Gold-Exploration Potential in the Bearlodge District, Wyoming
With Comparisons to the Cripple Creek District, Colorado
Rare Element Resources Ltd

The Bearlodge alkaline-igneous complex in northeastern Wyoming shares many attributes with the Cripple Creek complex in Colorado and it has significant potential to host economically viable gold deposits. Both systems are Tertiary in age, have an undersaturated phonolitic-magmatic affinity with multiple-intrusive and hydrothermal events, contain numerous breccia bodies (including diatremes), exhibit an erosion level of exposure that is high in the intrusive system, and display a close association of gold mineralization with potassium-feldspar/pyrite (plus or minus carbonate) metasomatic alteration.

The Cripple Creek complex has demonstrated significant gold mineralization over a vertical range in excess of 1,000 metres. The depth range of gold mineralization in the Bearlodge complex has yet to be determined. To date, sporadic precious-metals exploration by several companies has been carried out with the objective of identifying large-tonnage, bulk-mineable deposits of low to intermediate grade. The potential for deeper, higher-grade vein-type deposits has been largely ignored. Past exploration efforts identified several areas of low-grade gold mineralization. These are either incompletely explored or too small to be economically viable.

The Bearlodge alkaline complex retains significant potential to host economically viable gold deposits. Potential exists for both bulk-mineable deposits amenable to open-pit extraction and for deeper, high-grade veins, structurally controlled veinform deposits or stockwork deposits. The following discusses key aspects of the similarities between the Cripple Creek and Bearlodge districts and proposes an exploration strategy for the Bearlodge district. This strategy re-interprets field data, which was collected by several major companies over the last 30 years, in light of new data gained from detailed studies of the Cripple Creek district by Eric Jensen (Jensen, E P, 2003, Magmatic and hydrothermal evolution of the Cripple Creek gold deposit, Colorado, and comparisons with regional and global magmatic-hydrothermal systems associated with alkaline magmatism: unpub PhD dissertation, University of Arizona).

CRIPPLE CREEK MINING DISTRICT, COLORADO

The Cripple Creek mining district has produced in excess of 21 million ounces of gold since its discovery in 1878. Total gold production plus economic resources from the district are now more than 28 million ounces. Gold occurs primarily in telluride minerals contained within narrow vein sets; but economically important gold mineralization also is present in hydrothermal breccias and low-grade, bulk-tonnage deposits. Important aspects of the geology, alteration, and mineralization of the Cripple Creek mining district are summarized in Table 1, along with comparable features of the Bearlodge district.

The Cripple Creek district is characterized by an Oligocene alkaline diatreme complex, which occurs at the junction of four Precambrian lithologic units along the western edge of the Pike's Peak batholith. The diatreme has an elliptical surface expression and is about five kilometres in diameter. The upward-flaring body is filled by heterolithic volcanic breccia, while multiple alkaline-igneous intrusive bodies penetrate the diatremal breccias and adjacent Precambrian host rocks.

Table 1. Comparisons between the Cripple Creek district, Colorado and the Bearlodge district, northeastern Wyoming.

District	Alkaline Rocks	Geological/Tectonic Framework	Styles/Structural Controls of Mineralization	Ore Minerals/Key Geochemical Anomalies	Alteration/Mineralization
Cripple Creek, CO Au(Te) High grade; historic production: 41Mt @ 17.1 g/t Au; lowgrade resource: 170Mt @ ~1 g/t	Volcanic breccia, phonolite, ne-monzosyenite, phonotephrite, lamprophyre, bedded volcaniclastics, hydrothermal breccias; 30 Ma (Oligocene)	Emplaced during incipient phases of crustal extension. Contemporaneous with similar alkalic magmatism along the Rio Grande Rift, although district is about 40km off the Rift axis. Magmatism bears strong similarities to East African Rift and Rhinegraben (Germany) phonolites.	High-grade Au-telluride epithermal veins w/Ksp alteration halos containing dissem. native gold and tellurides. Deep, high-T base metal mineralization. Sub-radial pattern of vein orientation at district scale, merging with NNW-SSE and NE-SW regional Precambrian trends.	Au tellurides, auriferous pyrite, native gold. Anomalous Te, Sb, As, Ba, W, K, Tl, REE	Early shallow: Ksp-hm±CO_3 Late shallow felsic rx: Q-py-CO_3-adul-fl-SO_4-sl-gn-tet-tel//Ksp-py-CO_3-Au°-tel±ser (bi, px, hb). Late shallow mafic rx: Q-py-CO_3-Ksp-rosc-fl-SO_4-sl-gn-tet-tel//ser (pl, mafics)-adul (flds)-py-CO_3-ser(bi, px, hb)-Au°-tel Early deep: barren bi-mt-or Late deep: [bi-Ksp-py-SO_4-CO_3-gn-sl]
Bearlodge, WY Vein assays to 12.5ppm Au East and West Breccia deposits contain ~ 8Mt @ 0.023 opt Au	Phonolite, trachyte, syenite, ne-syenite, malignite, lamprophyre, volcanic breccias, hydrothermal breccias, carbonatite; 50Ma (Eocene)	Stock, sill, and laccolith complex emplaced as the Bearlodge dome in Eocene time. Part of a N75ºW belt of Paleocene to Eocene alkalic intrusive complexes crossing the northern part of the Black Hills Uplift, and extending from Bear Butte, SD to Devil's Tower and Missouri Buttes in NW Wyoming. The intrusive rocks are silica-saturated in the eastern part of the belt and grade to silica-undersaturated in the western part (including the Bearlodge Mountains).	High to low grade epithermal, gold-bearing veins w/Ksp alteration halos. Low grade, Au-mineralized intrusive and volcanic breccias. Deep, high-T base metal-Ag minz. in association with Ksp fenite. REE-minz. carbonatite dikes and breccias.	Auriferous py, native gold are identified. Ancylite and bastnaesite in REE-minz'd. carbonatites. Anomalous Te, As, Sb, Ba, Mo, K, REE	Early Ksp-bi-mt alteration associated with base metal mineralization. Kspar-py alteration halos on CO_3-fl-SO_4-py±Q±Au° veins

Jensen (2003) describes the alkaline-magmatic and hydrothermal history that led up to, and beyond the gold-mineralization events. Briefly, the alkaline-igneous evolution of the complex can be summarized as follows:

1. Early megacrystic syenite. The syenite is identified in xenolithic blocks carried by phonolitic intrusions.
2. Phonolitic and tephriphonolitic heterolithic breccia that constitutes the main mass of the diatreme.
3. Early porphyritic phonolite and tephriphonolite stocks and sills.
4. Tephriphonolite and trachyandesite stocks and dikes.
5. Nepheline monzosyenite stock.
6. Phonotephrite dikes.
7. Late-stage phonolites in dikes, laccoliths, plugs, and flows.
8. Porphyritic phonolite and tephriphonolite dikes.
9. Lamprophyre dike swarms.

The main episodes of alteration and mineralization, accompanied the intrusive and volcanic activity, are summarized in Table 2 below:

Table 2. Cripple Creek alteration summary.

Timing	Alteration/Mineralization Style	Comments
Recorded in early xenoliths	Bi-py-CO_3; Na amphiboles; cpx-rich altn (ab, Ksp, Na-px); alkali-flds-py (Ksp-ab-py-CO_3)	First 3 alteration types are probably high-Temperature.
Early alteration (pre-lamprophyre intrusive activity)	Alkali flds-hm (Ksp-ab-illite-hm-leuc-CO_3); Chl-ab-hm; bi-mt-Ksp	Minor sl, cp, gn associated w/Hi-T bi-mt-Ksp altn.
Late (post lamprophyre) alteration/ High-Temperature	Pervasive biotization (bi-py-CO_3-Ksp-ab, minor gn, sl); bi-Ksp-fl; phlogopite/polymetallic minz (phlog-Ksp-illite-CO_3-leuc-py>>gn, sl; veins with phlog-py-CO_3-SO_4, Q, gn, sl, fl, ± Au in sulfides	Phlogopite-polymetallic altn/mineralization is seen in only the deepest exposures.
Late (post lamprophyre) alteration/Low-Temperature	Ksp-py(Ksp-py-il-leuc-CO_3; veins with Q-fl-CO_3-bar-cel-py±sl, gn, tet, Au tellurides); REE-apatite veins; late specularite in vugs, fx with CO_3±py	Ksp-py alteration accompanies all significant Au mineralization at Cripple Creek
Post-ore events	SO_4-rich (illite-py-leuc in wall rocks; massive SO_4-py-gn-sl-mb in veins); CO_3-rich (Ksp-illite-CO_3-py-leuc in wall rocks; massive CO_3-py±Q, gn, sl, mb in veins); phyllosilicate altn. (illite-halloysite-Q, or kaol-dik-py)	High- to moderate T; mostly post-dates significant Au mineralization.

All of the significant gold (telluride) mineralization at Cripple Creek is post-lamprophyre in age. It is accompanied by pervasive potassium-feldspar/pyrite alteration.

The major categories of gold deposits in the Cripple Creek district are:

- Gold-mineralized veins with significant vertical extension. These high-grade veins account for more than 85 percent of the historical production. The veins are narrow (most are less than 5 centimetres in width) and commonly occupy sheeted fracture zones. They consist of gold tellurides in quartz plus or minus variable fluorite, carbonate, pyrite, barite, celestite, tetrahedrite, sphalerite, galena, and rare-earth-element (REE) minerals. The veins have selvages of potassium-feldspar/pyrite alteration. Gold is disseminated in the altered wall rocks, where it either occupies altered mafic-mineral sites or is encapsulated in potassium feldspar and quartz (which are both alteration products). Native gold is more common in the wall rocks than in the veins. Apatite with light-REE-enriched rims is commonly abundant in wall rocks adjacent to the veins.

- Hydrothermal breccia deposits. Two types of hydrothermal breccias are associated with economic gold deposits. The quartz-fluorite breccias consist of either monolithic or heterolithic igneous and Precambrian clasts in a matrix assemblage of quartz-fluorite greater than pyrite ± celestite and barite. These breccias are generally low-grade (1 – 10 ppm Au), but locally grade to greater than 30 parts per million gold. The manganiferous hydrothermal breccias have a matrix of rhodocrosite, fluorite, and sulfates, with subordinate quartz, pyrite, and adularia, and accessory galena and REE minerals (bastnaesite and monazite). They contain erratic gold mineralization, with levels from the hundreds of parts per billion to greater than 50 parts per million gold. Anomalous Ba, Sr, Mn, and REE characterize them geochemically. Other types of hydrothermal breccias are present in the Cripple Creek district, both pre- and post-ore, but the other types lack significant gold mineralization.

- Disseminated deposits. The disseminated deposits occur as narrow gold-telluride veins in sheeted fracture zones within 300 metres of the surface. Coalescing potassium-feldspar/pyrite alteration halos produce large volumes of altered rock associated with these deposits. The alteration develops over widths of several tens of metres.

At deeper levels in the system, late-stage polymetallic veins and disseminated galena, sphalerite, and molybdenite in zones of potassium-feldspar/illite/pyrite alteration may be high-temperature complements to the shallower epithermal gold-telluride mineralization.

Three-fourths of the gold produced from the Cripple Creek district came from within 300 metres of the surface, while less than five percent of the gold was produced from depths greater than 600 metres. The mineralization exhibits a pronounced structural control that is dominated by north-northwest/south-southeast trends. Orientations of the deep-seated structural elements controlling gold mineralization are often difficult to recognize at the scale of an individual deposit. The controlling structures, veins, and alteration selvages are more narrowly defined at depth but tend to bloom in the upper levels of the diatreme. This may be due to the inherent permeability of the host volcanic breccia or the more confining pressures found at depth.

Potassium-feldspar/Pyrite Alteration

The intimate association of the gold-telluride and gold mineralization with large volumes of pervasive and structurally controlled potassium-feldspar/pyrite alteration has important implications for gold exploration in alkaline-igneous rocks. The mineralogical changes that take place during this alteration are summarized as follows:

Primary Phase(s)	Alteration Phase(s)
Feldspar, feldspathoids	Potassium feldspar ± albite
Calcic plagioclase	Alkali feldspar + illite + carbonate
Mafic minerals (bi, px, amph)	Pyrite, carbonate, illite, leucoxene

Accessory minerals accompanying the alteration include barite, celestite, apatite, rare-earth-element (REE) minerals (bastnaesite and monazite), galena, sphalerite, and tetrahedrite. In many cases, the wall rocks adjacent to the mineralized veins carry relatively abundant apatite with light-REE-enriched rims. The abundance of K_2O in altered rocks can be in over 14 percent.

According to Jensen (2003), the potassium-feldspar/pyrite alteration is not texture-destructive and is often difficult to recognize in hand specimen, or even under the petrographic microscope. Jensen indicates that major-element analyses and scanning-electron-microscopy imaging are often required to recognize the nature and extent of the alteration in the wall rocks. For these reasons, this alteration type and its associated mineralization may be under recognized and under reported in many alkaline systems. The ability to recognize the potassium-feldspar/pyrite alteration with confidence may provide a significant edge to an exploration program that targets gold mineralization in these systems.

BEARLODGE ALKALINE-IGNEOUS COMPLEX, NORTHEASTERN WYOMING

Important aspects of the geology, alteration, and mineralization of the Bearlodge alkaline-igneous complex are summarized, and compared to those of the Cripple Creek complex in Colorado, in Table 1. The Bearlodge complex is a component of the Black Hills Uplift of western South Dakota and northeastern Wyoming. The Black Hills Uplift has a northwest-southeast trend and consists simplistically of two up-thrown blocks of Precambrian basement penetrated by a series of Tertiary alkaline-igneous intrusions. Overlying Paleozoic and Mesozoic clastic and carbonate sedimentary rocks form a series of large-scale monoclinal folds that encircle the Black Hills Uplift. Oligocene, Miocene, and Pliocene sediments rest with angular discordance on the older sedimentary and igneous rocks.

The Tertiary alkaline-igneous belt, which contains the Bearlodge complex and a series of other intrusive centers, trends about north 75º west and extends from Bear Butte in South Dakota to Devil's Tower and the Missouri Buttes in northeastern Wyoming. The ages of the intrusive bodies range from about 38 to 60.5 million years. There is a tendency for the alkaline-igneous rocks to be silica saturated in the eastern part of the belt and silica undersaturated in the western part of the belt. The Bearlodge complex consists predominantly of silica undersaturated alkaline-igneous intrusive rocks, and it is the only intrusive series in the alkaline belt known to host carbonatitic intrusive rocks (although there has been some speculation that carbonatitic rocks may be present at depth beneath the Devil's Tower intrusion. The high-level nature of the Bearlodge complex is supported by the presence of sparsely scattered outcrops of coeval pyroclastic deposits in the southern Bearlodge Mountains. In addition to the exposed alkaline-igneous intrusive and pyroclastic rocks, numerous small concentric anticlinal domes are scattered throughout the belt and are thought to be cored by intrusive plugs. These domal areas include Green Mountain, Lime Buttes, Gypsum Buttes, Strawberry Mountain, and Soldier Creek. The intrusive rocks of the Bearlodge complex belong to an undersaturated sodic-alkaline-igneous series and include trachyte, phonolite, latite, syenite, nepheline syenite, malignite, pyroxenite, lamprophyre, and carbonatite. The bulk of exposures in the core of the complex are sub-volcanic phonolite and trachyte, with subordinate syenite, nepheline syenite, malignite, and pseudoleucite-phonolite porphyry. Carbonatite exposures occur only on the northeastern flank of Carbon Hill and on the southwestern flank of Bull Hill. Geological and geophysical data are consistent with the intrusion of alkalic-silicate stocks and dikes into Precambrian basement (predominantly granitic) and Paleozoic and Mesozoic sedimentary rocks. The alkaline rocks were also intruded as sills into the suprajacent Paleozoic sedimentary rocks and, therefore, the Bearlodge complex may be grossly laccolithic in form. The dominant alkaline stock has enveloped several large roof pendants of Precambrian basement in the southern half of the central dome.

Numerous intrusion and intrusive breccias occur within the complex, and at least one diatremic body has been identified. The intrusion breccia bodies consist of a phonolitic to trachytic igneous matrix carrying varying proportions of cognate clasts, as well as local minor syenite and/or malignite clasts. In contrast to the intrusion breccias, the heterolithic intrusive breccias contain abundant clasts of phonolite-trachyte, syenite-malignite, and pseudoleucite porphyry in a fine-grained carbonate-biotite-sulfide (± potassium feldspar) matrix. The sulfides are oxidized in surface exposures, and the carbonate has been dissolved and replaced by silica and iron oxides. The Bull Hill and Carbon Hill breccias are the most prominent examples of the heterolithic intrusive breccias. Carbonatite and silicocarbonatite dikes intrude the heterolithic breccias and are late in the igneous sequence. Lamprophyre and pseudoleucite-phonolite-porphyry dikes are also late in the intrusive sequence.

Geological events that can be identified in the core of the complex include multiple intrusions of predominantly phonolitic to trachytic alkalic-silicate igneous rocks, multiple episodes and types of brecciation, carbonatite magmatism, alkali-ferric-iron metasomatism (fenitization), hydrothermal alteration, and oxidation (by descending meteoric waters). Pre-intrusion, syn-intrusion, and post-intrusion faulting and deformation disrupt the geology; although displacements appear to be relatively small. Surface rock exposure in the complex is probably on the order of five percent or less, which further complicates interpretation of the geological and mineralization history. The Bearlodge complex is elongate northwest-southeast. Major structural trends are oriented both northwesterly, parallel to the elongation of the complex, and northeasterly or east-northeasterly. The complex plays host to a variety of mineralization types, including gold, lanthanide rare-earth elements, base metals, and thorium. Lithologies, mineralization, and alteration patterns share many features with the Cripple Creek complex in Colorado (Table 1).

Gold Mineralization

The Bearlodge complex contains wide areas with strong (≥100ppb Au) and mid-level (50 – 99ppb Au) gold anomalies in rock-chip and soil samples. A significant number of rock-chip samples carrying gold values in excess of one part per million have been collected from the property by a variety of companies over the last thirty years. The highest-grade sample assayed 14.2 parts per million gold (0.42 opt Au). Other anomalous elements that characterize mineralization in the complex include tellurium, arsenic, antimony, molybdenum, barium, and strontium.

The limited rock exposure in the district has hampered effective gold exploration; however, in 1985, FMC discovered a small gold occurrence in the East and West Breccia bodies, southeast of Bull Hill. This was subsequently drilled out by International Curator and Coca Mines from 1987 to 1990. The East and West Breccia bodies contain an aggregate of approximately 7 to 8 million tons at a grade of 0.023 ounces of gold per ton. (These tonnage, grade and other assay numbers are historical and may not comply with Canada National Instrument 43-101 standards. As such, these numbers cannot be relied upon until they are confirmed using modern NI 43-101 standards.) One of the drill holes cut an intercept of 30 feet grading 0.166 ounces of gold per ton and included a ten-foot interval assaying 0.46 ounces of gold per ton. Most of the drill holes in the East and West Breccia bodies were shallow (less than 500 feet) and little attempt appears to have been made to evaluate potential deeper, structurally controlled mineralization. In part, this may have been due to the aforementioned lack of exposure that seriously limited structural analysis of the mineralized zones.

Phelps Dodge Corporation conducted exploration from 1994 to 1996. Surface geochemical data identified two areas that warranted further investigation; a broad area over the northwestern part of Taylor Divide, and a similarly broad area over, and adjacent to the northeast-trending Carbon Hill (Figure 1). In order to partly compensate for the minimal surface outcrop in these areas, Phelps Dodge designed and permitted a series of 30 trenches. Most of the trenches were mapped and sampled. The Rare Element Resources' Bear Lodge data files, acquired from Phelps Dodge in 1998, appear to contain geological maps and gold assays for some, but not all of the trenches. The maps show interpreted lithology, but very limited structural data. Structural data from the Taylor Ridge adit (now closed) records northwest-striking veins and structures that dip steeply to the northeast. The strongest gold mineralization was identified along Taylor Ridge in trenches T-7 (370 feet assaying 442 ppb Au), T-8 (190 feet assaying 512 ppb Au), and T-9 (270 feet assaying 266 ppb Au). The strongest gold mineralization in the Carbon Hill area was defined along its southeastern flank in trenches T-3 (190 feet assaying 215 ppb Au), T-4 (200 feet assaying 617 ppb Au), T-5 (50 feet assaying 558 ppb Au), and T-6 (20 feet assaying 1280 ppb Au). No structural data have been found for the Carbon Hill trenches.

In 1995, Phelps Dodge followed up the trench geology and assay work with a reverse-circulation drilling program, which consisted of 11 drill holes totaling 4980 feet. All of the drill holes appear to have been vertical and the deepest drill holes were to depths of 500 feet. The most productive drill holes appear to have been collared in the Taylor Divide area, near the Taylor Divide adit (drill-hole SU-13) and near trenches T-7 and T-8 (drill-hole SU-10). Drill-hole SU-13 averaged 383 parts per billion gold over its entire depth interval of 500 feet, and included a 25-foot interval that assayed 906 parts per billion gold. Drill-hole SU-15 (depth 500 feet) was collared in the vicinity of trench T-4, along the southeastern flank of Carbon Hill. The drill hole had a vertical orientation and encountered a 250-foot interval assaying 256 parts per billion gold. The first-phase drill holes all had vertical orientation, despite the trench mapping data that indicate that the mineralized structures dip to the northeast and away from the course of the drill hole.

Phelps Dodge conducted a follow-up reverse-circulation drilling program in 1996, which consisted of 4002 feet of drilling in eight drill holes. Drill-hole orientation data are incomplete on the log sheets, although it appears that at least some of the drill holes were angled at 40º to 50º. The strongest gold mineralization in the SU96-series holes is in drill-hole SU96-4, with intervals of 30 feet at 3,859 parts per billion gold and 45 feet at 640 parts per billion gold.

During 1986 to 1988, Newmont Mining Company conducted limited exploration on a small land package in the Bearlodge district that included the Bull Hill and Carbon Hill areas. Newmont drilled seven RVC holes totaling about 3100 feet. Most of the holes were collared in the greater Carbon Hill area and targeted soil and rock chip gold anomalies. All of the holes were vertical and not located with regard to, or knowledge of the underlying structural controls on mineralization.

Gold mineralization and accompanying wall-rock alteration in the Bearlodge complex have not been subjected to the same degree of detailed study as that described for the Cripple Creek district. The gold mineralization does not appear to be lithology specific. It is hosted in a variety of lithologies, including phonolite-trachyte, syenite, malignite, Precambrian granitoids, and Paleozoic sedimentary rocks (Deadwood and Pahasapa formations). Gold is also found in breccias with igneous or metasomatic/hydrothermal matrices carrying variable proportions of the above lithologies.

Petrographic studies by FMC, International Curator, Western Nuclear and Hecla Mining Company indicate that the gold mineralization is associated primarily with potassium-feldspar/pyrite (plus or minus carbonate) alteration. The data indicate that the highest-grade gold mineralization in samples collected from the Bearlodge complex appears to be associated intimately with potassium-feldspar fenites, which are referred to in various reports as “syenite”, “pulaskite”, or “de-silicated Precambrian granites”. These coarser-grained, fenitized rocks commonly contain iron oxides plus or minus carbonate, fluorite and silica (the silica is probably very late) in veinlets, stockworks, and interstitial to the feldspars. Although it was never determined quantitatively, it is likely that at least some of the gold is derived from oxidized pyrite as it is enveloped in the iron oxides.

In Western Nuclear sample W129-4 (0.37 opt Au), free gold was observed interstitial to fluorite in a carbonate-fluorite vein cutting “pulaskite” (here, potassium-feldspar fenite was probably misidentified as pulaskite). The high-grade sample collected by Hecla (H023; 0.42opt Au) from the ridgeline west of the Bock mine is a brecciated syenite fenite with iron oxides in stockwork veinlets and interstitial to the potassium feldspars. These rocks appear similar to the desilicated “bug-hole granites” described at Cripple Creek as a favored target for early prospectors. Higher gold grades are also associated with phonolitic/trachytic rocks. International Curator’s drill-hole S-35 cut an interval of 15 feet at 0.31 ounces of gold per ton (270 to 285 feet) in fractured “trachyandesite”, later identified as phonolite. Paster (1985 petrographic report to FMC) described a very “fresh-looking” phonolite from a five-foot interval assaying 0.181 ounces of gold per ton (drill-hole S-31, 300 to 305 feet). The sample was from a potassium-feldspar stockwork and contains trace pyrite and oxidized pyrite (hematite). Paster suggests that the gold may be primary and related to the fresh feldspathoids; although, it is more likely that the gold is related to potassium-feldspar/pyrite alteration, as at Cripple Creek, Colorado.

Limited multi-element geochemical data from the Phelps Dodge 1995 trench and drill-hole assay program indicate that the mineralized and altered phonolitic/trachytic rocks carry up to 13.6 percent K_2O. Jensen’s work at Cripple Creek indicates that many gold-mineralized and potassium-feldspar/pyrite altered phonolites are difficult to recognize using standard megascopic and petrographic techniques, without resorting to extensive major element analyses and scanning-electron-microscopy imaging. At the Bearlodge complex, recognition of this alteration type is further inhibited by surface oxidation that imparts a reddish-brown to purplish cast to the phonolitic and trachytic intrusive rocks.

The deep, high-grade copper-silver-mineralized intercept in Duval drill-hole WBD-5 (40 feet at 3.5% Cu and 4.7 opt Ag; 1,400 to 1440 feet) occurs in “pulaskite” (now recognized as fenite). The “pulaskite” hosts an assemblage of chalcopyrite-pyrrhotite-potassium-feldspar plus or minus amphibole and/or pyroxene (acmite) and it is in contact with carbonatite. It is likely that the metalliferous fenite solutions that gave rise to the high-grade copper-silver fenite were derived from carbonatite. This deep base-metal mineralization may be analogous to the deep polymetallic veins described at Cripple Creek

The origin of the gold-bearing metalliferous fenite solutions is of interest in the development of gold-exploration models for the Bearlodge complex. Potassium-feldspar/pyrite alteration associated with gold mineralization may, in part, be related to potassium-feldspar fenitization accompanying carbonatite intrusion. Significant gold has been produced from the Phalaborwa porphyry-copper carbonatite in South Africa, where it appears also to be accompanied by potassium-feldspar alteration.

In 1989, Hecla Mining Company conducted a drilling program in the Bearlodge complex to explore for carbonatite-hosted rare-earth-element (REE) mineralization. The drill core was subsequently assayed for gold when Hecla's exploration focus shifted to precious metals in 1990. A carbonatite dike cut in Hecla drill-hole WP-2 (443 to 452.5 feet) assayed 0.021 ounces of gold per ton, in addition to containing strongly anomalous REE's and yttrium (1600 ppm Y). Petrographic examination suggested that the gold was probably hosted in pyrite, although that supposition was not confirmed quantitatively. This result indicates that at least some of the Bearlodge complex carbonatites may be the most gold-anomalous carbonatites in the world. Prior to this discovery of high-gold levels in Bearlodge carbonatite dikes, gold abundances of 30 – 50 parts per billion in carbonatites were considered "highly anomalous". The auriferous carbonatites may be the source for the gold-bearing fenite solutions responsible for the high-grade gold occurrences in the Bearlodge complex (represented by the aforementioned samples H023 and W129-4). Alternatively, high-grade gold mineralization, such as that described in FMC drill-hole S-31 (300 to 305 feet) may accompany deuteric fenite fluids internally derived from an auriferous CO_2, alkali, and ferric iron-rich phonolitic magma.

Use of Cathodoluminescence to Recognize Potassium-Feldspar/Pyrite Alteration and other Mineralogical Features Related to Gold Mineralization in Alkaline-Igneous rocks

Broad zones of pervasive potassium-feldspar/pyrite-altered wall rock accompany gold mineralization at Cripple Creek and many other gold deposits related to alkaline-igneous rocks. REE-enrichment is also a key geochemical feature in veins and wall rocks at Cripple Creek, and perhaps at other deposits, as well. The REE minerals, bastnaesite and monazite, are not uncommon in the gold-telluride veins at Cripple Creek, and abundant apatite with Light-REE-enriched rims is present in wall rocks haloing the veins. This REE-rimmed apatite appears to be a good indicator of proximal gold mineralization. Collectively, these characteristics do not lend themselves well to field observation and description. They are often recognized in deposits only after extensive academic studies, which utilize chemical analyses and sophisticated scanning-electron-microscopy imaging. The potassium-feldspar/pyrite alteration, as already noted, is not texture destructive and, in many cases, is not easily identified in the field, or even with the use of the standard petrographic microscope. Jensen (2003) describes lamprophyric intrusive rocks, an excellent host for gold-telluride mineralization at Cripple Creek, that have the appearance of essentially unaltered phonolite, owing to pervasive potassium-feldspar alteration.

Jensen suggests that the inability to reliably recognize this alteration style in the field has led to the underreporting of altered and mineralized rocks in many complexes. The recent, and as yet unconfirmed report of a potentially significant gold discovery at Mineral Hill in Crook County, Wyoming, may have been missed during earlier exploration in the district due to this factor.

Effective gold exploration in alkaline-igneous environments requires the development of rapid, reliable recognition criteria for the potassium-feldspar/pyrite alteration and other mineralogical factors that accompany gold-telluride mineralization in these systems. The cathodoluminescence (CL) petrographic technique has proven to be a sensitive and reliable indicator of alteration and mineralization in a variety of alkaline-igneous systems. CL takes place when a beam of energetic electrons bombards the surfaces of certain materials, and visible radiation is emitted from those surfaces. This phenomenon is the basis for a technique that can be used in the petrographic examination of geological and other materials. CL examination of geological samples can be done on an scanning-electron-microscopy instrument or, more quickly and conveniently, on a dedicated cathodoluminescence instrument, such as the Luminoscope.

In unaltered feldspathic rocks, trace amounts of Ti^{+4}, Fe^{+2} and Mn^{+2} substitute for Si^{+4} and Al^{+3} in the feldspar lattice and act as activators for CL. When viewed under the Luminoscope, potassium feldspar most commonly luminesces a light-blue hue of moderate intensity from Ti^{+4} activation. Calcic plagioclase may luminesce green to yellowish green, due to Fe^{+2} and/or Mn^{+2} activation. The potassium-feldspar alteration observed in many alkaline systems is a product of the interaction between magmatically derived alkali-ferric iron-rich metasomatic fluids and wall rocks. During this alteration process potassium (± Na) and Fe^{+3} rich fluids interact with feldspars in the wall rocks and convert calcic plagioclase to potassium feldspar and/or albite. Fe^{+3} substitutes in the feldspar lattice for Al^{+3} and activates a CL with a generally brick-red hue, which ranges from weak to moderately strong intensity. Fluid egress is primarily along microfractures and cleavage planes, a feature that can often be seen plainly in the CL images. The presence of activators, in addition to Fe3+, may result in a more complex CL, although one that is still markedly different from that observed in unaltered rocks. With CL examination of a suite of rocks from Cripple Creek, it was possible to distinguish not only altered from unaltered phonolites and lamprophyres (rocks that had undergone potassium-feldspar metasomatism), but also between different styles of potassium-feldspar alteration (barren versus gold-telluride-mineralized associations). Scanned CL spectra provided a quantitative basis for the interpretation of the visible CL images.

Another feature of the Cripple Creek alteration and mineralization that is impossible to recognize in hand specimen or thin section (standard petrographic techniques) is the apparently enhanced REE-rimmed apatite abundances in wall rocks haloing mineralized veins. Under the Luminoscope, primary igneous apatite most often shows a strong yellow CL from Mn^{+2} and/or heavy-REE activation. Hydrothermal apatite identified in many epithermal vein systems (not necessarily alkaline-igneous-related systems) generally has a straw yellow to salmon pink CL (activation not investigated). Light-REE-enriched apatite shows a distinctive lavender CL. All three types are distinguished easily from one another under the Luminoscope. Other luminescent phases common to alkaline-igneous-mineralized systems, which are identified easily under CL, include carbonates, fluorite, anhydrite, and sometimes barite and celestite.

Proposed Exploration Approach

The last major gold-exploration effort in the Bearlodge district was conducted by Phelps Dodge in 1995 and 1996. It was obvious during examination of the Phelps Dodge data files that it ceased exploration due more to the downturn in gold prices than to lowered expectations for the property. Trench and drill assay results show the presence of strongly anomalous gold mineralization at the surface and at depth, which does not appear to have been evaluated to completion. Despite the limited data that indicate structural control of the mineralization, all of the Phelps Dodge 1995 drill holes were vertical. The incomplete structural data indicate that mineralized structures in the Taylor Divide area have a northwesterly strike and dip steeply to the northeast. At least some of the follow-up holes in 1996 appear to have been angle holes at -40º to -50º; but reliable drill-hole orientation data for all of the holes have yet to be discovered in the data package. Relatively little structural data were acquired during the geological trench-mapping program. Similarly, Newmont's drilling in the Carbon Hill area was oriented vertically and paid little regard to structural considerations.

Phelps Dodge's initial exploration approach in 1995 was different from that of other companies that conducted exploration in the Bearlodge district, in that it attempted to partly compensate for the lack of surface outcrop by conducting a trenching program to create rock exposure in prospective areas. This is the most productive initial surface-exploration approach and one that should be continued. Unfortunately, the Phelps Dodge trenches have been reclaimed and the data acquired during the program appears to be incomplete. An exploration program designed to proceed with the trenching approach is as follows:

Phase 1. Trenching – Re-open selected Phelps Dodge trenches and site additional trenches in prospective areas. The trenches should be subjected to detailed geological mapping and sampling, with particular attention paid to the structural environment. New trenches should be chip-channel sampled over intervals of two or three metres. Re-opened Phelps Dodge trenches should have selected intervals assayed, generally zones known to be high-grade from previous work, if those areas can be determined with certainty.

Phase 2. Petrographic and cathodoluminescence (CL) characterization of the highest-grade gold samples and adjacent altered rock in order to determine the nature of the gold mineralization and accompanying alteration and to develop reliable pathfinder mineralogical exploration criteria. This phase would require detailed petrographic analyses of 15 to 20 altered and mineralized samples selected during Phase 1 fieldwork. Following sample characterization and the identification of reliable mineralogical pathfinders for gold, the method can be used for target evaluation and as a reconnaissance tool to identify additional prospect areas.

Based on the results from Phases 1 and 2, a reverse-circulation drilling program will be proposed to evaluate the most prospective target areas. The drill holes will be angled at perhaps -40º and -60º in order to transect the mineralized structures and test the vertical distribution of the mineralization.

Prospective Target Areas

Currently known prospective target areas on the Rare Element Resources property are as follows:

Taylor Divide – the area is characterized by strongly anomalous gold mineralization in surface samples, exploration trenches (T-7, T-8, T-9, T-10, T-25, and T-26), and scattered reverse-circulation drill holes (SU-9, SU-10, SU-12, and SU-13). Mineralized structures in the area appear to strike northwesterly and dip steeply to the east.

Southeast flank of Carbon Hill – the area is characterized by strongly anomalous gold in surface samples, exploration trenches (T-4, T-5, and T-12), and reverse-circulation drill holes (SU-15 and SU-16).

Carbon Hill – the area has a broad zone of potassium-feldspar/pyrite alteration, as well as gold anomalies in soil and rock-chip samples and in exploration trenches. All of the gold-exploration drill holes (Phelps Dodge and Newmont) are vertical and intersect sporadic strongly anomalous gold.

Western periphery of the Bull Hill heterolithic breccia – the area shows scattered gold anomalies in soil and rock-chip samples. Hecla drill-hole WP-1 was collared northwest of Bull Hill along the crest of the ridge, about 300 metres southwest of the gate on the Bull Hill road. The hole was oriented N70E, -70º and intersected 106 feet assaying 251 parts per billion gold (620 to 726 feet). The last assay interval in the drill hole (720 to 726 feet) assayed 415 parts per billion gold. There are other instances of anomalous gold peripheral to Bull Hill, including the trench behind drill-hole RES04-3 (2.72 ppm gold) and a 2.4-parts-per-million gold assay reported from a trench sample at the base of the ridge just past the turn-off from the Whitetail Creek road to the Bull Hill road.

East and West Breccia bodies – these mineralized breccias are located about 1.6 kilometres southwest of Bull Hill. They contain about 7 to 8 million tons grading 0.023 ounces of gold per ton. (These are historical numbers upon which there can be no reliance until they are confirmed using standard NI43-101 methods.) The mineralization was discovered by FMC in 1985 and subsequently drilled out by International Curator and Coca Mines (Hecla). Overall the breccias are low grade; however, high-grade intercepts were cut in several drill holes (IC drill-hole S-35 – 30 feet at 0.166 opt Au, including 10 feet at 0.46 opt Au; IC drill-hole S-34 - 10 feet at 0.16 opt Au and 15 feet at 0.32 opt Au; IC drill-hole S-39 – 5 feet at 0.35 opt Au). The potential for deeper level, structurally controlled mineralization has not been adequately investigated.

Bull Hill gold anomaly – a soil and rock-chip gold anomaly (greater than 2 ppm Au) occurs near the summit and along the north flank of Bull Hill. Exposure is poor and very little attention has been paid to this area.

Section 33 diatreme – this area was identified during Rare Element Resources' 2004 exploration. This is a mineralized intrusive breccia or diatreme located in the NW ¼ of Section 33, T52N, R63W. Reconnaissance rock-chip sampling resulted in gold assay values of up to 551 parts per billion. Strongly anomalous gold (maximum 10 feet at 750 ppb Au) was also identified in limited shallow drilling by Western Nuclear in the early 1980's. Western Nuclear's geological summary memorandum recommended several deep drill holes to test the breccia at its deeper levels.

CANADA NATIONAL INSTRUMENT 43-101

Drilling, tonnage and grade data presented from the past exploration work of Duval, FMC Corporation, Coca Mines, International Curator, Western Nuclear, Phelps Dodge Corporation and Hecla Mining Company were gathered prior to the promulgation of Canada National Instrument 43-101. They may not have been gathered according to standards acceptable to this instrument; therefore, there can be no reliance upon them until they are substantiated by acceptable NI43-101 methods.

William H. Bird, PhD, PGeo, serves the Board of Directors of the Company as an internal, technically Qualified Person. Technical information in this report has been prepared in accordance with Canadian regulatory requirements set out in National Instrument 43-101 and reviewed by Dr Bird.

This report contains Forward-looking statements, such as those dealing with exploration potential. These involve known and unknown risks and uncertainties that may cause the Company's actual future-period results to differ materially from forecasts. Please refer to the Company's financial statements for a discussion of the Company's risks. This report was prepared by Company management, who take full responsibility for content.