and quartz.

Base metal skarn mineralization at the Keystone Mine is both oxidized and sulfidic. Oxide mineralization consists of limonite-goethite gossans with cerussite, wulfenite and hemimorphite; malachite and chrysocolla are also present. Sulfide mineralization consists of argentiferous galena, sphalerite, chalcopyrite, pyrite and lesser pyrrhotite. Sulfides occur as seams, clots and disseminations within garnet-actinolite skarn. Directly northeast of the Keystone Mine, along the edge of the marble front, low grade gold-bearing garnet-pyroxene skarn with retrograde epidote was identified in recent drilling along favorable beds in the Devonian Wenban limestone.

Along the east and southeast contacts of the Walti intrusion, and along the north, west and southwest contacts of the

Figure 13. Hand samples from the Tertiary breccia outcrops in Figure 12. Volcanic material is highly bleached, partly silicified and forms both clasts and matrix. Upper Plate siltstone and mudrock clasts are lighter gray.

Mud Springs intrusion, broad areas of Upper Plate and Lower Plate rocks are hornfels- or skarn-altered, though Upper Plate units are more altered than the Lower Plate units. The Lower Valmy, Comus and Horse Canyon units are especially favorable for skarn-hornfels development.

Skarn and hornfels developed in the Comus is most extensive and is different from the skarn and hornfels associated with base metal mineralization at the Keystone Mine. Recent drilling in the Nina Skarn and Sophia areas identified variably gold bearing skarn developed in calcareous Comus and greenstones. Several characteristic, easily recognizable textures within the skarns facilitate drill-hole correlations.

In the Nina Skarn and Sophia areas the lower part of the Comus is consistently tan-brown-gray in color and is logged as biotite hornfels. Thin section work describes a brown-colored sericite, jarosite or siderite as being present, and not biotite. The brown hornfels is cut by veins and fracture-controlled, very fine-grained skarn alteration (Figure 14). The vast majority of the Comus is variable shades of green-pink-gray-white and is characterized by diopside-garnet prograde skarn or hornfels, with fracture and bedding controlled epidote-chlorite-pyrite-magnetite-quartz retrograde skarn overprinting the garnet-pyroxene skarn (Figure 15). Pinkish K-feldspar is present, though its paragenesis is unclear. Clinopyroxene, phlogopite, tremolite and talc were identified by Chapin in thin sections from Comus hornfels as well.

Gold grades up to 2.5 gpt have been encountered in drilling at Nina Skarn and Sophia, within garnet-pyroxene skarn where retrograde epidote and chlorite are present. Intervals several-hundred meters thick of continuous anomalous gold (> 25 ppb Au) have been encountered. Gold correlates best with Cu, and less strongly with Ag, Bi, Te and Zn. In surface soil sampling along the west contact of the Mud Springs intrusion, arsenic correlates with the previously listed elements. Where oxidized, gold bearing skarn commonly displays limonite veinlets and disseminations and occasionally greenish copper secondary minerals. Where sulfidic, pyrite, lesser pyrrhotite and chalcopyrite, and traces of sphalerite, arsenopyrite, molybdenite and possibly bismuthinite are present. Pyrite is the dominant sulfide and is generally present as 1–3% disseminations and veinlets, with local concentrations > 20%. Increased sulfide content seems to have no correlation with increased gold grade. Overall mineralogy at Nina skarn suggests gold mineralization is of the oxidized skarn type, while the As-Bi-Te in soils around the Mud Springs intrusive suggests a reduced skarn may be present as well (Ray, 1998).

Hornfels developed in the Valmy typically causes the otherwise non-reactive siliceous rocks to change color (typically lighter) and become generally harder. Mudstones commonly appear chert-like in outcrop, while chert becomes recrystallized to resemble quartzite. Retrograde alteration consisting of chlorite, epidote and quartz is found in the hornfels.

Carlin-Style Alteration

Carlin-style alteration is identified in many areas of the Keystone project, but is best developed in the Tip Top, Greenstone Gulch, Sophia and Jasperoid Ridge target areas within the calcareous Upper and Lower Plate rocks. The calcareous rocks show decalcification, dolomitization, silicification, calcite veining and argillization, while siliceous Upper Plate rocks show variable silicification, quartz veining and argillization. Igneous rocks are variably argillized or sericitized, especially dikes and sills.

The best exposures of Carlin-style alteration at Keystone are at Tip Top, mostly in Devonian Lower Plate rocks in an

Figure 14. Lower Comus hornfels, "biotite hornfels", cut by fracture-controlled skarn of currently uncertain mineralogy. Interval assayed 10–32 ppb Au with anomalous Cu-Bi-Te-Tl.

Figure 15. Comus garnet-pyroxene skarn with retrograde quartz-chlorite-epidote-pyrite alteration. Lighter colored rock at lower right is greenstone. Interval assayed 42–119 ppb Au with anomalous Ag-Bi-Te.

area that was fairly extensively drill tested with mostly shallow drilling. Alteration here is controlled by both stratigraphy and structure. Decalcification is widespread and though it is typically weathering recessively, it is well exposed in road cuts. Decalcification makes limestone punky to powdery in outcrop, with explosive HCl reactivity likely due to surface carbonate deposition in pore space. In drill-holes, decalcified limestone is soft, punky and absorbent with little to no HCl reactivity. Multi-element analyses show depletion in Ca, Mg and Sr in decalcified limestone samples. Figure 16 below illustrates decalcified Wenban limestone in a core hole from the Tip Top target area.

Decalcification from hydrothermal fluid moving along the Devonian Wenban-Horse Canyon contact developed aerially extensive collapse breccias at Tip Top, as well as at Sophia. Collapse breccia at this contact is not well exposed at the surface at Sophia, but is better seen where encountered in several drill-holes, with voids up to 20 feet across. Figure 17 illustrates Devonian Horse Canyon collapse breccia in drill core from the Sophia target area.

Dolomitization is more localized than decalcification and is well developed in Devonian Lower Plate rocks at Tip Top, both in outcrop and in drill-holes. Dolomitization in both cases

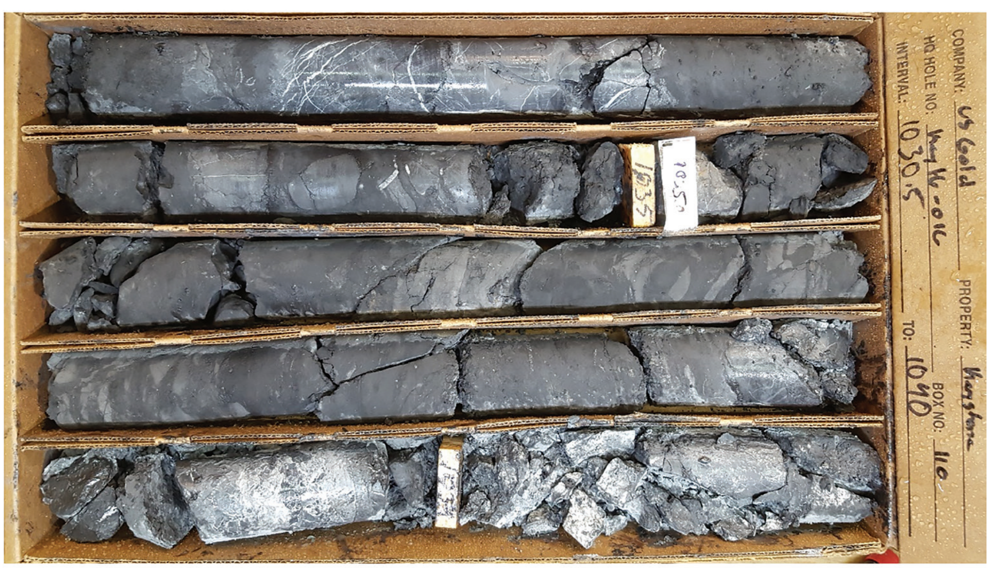

Figure 16. Strongly decalcified Wenban unit 8 limestone below gold mineralized zone. Interval assayed 6 ppb Au with anomalous As-Mg-Mn.

Figure 17. Oxidized collapse breccia developed in Horse Canyon above a steep dipping fault. Interval assayed 18–51 ppb Au with anomalous As-Sb-Ba-Tl-Hg and Cu-Zn-Ni-Co. Au to 144 ppb, Hg to 42 ppm and Tl to 167 ppm present throughout the collapse breccia illustrated here.

is intimately associated with the strongest gold mineralization. In outcrops, dolomitized limestone is pink-orange in color, sparry and is mostly confined between the Horse Canyon-Wenban contact and a west-northwest-striking, shallow south-dipping, gold-mineralized fault cutting the Wenban unit 8. Multi-element analyses show a strong increase in Mg and decrease in Ca where limestone is dolomitized. In addition, the textures and colors are changed, imposing a lighter gray-tan color and sugary texture to the rock. The highest gold grades encountered in drilling at Keystone to date (4 gpt+) are directly adjacent to or within dolomitized limestone. Figure 18 illustrates dolomitized limestone in drill core from the Tip Top target area.

Silicification and jasperoid development is extensive throughout the Keystone project. Jasperoids are commonly developed along specific contacts, such as the Horse Canyon-Wenban contact, along major thrust faults like the Roberts Mountains Thrust, or along steeply dipping northwest and northeast striking faults. Silicification in Upper Plate rocks commonly displays quartz veinlet swarms and is best developed in carbonate rich or homogenous, brittle rocks such as limestone, siliceous or calcareous mudstone or sandstone-quartzite. Not all jasperoids are gold bearing; drill intercepts and outcrop data show that the silicified zones and jasperoids are generally only weakly gold mineralized. Figure 19 illustrates gold barren jasperoid in drill core from the Gund North target area.

Above and around many Carlin-type deposits a strong calcite veinlet swarm "halo" has been developed, and this is seen at Keystone above or adjacent to decalcified-dolomitized-silicified zones. These calcite halos are useful in identifying focused targeting areas or in deciding when to stop drilling. Figure 20 below illustrates a calcite halo outboard of silicification in drill core from the Gund North target area.

Argillic alteration mostly affects intrusive rocks, both Tertiary dikes and Paleozoic greenstones. In the Tip Top and Sophia target areas, argillized dikes are spatially associated with mod-strong, variably gold bearing Carlin-style alteration in sedimentary rocks. Clay minerals identified in these dikes are mostly illite or kaolinite. Illite from altered dikes in drill core at Tip Top has been dated at 35.54 Ma (Aliaga, 2018). Figure 21 below illustrates the argillized dike from which the dated illite was extracted from drill core.

Figure 18. Dolomitized Wenban 8 unit limestone. Interval assayed 40 ppb Au with anomalous As-Mg-Mn-Zn.

Figure 19. Jasperoid developed in Wenban limestone directly below the Roberts Mountains Thrust. Interval assayed < 5 ppb Au with anomalous As-Hg-Sb-Tl-Zn.

Epithermal-Hot Spring Alteration

Epithermal and hot spring styles of alteration and mineralization are scattered across the Keystone project but are mostly in Lower Plate rocks along the western range front. Gold-silver bearing quartz vein-matrix breccias are present, along with separate thick masses of travertine-like calcite-aragonite, jasperoid and breccia without gold, all hosted in Lower Plate carbonates or along the western range front.

Gold-silver mineralization and alteration with characteristics similar to both low sulfidation epithermal deposits and Carlin-types is present in the PDF target area. A small collapse breccia developed in Wenban limestone is present there, confined to the intersection zone of north-northwest, north-south and north-east striking gold bearing faults. Weak jasperoid is developed, along with gold-silver bearing, sugary white to greenish quartz veins and breccia cement. A calcite carapace is present at the roof of the collapse breccia. Gold correlates with silver and Hg, As and Ba are somewhat elevated. Arsenic is fairly low, ranging from < 100–200 ppm. Of importance, Se and Te are not anomalous or are absent in rock samples from the breccia. Gold values are in the 0.5–2 gpt range, while silver values are typically 1–25 gpt. Placer Dome drilled two shallow holes here in 2005, but based upon US Gold Corp mapping and structure contour work, they drilled through a major north-

Figure 20. Calcite veinlet swarm ("Calcite Halo") below jasperoid developed in Wenban limestone. Interval assayed <5 ppb Au with weakly anomalous Ba and Sb.

Figure 21. Illitized andesitic dike cutting Wenban limestone. Interval assayed < 5 ppb Au with anomalous Mg-Mo-Sb-Zn.

south bounding fault at 100 ft and stayed in the footwall of the entire zone to 1,100 ft, with no significant gold intercepts. With hindsight, a better drill test would have been oriented west to east, instead of north to south, and would have accounted for the plunge of fault zone intersections.

This style of gold mineralization is visually similar to the Pinion deposit south of Carlin (Figure 22) and to some mineralization the lead author observed in the Dee and Meikle mines north of Carlin. Figures 23 and 24 below illustrate the gold-silver bearing quartz cemented collapse breccia at PDF.

Hot springs are present in the vicinity of the PDF and Potato Canyon target areas, and at the Gund Ranch just off of the range front. The hot springs are localized along the north-south trending range front faults. However, hot water (>200°F) was encountered in drilling in Potato Canyon, well away from the range front faults. Many of the scarps along the west range front at Keystone are held up by thick ledges-veins of travertine-like calcite. Inward from the range front, scattered mounds of travertine-like calcite are present in Wenban limestone, with associated alteration that resembles Carlin-type in style and geochemistry. Decalcification, silicification, calcite veining, bleaching and brecciation are present in association with some of the travertine deposits, with highly elevated Hg, Tl and Sb, but with little As and rarely detectable Au or Ag. It is unclear if the travertine is overprinted on older Carlin-style alteration or not, though the lack of As and precious metals in rocks and soils suggests it may not. Much of this alteration and the travertine is located along faults that were likely active beginning in the Miocene and are still active today.

Supergene Oxidation

Supergene oxidation is ubiquitous at Keystone. While most areas show orange-brown limonite after oxidized sulfides or transported limonite on fractures, large areas are hematitic, deep maroon to purple-red and bleached. How much of this maroon oxidation is related to mineralization is unclear, but the similarity in color and character to rocks observed by the lead author in the Rain and Goldstrike districts is striking. Given that the Eocene paleosurface is present at Keystone, Rain and Gold-

Figure 22. Gold mineralized core from the Pinion deposit, Railroad district, Elko Co., Nevada (after Bogner, 2014).

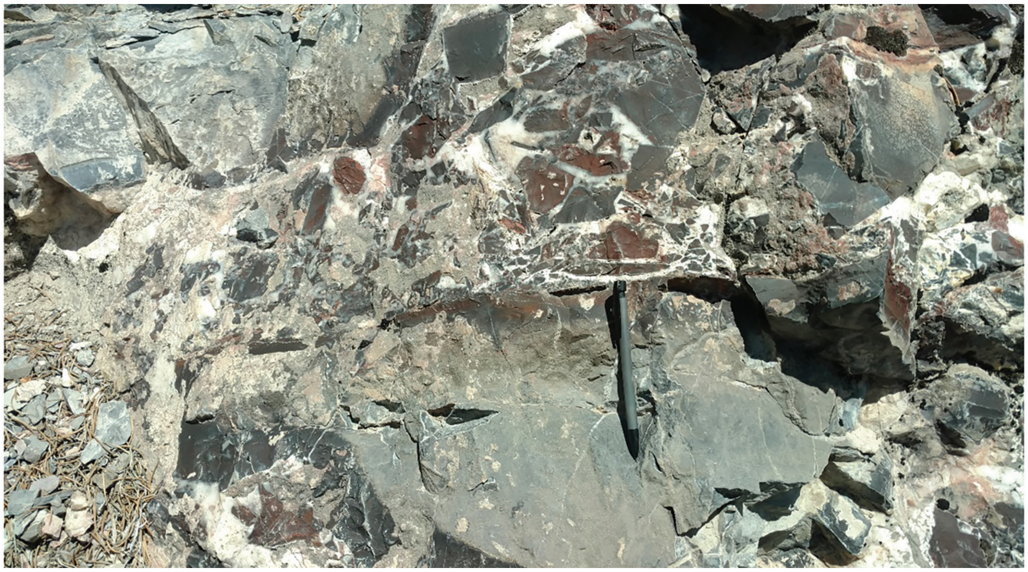

Figure 23. Close-up view of PDF collapse breccia developed in Wenban 5 unit limestone. Note the narrow silicified rind (jasperoid) development around the breccia and silicification of clasts, within quartz matrix. A rock chip sample from this breccia assayed 1.255 ppm Au and 2.81 ppm Ag, with anomalous As and Cr.

strike (Arturo-Dee), the hematitic staining may represent deep tropical weathering and not be reflective of underlying mineralization; drilling to date certainly supports that hypothesis. Another possibility is the extensive oxidation may represent near Eocene paleo-surface steam heated or hot spring activity.

Areas with exposed anomalous gold mineralization are commonly colored by a mixture of orange-red iron oxides unlike the maroon-purple oxidation mentioned above. Orange-red oxides are seen in Upper Plate and Lower plate rocks, even those close to the Walti pluton, meaning this style of oxidation

Figure 24. Looking northwest at the PDF collapse breccia. Note carapace of calcite at the top, with quartz matrix breccia below and quartz-jasperoid bedding conformable zones to the right. Top center is jasperoid developed along a N35E striking fault. The north-south striking bounding fault is located directly behind the tall tree along the right side of the breccia zone. Host rocks are Wenban units 5 and 4.

is likely supergene, as the rocks currently exposed around the Walti pluton were much deeper below the Eocene paleosurface when the Walti was intruded.

Goethite-limonite gossans are locally developed in many places around the Keystone project. The largest occurrences are present in the vicinity of the Keystone Mine and in the southeast quarter of the project (South Cross target area), hosted in Devonian Wenban and Slaven Formations, respectively. While the gossans at the Keystone Mine represent oxidation of skarn hosted sulfide minerals, the gossans in the South Cross area may reflect SEDEX massive sulfide deposits related to bedded barite in the Slaven and are not precious-metals bearing. Authigenic pyrite is abundant in the Slaven Formation, and this pyrite could also have been caused by biologic activity (Chapin, 2020, personal communication)

Breccias

Tectonic Breccias

Tectonic breccias are common throughout the Keystone project and reflect many different ages of faulting-fracturing. Tectonic breccias are typically identified by context, in which they are mostly confined to fault zones. These fault breccias can be altered and mineralized, or not. Clasts can be sub-angular to rounded and matrix can be rock flour or gouge. Some tectonic breccias are mineralized and cemented by quartz-silica or calcite. Figure 25 illustrates a mineralized fault-tectonic breccia in drill core from the Simpson Hills target area.

Collapse Breccias

Collapse breccia is also widely scattered throughout the Keystone project. Collapse breccia is typically a dissolution product, and as such it is present in many areas along the Horse Canyon-Wenban contact. Collapse breccias are also developed at the intersections of alteration-mineralization controlling faults and favorable lithologies (ie. Wenban unit 5). Collapse breccias are a common feature in many Carlin-type deposits throughout Nevada and make great hosts for gold mineralization.

See Figures 17, 23 and 24 for good examples of collapse breccias.

Pebble Dikes-Convective Breccias

In the Sophia target area, several north-northwest-striking, steeply-dipping gold-arsenic- bearing breccia veins are present. These breccia veins are up to a half meter wide, clast supported with sub-angular to rounded clasts of highly altered sedimentary rocks and igneous rocks, much resembling conglomerate. The veins are typically silicified, though some igneous clasts are still clay-rich; igneous clasts that are silicified are vuggy from leached feldspar phenocrysts. Outcrop and hand sample observations are unclear as to Upper Plate or Lower Plate affinities for the sedimentary clasts. Gold grades are generally >0.300 ppm and arsenic values are > 1000 ppm to > 1%. Unfortunately, we do not have a photograph of one of these breccia veins.

Figure 25. Poorly mineralized fault-tectonic breccia zone developed in Wenban limestone. Fault plane is at 507 ft. Note gouge and strong sulfide above the plane, and dolomitized-dolomite veined breccia in the immediate footwall of the plane. Interval assayed < 5–6 ppb Au with anomalous As-Ba-Hg-Mg-Mo-Ni-Sb-Tl-Zn. Tl is especially high, to 30 ppm.

EXPLORATION

Pre-1966 Mining-Exploration History

Historic mining in the Roberts Mining District was limited to the Keystone Mine, located within and at the northern end of the Keystone project. Discovered in 1870, the mine produced a small but unknown amount of silver-lead-zinc and copper before 1948 from polymetallic skarn deposits developed along the northern contact of the Walti pluton. Ore was processed in a small mill and smelter built at the Keystone townsite and was shipped out for processing at later dates. Limited records between 1948–1962 give a production of 114 tons of ore, which produced 417 oz t Ag, 17,900 lbs Pb, 19,800 lbs Zn and 1,400 lbs Cu (Roberts and others,, 1967).

Many small, very obscure prospect pits are scattered throughout the Keystone project, which explore iron stained or silicified exposures in both Upper Plate and Lower Plate rocks. Given how weathered and overgrown many of these prospect pits are, they likely date to the late 1800's.

Turquoise exploration occurred in several areas at Keystone, though no records exist of this work. Bulldozer cuts and pits in the Sophia and Greenstone Gulch target areas expose scattered fracture coatings and veinlets of turquoise and variscite hosted in Upper Plate rocks. This work likely occurred between the 1950s and 1970s.

1966–2019 Exploration

Many major and junior mining-exploration companies and private individuals held and-or explored various small claim blocks throughout the current Keystone project area between 1966 and 2015. The vast majority of the exploration work was completed in the early 1980s, with another large push in the mid 1990s, nearly all of it directed at precious metals exploration, primarily gold. None of this work led to the definition of an orebody, though drilling did encounter spotty gold, silver and base metal mineralization of potentially economic grades in many areas. A summary of the work completed between 1966 and 2019 is given below in outline form, generally in chronological order.

- 1966—Bear Creek Mining examined the Keystone Mine and took a few rock samples but did not acquire the project.
- 1967—Newmont Exploration drilled six rotary holes in the pediment area at the northwest corner of the Keystone project, looking for Carlin-style gold. Low grade (<0.500 ppm) gold was encountered in several holes, but Newmont walked away.
- 1968—Union Pacific examined the Keystone Mine area but did not acquire the project.
- 1971–1981—Exxon was active in the northern part of the project area. BLM records show they drilled in 1981, but no data or drillhole location maps have been located.
- 1972—Norandex examined the Keystone Mine, took one rock sample, but did not acquire the project.
- 1972–1980—Two drilled by unknown parties were located during mapping along the eastern flank of the Keystone project. One hole was drilled in a small phyllic alteration zone on the south side of the Mud Springs intrusive, likely looking for porphyry copper style mineralization. The other is further south in the vicinity of bedded barite prospects hosted in Devonian Slaven Formation, suggesting it may have been drilled to evaluate barite. The well overgrown and weathered nature of the associated disturbance suggests these were drilled pre-1980.
- 1980—Chevron acquired claims in the northern half of the Keystone project and completed some mapping and sampling.
- 1981—Chevron drilled 24 shallow rotary holes in the Keystone Mine area. Spotty gold mineralization to 3 ppm over widths of 5–15 feet was encountered in several holes. Most of these holes were drilled in the Tip Top target area.
  - —Baroid Drilling Fluids did some trenching in bedded barite occurrences in the southeast quarter of the Keystone project.
- 1982—Chevron drilled six shallow rotary holes to follow up on 1981 drilling. Chevron then gave up control of the project to USMX (US Minerals Exploration).
- 1983—USMX drilled 19 holes, mostly in the Tip Top target area.
- 1984—Noranda entered into a JV with USMX. Completed geologic mapping, took 99 rock samples and 222 soil samples, on an ~300 × 300 ft grid. Noranda drilled five rotary holes.
  - —Arista Gold & Silver, Inc. acquired claims in the north area of Keystone, took 36 rock samples.
- 1985—Arista completed additional geologic mapping, took 182 rock samples 882 soil samples on east-west lines. Also considered twinning Newmont drillhole K-4.
  - —Placer Dome leased the Arista claims in late 1985 and completed additional geologic mapping, soil and rock sampling.
- 1986—Placer Dome completed additional geologic mapping, took 34 rock samples and 918 soil samples. Drilled six rotary holes, then terminated the lease.
- 1987—Arista drilled three rotary holes, two of them deepening previous holes.
  - —Nerco Minerals did some trenching and drilling on claims within the Keystone project, but no data or location information known.
- 1988—Coral Resources leased the Arista claims, drilled 10 RC holes.
- 1989—Coral Resources drilled nine rotary holes.
  - —Golden Reef did some drilling in the Keystone project, but no data or location information known.

- 1990—Coral Resources drilled 21 holes, one deepening hole MP89-2. No location information or data known for the 20 other holes.
- 1994—Placer Dome returned to the Keystone project, took 393 soil samples and 105 rock samples.
  - —Cameco US Inc. leased claims in the Sophia target area from Gary Clifton, completed geologic mapping and rock sampling, drilled two rotary holes.
  - —Western Mining Corp. drilled within the Keystone project, but no data or location information known.
- 1995—Uranerz located the Golden Key project at Keystone, completed aerial photography and purchased mag survey data from Placer Dome.
- 1996—Uranerz completed geologic mapping and rock sampling. Took 10 rock samples, 78 enzyme leach samples and 730 soil samples. Drilled 13 rotary holes; location data are poor.
  - —Golden Glacier Resources completed a promotional report on previous Arista claims.
- 1999—Nevada Pacific Gold Ltd. (NVP) acquired claims over part of the Keystone project but completed no geologic work, or no data are known.
  - —Great American Minerals (GAM) began acquiring claims between 1999 and 2005. No data are known for any geologic work completed.
- 2005—Placer Dome returned to Keystone and leased the NVP and GAM claim blocks.
  - —Placer completed geologic mapping on NVP claims, took 1,540 soil and soil gas samples spaced ~120m apart, took 749 rock samples and 14 fossil samples for biostratigraphic purposes. Completed a detailed aeromag survey, 15 CSAMT lines for 32.3 line-km, and a gravity survey with 771 stations. Drilled two RC holes, including the deepest at Keystone (2,520 ft), in the Simpson Hills target area.
  - —Placer completed geologic mapping on GAM claims, took 434 soil samples and 415 soil gas samples spaced ~120 m apart, took 311 rock samples and 9 fossil samples for biostratigraphic purposes. Completed a detailed aeromag survey, 3 CSAMT lines for 4 line-km, and a gravity survey with 582 stations. Drilled two poorly designed holes in the PDF target area.
  - —US Gold Corp. (now McEwen Mining) drilled 35 core and RC holes in the northern part of the Keystone project, mostly around the Keystone Mine.
- 2006—Placer Dome drilled one additional RC hole in the Simpson Hills target area. Barrick Gold took over Placer and the Keystone leases were dropped.
- 2009—Golden Predator Royalty & Development Corp held claims on the west side of the Keystone project but did not complete any geologic work.
- 2015—Dave Mathewson (Nevada Gold Ventures) and Don McDowell (Americas Gold) staked claim blocks together to consolidate the Keystone district.

2016–2019 Exploration by US Gold Corp.

- 2016—US Gold Corp. acquired the Keystone project and began surface exploration work, including geologic mapping, rock sampling, gravity surveys, and additional claim staking. 82 rock samples were taken, a gravity survey with 1,134 stations completed and five scout diamond core holes were drilled. No significant gold intercepts were encountered, but several holes showed thick intervals of anomalous gold with Carlin-style alteration and trace element geochemistry.
- 2017—US Gold Corp. staked additional claims and expanded surface exploration work. A gravity survey with 381 stations was completed, along with a ground magnetic survey in the Keystone Mine area, consisting of 41 line-km in 50 m spaced lines. Geologic mapping was ongoing and surface sampling included: 704 rock samples, 1,328 soil samples, 589 stream sediment samples and 618 altered cobble samples. In addition, one diamond core scout hole and 10 RC holes were drilled across several target areas. Two of the holes encountered significant gold mineralization: Key17-04rc and Key17-07rc.
  - —Key 17-04rc was drilled in the Tip Top target area and encountered 25 feet of 0.038 opt Au (7.6 m of 1.291 gpt) starting at 955 feet (291.1 m). This intercept is localized within a broad tectonic breccia zone along the Roberts Mountains Thrust and is Carlin-style in alteration and geochemical signature. Strongly anomalous Au-As-Sb-Tl-Hg-Zn-Mg characterizes the interval. Gold is directly adjacent to dolomitized Wenban Limestone and Carlin-style alteration is terminated at depth against a broad shear zone with strongly anomalous (> 1,000 ppm) Zn and V.
  - —Key17-07rc was drilled in the Sophia target area and encountered 30 feet of 0.015 opt Au (9.1 m of 0.502 gpt) starting at 1,100 feet (335.3 m). This intercept is interpreted to be highly bleached and silicified Comus skarn, with abundant arsenopyrite. Highly elevated Au-As-Sb-Bi-Te with less Tl and Hg suggests a reduced skarn environment with a Carlin-style overprint, or a transition between the two geochemical domains.
- 2018—US Gold Corp. continued surface exploration work and completed additional drilling. A gravity survey with 604 stations was completed. Geologic mapping was completed and a Master's Thesis describing and dating the igneous rocks and some alteration was completed. Surface sampling was ongoing and included: 1,152 rock samples, 3,194 soil samples, 77 stream sediment samples and 43 altered cobble samples. In addition, between 2017 and 2018, 96 fossils were collected and submitted for biostratigraphic work. The BLM and NDEP finalized an Environmental Assessment and approved a Plan of Operations for up to 200 acres of disturbance. 15 RC holes were drilled in several target areas, some with no previous drilling historically.

Three holes encountered significant gold mineralization or strongly anomalous alteration and pathfinder metals with important future exploration implications: Key18-03rc, Key18-09rc and Key18-11rc.

— Key18-03rc was an angle hole drilled in the Sophia target area, the southern-most hole to date. The hole encountered 25 feet of 0.011 opt Au (7.6 m of 0.363 gpt) and 1.404 opt Ag (48.071 gpt), starting at 1,840 feet (560.8m). This intercept is interpreted to be in the upper part of the Wenban unit 5 and the hole was lost in many voids below. Chips are silicified limestone cut by abundant quartz-calcite-stibnite veinlets. Geochemically, the entire interval into the multiple voids is anomalous in Au-Ag-As-Sb-Hg-Tl-Se-Te-W. With the occurrence of trace amounts of realgar observed in drilling at Tip Top, the stibnite in this intercept is the only other occurrence at Keystone of low temperature minerals characteristic of Carlin-type gold deposits elsewhere in Nevada. Silicified limestone with quartz-stibnite veinlets and low-grade gold has been observed by the lead author at the Goldstrike mine lying directly adjacent to gold orebodies.

— Key18-09rc was drilled in the Sophia target area, near the interpreted intersection of northwest and northeast striking fault zones. The hole encountered two distinct styles of mineralization, with the best intercept being 20 feet of 0.033 opt Au (6.1 m of 1.135 gpt) starting at 965 feet (294.1 m). This intercept is of Comus Forma-

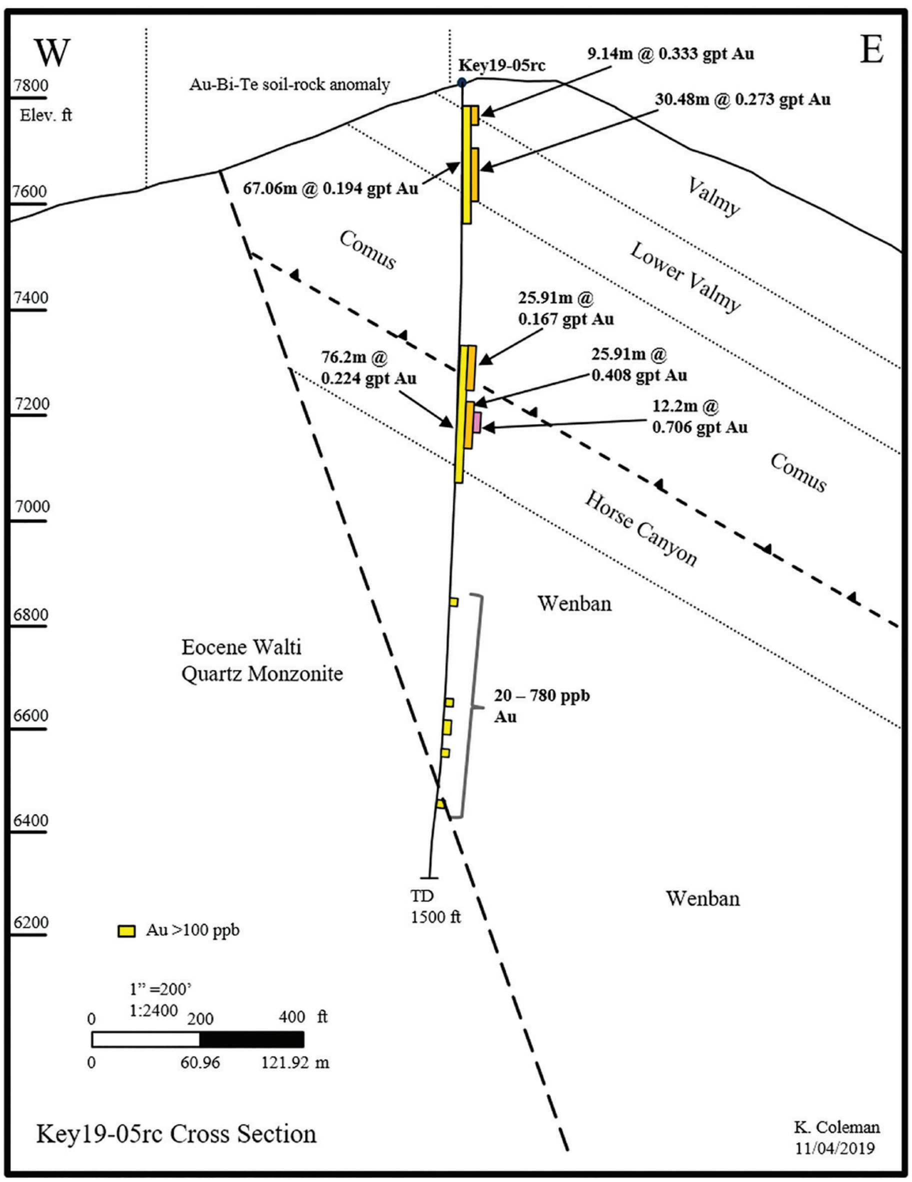

Figure 26. Note two thicker gold intercepts, which are open in all directions.

Table 2. GOLD INTERCEPTS FROM KEY19-05RC IN THE NINA SKARN TARGET AREA.

Key19-05rc	From (ft)	From (m)	To (ft)	To (m)	Length (ft)	Length (m)	Au Intercept (opt)	Au Intercept (gpt)
	40	12.2	260	77.7	220	67.06	0.006	0.194
Including	40	12.2	70	19.8	30	9.14	0.010	0.333
and	120	36.6	220	65.5	100	30.48	0.008	0.273
	495	150.9	745	225.6	250	76.2	0.007	0.224
including	495	150.9	580	175.3	85	25.91	0.005	0.167
and	600	182.9	685	207.3	85	25.91	0.012	0.408
including	**615**	**187.5**	**655**	**198.1**	**40**	**12.2**	**0.021**	**0.706**

tion garnet-pyroxene skarn with variable quartz-pyrite-epidote-chlorite-magnetite. Geochemically, the interval is anomalous in Au-Cu-Te-Bi.

— Beginning at 1,200 feet and continuing to the end of Key18-09rc (1,625 ft), the rock is mostly oxidized and brecciated across the Upper Plate-Lower Plate contact zone. The hole was lost in a 20-foot wide open void hosted in Horse Canyon collapse breccia. This entire 400-foot interval is interpreted to be Carlin-style alteration which overprints the skarn in the Comus and affects Lower Plate carbonate rocks. Decalcification, argillization and silicification are the alteration styles observed throughout the 400 foot interval, which is strongly anomalous in Au-As-Sb-Hg-Tl-Zn and lesser Cu-Ni-Co-V. High values include: 250 ppb Au, 4,938 ppm As, 723 ppm Sb, 13 ppm Hg, 380 ppm Tl, 7,401 ppm Zn.

— Key18-11rc was drilled in the Tip Top target area and encountered 40 feet of 0.017 opt Au (12.2 m of 0.592 gpt) starting at surface. Brecciated, variably decalcified and silicified, limonitic and calcite veined Wenban unit 8 limestone characterizes the interval, which is geochemically anomalous in Au-As-Sb-Hg-Tl-Zn-Ba-Ni-W. Alteration and anomalous geochemistry is less continuous throughout the top 400 feet of the hole, with similar anomalous geochemistry. Trace amounts of realgar and arsenopyrite were observed.

- 2019—US Gold Corp. carried out reduced surface exploration and drilling activities. Limited target scale detailed geologic mapping and rock sampling was completed, with 86 rock samples taken. One diamond core hole was drilled along with six RC holes, in several target areas, including the first ever hole drilled in the Nina Skarn target area.

— Key19-01c, the core hole, tried to twin Key18-09rc to explore beyond the 20 foot- wide void encountered in that hole. The core hole did not reach the void; however, it did verify the geologic logging in Key18-09rc and encountered much of the same mostly oxidized, Carlin-style alteration and collapse breccia. 357 feet of Carlin-style alteration and geochemistry was encountered before drilling through a fault zone into Wenban marble. Au is continuously anomalous over the 357 feet, from 8–2,112 ppb, with associated strongly anomalous As-Sb-Hg-Tl-Zn-Bi-Mo-Cu. High pathfinder metal values include: 2,780 ppm As, 43 ppm Hg, 167 ppm Tl and 185 ppm Sb.

— Key19-05rc, the hole drilled at Nina Skarn, shows the thickest strong gold intercept ever encountered at Keystone. This hole encountered 1,365 feet (416 m) of continuously anomalous (average 93 ppb Au), mostly oxidized, gold mineralized skarn-hornfels-marble, starting at surface. Two thick intercepts of stronger gold mineralization were encountered within the 416 m interval, detailed in Table 2 below. Skarn developed in the Lower Valmy, Comus and Horse Canyon hosts the strongest gold mineralization; skarn is weakly developed in otherwise marbleized Wenban limestone (Figure 26). Gold correlates best with copper throughout the interval, but the upper and lower thicker intervals have different geochemical signatures. The upper 67 m intercept is anomalous in Au-Cu-Ba-Tl while the lower 76 m intercept is anomalous in Au-Cu-Mo-Zn-Bi-Te. The anomalous Ba and Tl in the upper intercept may represent an overprint of Carlin-style mineralization.

DISCUSSION AND CONCLUSIONS

All work to date at Keystone has increased the overall prospectivity of the project to host significant gold deposits. The location of Keystone along the western margin of the Battle Mountain-Eureka gold belt, favorable host rocks and Late Eocene intrusions, and a variety of gold bearing alteration assemblages make the project worthy of further exploration. Recent work by US Gold Corp has focused on several areas with little to no historic exploration, and we see these areas as most prospective for gold deposits.

Aliaga's (2018) work dating the various intrusions at Keystone is one of the biggest advancements in the regional and project scale geology in the Cortez region. Magmatic activity at Keystone is almost certainly responsible for driving hydrothermal activity at Keystone and may be responsible, as well, for mineralization at Tonkin Springs, 5 miles east of Keystone. However, exposed intrusions at Keystone may not necessarily be responsible for exposed or drilled gold mineralization. In 2018, weakly anomalous gold mineralization (10–20 ppb Au) was encountered in drilling within clay-calcite-chlorite-pyrite altered Walti quartz monzonite, suggesting at least one gold event occurred ~35 Ma or slightly later. As documented by Arbonies (2010) in the Cortez district, a mineralized quartz porphyry dike yielded an age of 35.3 Ma. It is possible intrusions exposed at Keystone represent a near paleosurface expression of a broader magmatic system that was active at Cortez and Keystone and may underlie the entire region at greater depth.

Late Eocene volcanic rocks surround the Keystone window and the Eocene paleosurface is preserved in many places. This may have exploration implications for Keystone, mostly in relation to Carlin-type gold deposition. Most Carlin type deposits are accepted to have formed at depths of ~1.7–5 km below the Eocene paleosurface, though some (ie. Alligator Ridge) formed 300-800 m below Eocene paleosurface (Cline and others, 2005). This suggests the potential for big Carlin type deposits at Keystone is at great depths, limited to potentially underground exploitable deposits. However, Carlin-style alteration and gold mineralization is exposed at surface at Keystone, and given the ~1 km depth of emplacement of intrusions at Keystone, any near surface deposits yet to be discovered may be more like orebodies at Alligator Ridge or Gold Bar: smaller and unlike the big deposits to the north.

Drilling in the Nina Skarn target area identified strongly anomalous gold mineralization in between the Walti and Mud Springs intrusions. One exploration concept being used at Keystone is the zoned Eocene magmatic model, as the lead author observed when working in the Cove-McCoy district. At Cove-McCoy, a gold bearing skarn at McCoy is centered about a multi-phase Eocene intrusive, and distal to that, the Cove polymetallic and Carlin-style gold deposits are present (Johnston and others, 2008). A similar setting is present at Keystone, with

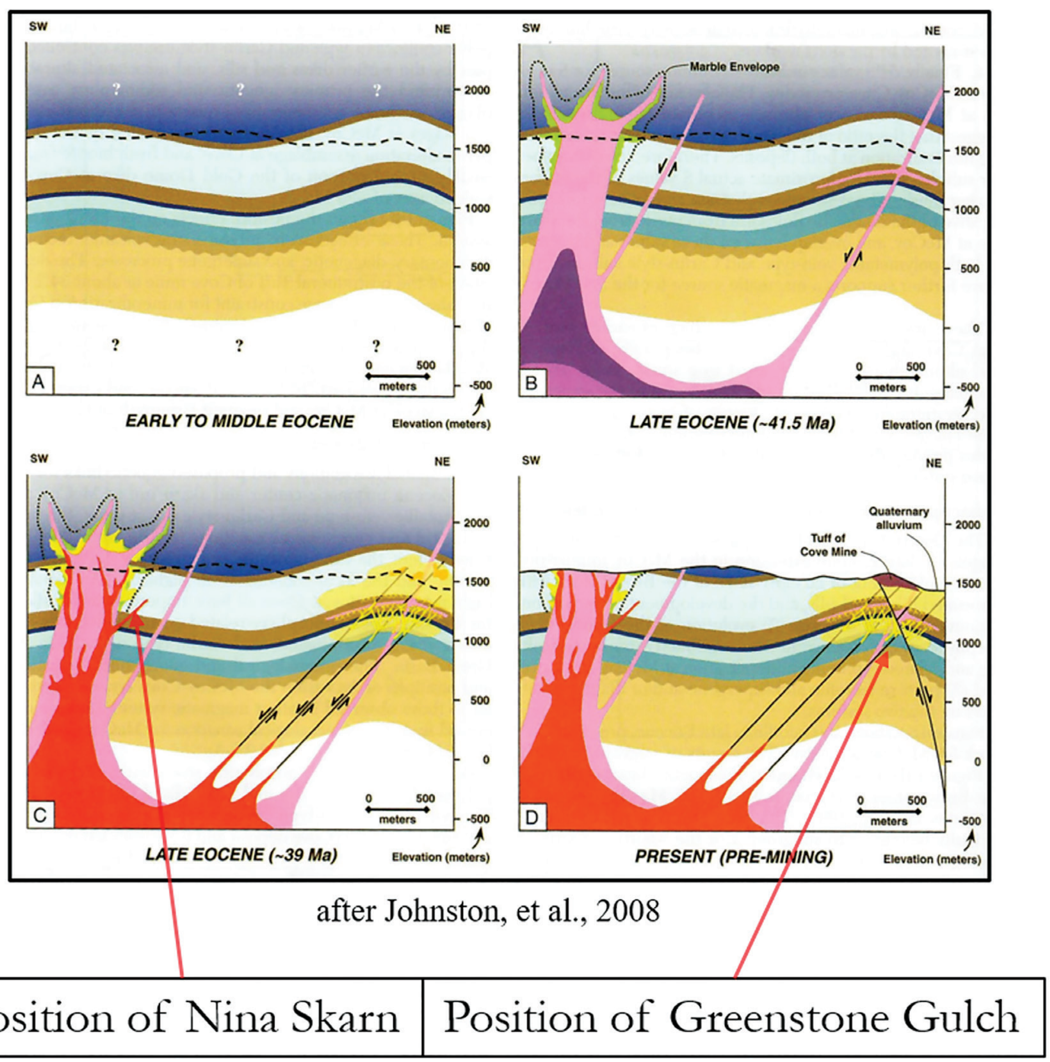

Figure 27. Zoned Eocene magmatic model for Cove-McCoy district, with postulated positions of further exploration targets at Keystone (after Johnston and others, 2008

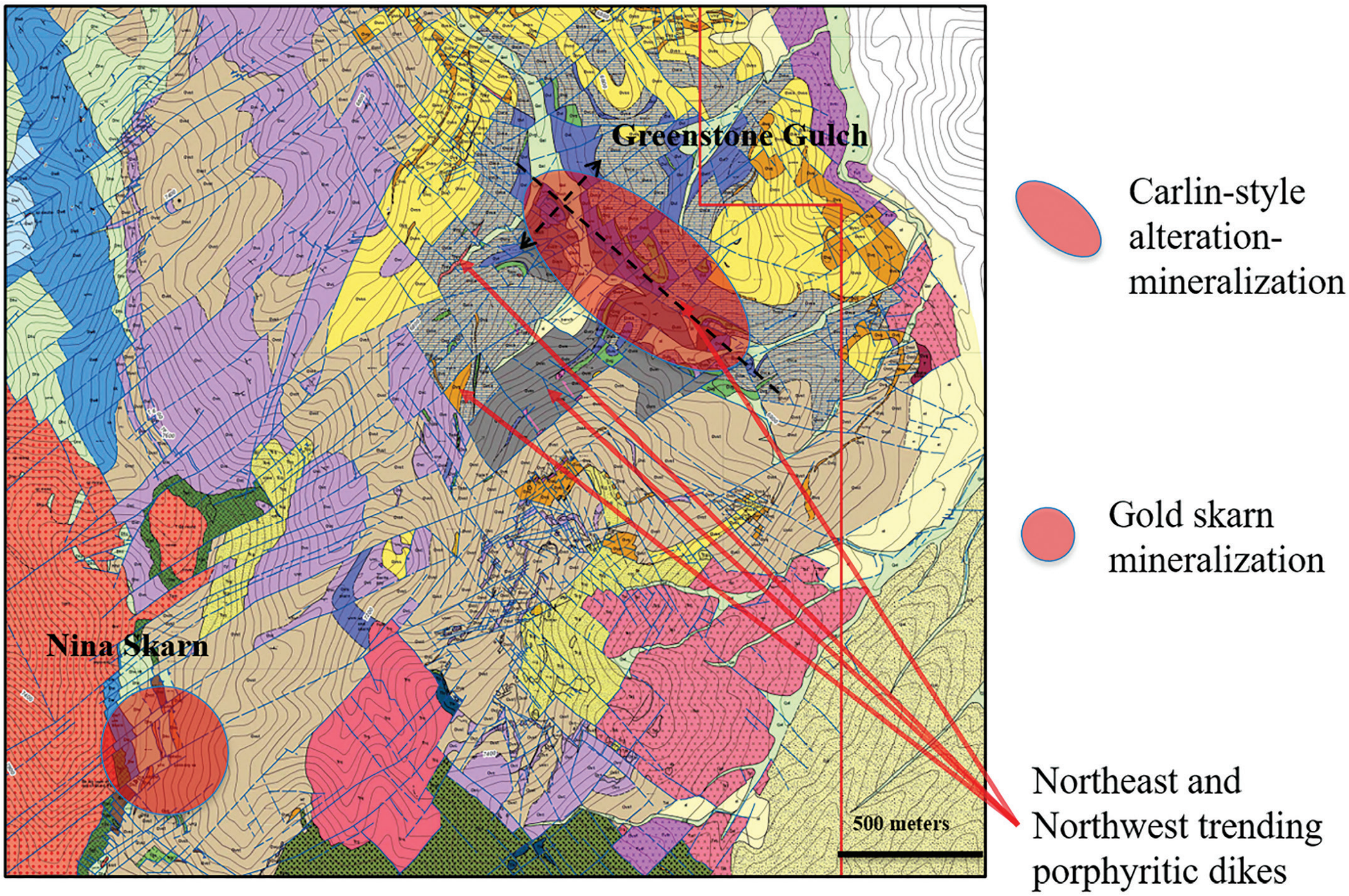

Figure 27. Greenstone Gulch target area relative to the Nina Skarn gold mineralization.

a yet to be tested target area, Greenstone Gulch, representing the strongest candidate for Carlin-style mineralization distal to the gold mineralized Nina Skarn (Figures 27 and 28). Comus Formation is exposed and altered at surface in Greenstone Gulch, with Lower Plate carbonate rocks expected to be present at relatively shallow depths.

In conclusion, Keystone represents a significant exploration opportunity for discovering a variety of Eocene mineral deposits. With good location, good host rocks, Eocene intrusions that were active during gold deposition, and exposed gold mineralization, further work may expand the total gold endowment within this stretch of the Battle Mountain-Eureka (BM-E) gold belt.

Many questions remain and are opportunities for further research and exploration:

- What is the expression of near paleo-surface mineralization at Keystone relative to any future deeper discoveries?
- Does Keystone represent the transition zone from larger to smaller gold deposits along the BM-E gold belt?
- Keystone and Cortez are adjacent to the general boundary with the Oligocene-Miocene ignimbrite province. Is there a relationship between the two and with the apparent decrease in gold deposit size south of Cortez?
- What relationship, if any, does the magmatic center at Keystone have with gold mineralization at Cortez, Tonkin Springs and Gold Bar?

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