The Fyre Lake project 1997: Geology and mineralization of the Kona massive sulphide deposit

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Abstract

Columbia Gold Mines' Fyre Lake project is located immediately to the east of Fire Lake, approximately 160 km north of Watson Lake in the Yukon Territory. The 1997 program, consisting of 44 diamond drill holes, doubled the known size of the Kona deposit. Mineralization within the Kona deposit has a defined strike length of 1500 m and a width of 250 m.

The Kona deposit is hosted within a strongly deformed and metamorphosed mafic to intermediate volcanic succession of chlorite-quartz and chlorite-actinolite-quartz schists. This volcanic package is overlain by a metasedimentary succession composed primarily of finely laminated carbonaceous phyllite that locally contains 1 to 20 m thick beds of micaceous volcanic-derived sediments. An intercalated unit of quartz-biotite schist and chlorite-mica-quartz schist marks the base of the metasedimentary succession.

The Kona deposit consists of two parallel northwest trending zones of copper-cobalt-gold volcanogenic massive sulphide mineralization: East Kona and West Kona. East Kona is made up of two distinct horizons: the Upper Horizon and the Lower Horizon. The Upper Horizon occurs immediately below the contact of the metasediments and the metavolcanics while the Lower Horizon occurs 40 to 70 m deeper, within the mafic volcanics. The mineralization of East Kona consists primarily of pyrite with lesser amounts of pyrrhotite and chalcopyrite occurring as massive to banded sulphides with local lenses of massive magnetite. The mineralization across West Kona changes from magnetite, pyrite, and chalcopyrite hosted within a grey siliceous matrix in the east, or down dip, through massive pyrite and lesser chalcopyrite into massive pyrrhotite in the west. The mineralization of West Kona occurs immediately below the metasedimentary and metavolcanic contact; the same stratigraphic position as the Upper Horizon of East Kona. All of the mineralized zones that make up the Kona deposit have an eastern dip and plunge to the southeast.

The Kona deposit, as defined to date, consists of a 15 million tonne mineralized container with the northern, near-surface portion amenable to open pit extraction. The last two holes of the 1997 program intersected mineralization 450 m along strike from previous drilling. The deposit remains open for expansion to the southeast.

Résumé

Le projet de Fyre Lake, de la société Columbia Gold Mines, est situé immédiatement à l'est du lac Fire, à environ 160 kilomètres au nord du lac Watson au Yukon. Le programme de 1997, qui comportait 44 trous de sondage, a permis de doubler la taille connue du gisement de Kona. Les minéralisations de ce gisement s'étendent sur une longueur de 1 500 mètres le long de la direction indiquée par forage et sur une largeur de 250 mètres.

Le gisement de Kona est inclus dans une succession métavolcanique mafique à intermédiaire intensément déformée et métamorphisée de schistes à chlorite-quartz et à chlorite-actinote-quartz. Cet ensemble volcanique est recouvert par une succession métasédimentaire composée essentiellement de phyllades carbonés finement laminés renfermant par endroits des couches de 1 à 5 mètres d'épaisseur de sédiments micacés d'origine volcanique. Une unité intercalée de schistes à quartz-biotite et de schistes à chlorite-mica-quartz matérialise la base de la succession métasédimentaire.

Le gisement de Kona comporte essentiellement deux zones parallèles de direction nord-ouest de minéralisations de cuivre-cobalt-or dans des sulfures massifs volcanogènes : East Kona et West Kona. East Kona comprend deux horizons distincts : l'Horizon supérieur et l'Horizon inférieur. L'Horizon supérieur est situé immédiatement sous le contact des métasédiments et des métavolcanites, l'Horizon inférieur étant situé 40 mètres plus bas, au sein des volcanites mafiques. La minéralisation d'East Kona se compose essentiellement de pyrite et, en quantités moindres, de pyrrhotine et de chalcopyrite se présentant sous forme de sulfures massifs à rubanés renfermant localement des lentilles de magnétite massive. La minéralisation de West Kona passe de magnétites, de pyrites et de chalcopyrites incluses dans une matrice siliceuse grise à l'est, vers l'aval-pendage, à des pyrites massives et, en quantités moindres, des chalcopyrites, et enfin, à l'ouest, à des pyrrhotines massives. La minéralisation de West Kona est située immédiatement sous le contact métasédimentaire et métavolcanique, c'est-à-dire dans la même position stratigraphique que l'Horizon supérieur d'East Kona. Toutes les zones minéralisées qui composent le gisement de Kona ont un pendage vers l'est et plongent vers le sud-est.

Le gisement de Kona consiste en une masse minéralisée d'environ 15 millions de tonnes dont la partie nord, en subsurface, se prête à l'extraction à ciel ouvert. Les deux derniers trous de sondage du programme de 1997 ont recoupé des minéralisations à 450 mètres des sondages antérieurs le long de la direction. Le gisement reste propice à l'expansion vers le sud-est.

INTRODUCTION

Columbia Gold Mines' Fyre Lake project is located immediately to the east of Fire Lake, which in turn, is approximately 160 km north of Watson Lake in the Yukon Territory (Fig. 1). The Fyre Lake project is within the Finlayson Lake district of the Yukon-Tanana Terrane. This portion of the Yukon-Tanana Terrane has undergone a resurgence of exploration activity in the past four years. During the 1997 field season, Columbia Gold Mines drilled 44 diamond drill holes totaling 13 598.98 m. In total, Columbia Gold Mines has drilled 115 diamond drill holes for a combined total of 23 266.91 m. All but 8 holes have been drilled within the Kona grid area (Fig. 2).

Columbia Gold Mines currently has an 80% interest in the main claim block surrounding the Kona deposit and wholly owns the rest of the claims that make up the property. In total the property consists of 415 Yukon Quartz claims that cover approximately 85 square km.

REGIONAL GEOLOGY

The Fyre Lake project area is underlain by an Early to Late Paleozoic metamorphosed volcano-sedimentary assemblage of the Yukon-Tanana Terrane. The Yukon-Tanana Terrane is an exotic terrane that was accreted to the North American continent during the Late Triassic and is regionally bounded to the southwest by the Tintina Fault and to the northeast by the Finlayson Lake fault zone (Mortensen and Jilson, 1985). The strongly deformed and metamorphosed lithologic units as described by Tempelman-Kluit (1977) and Mortensen and Jilson (1985) include:

1) a penetratively deformed Layered Metamorphic Sequence;

2) a group of Paleozoic plutonic and metaplutonic rocks;

3) a sheared mafic-ultramafic igneous assemblage; mapped as the Anvil-Campbell Allochthon (Tempelman-Kluit, 1977) and now included in the Late Devonian to Late Pennsylvanian-Early Permian Slide Mountain Terrane (Monger, 1984); and

4) various Cretaceous to Tertiary sub-volcanic and plutonic rocks.

Previous work (Mortensen and Jilson, 1985) had identified the rocks within the area of the Fyre Lake project as belonging to the middle unit of the Layered Metamorphic Sequence (LMS). The LMS is composed of three units with a estimated total thickness of 3 km (Mortensen and Jilson, 1985). The lower unit is dominantly micaceous and feldspathic quartzite, with carbonate beds in the upper portion of the unit. The middle unit

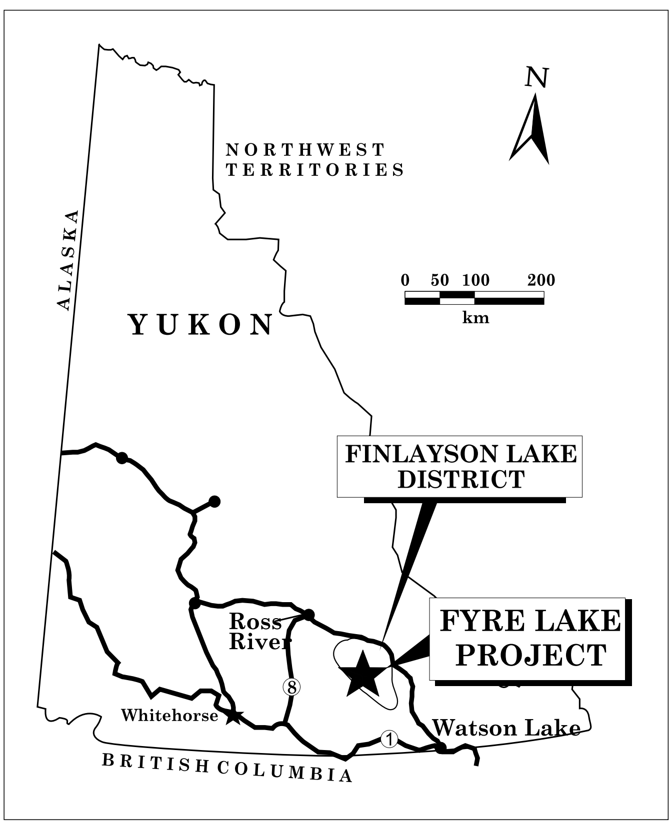

Figure 1. *Location of the Fyre Lake Project in the Finlayson Lake District.*

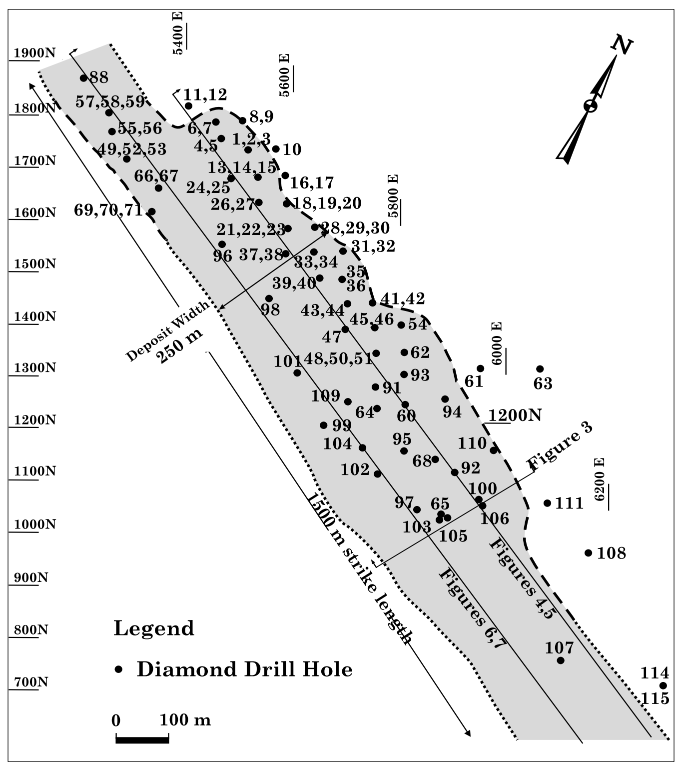

Figure 2. *Plan of the Kona deposit (shaded) showing the location of drill holes, the positions of the longitudinal projections in (Figs. 4, 5, 6, and 7), and the position of the schematic cross section (Fig. 3).*

consists of interlayered metavolcanic and metasedimentary rocks and is distinguished by the presence of carbonaceous material. The predominant rock type is grey carbonaceous siliceous siltstone. The metavolcanic rocks include mafic beds of green schist composed primarily of chlorite and commonly biotite, epidote and actinolite. The upper unit of the LMS, consisting of light grey limestone interbedded with calcareous quartzite, is of Early Pennsylvanian to Early Permian age. Mortensen and Jilson (1985) state that primary features within the LMS have been obliterated by the intense ductile deformation that occurred during Late Triassic to Early Jurassic time.

Sheared mafic and ultramafic volcanic and plutonic rocks of the Slide Mountain Terrane overlie the Layered Metamorphic Sequence and are preserved as klippen to the north and east of Fire Lake. This allochthonous assemblage has been interpreted as a dismembered ophiolite sequence comprised of massive greenstone with associated sediments, mafic and ultramafic gabbroic rocks and serpentine matrix melange (Stroshein, 1991).

There are three suites of metamorphosed mid-Paleozoic plutonic rocks in the region. The Simpson Range plutonic suite is composed of quartz monzonite to quartz diorite in a large fault-bounded stock. The second and third suites of metamorphosed plutonic rocks include the Hoole augen orthogneiss and Grass Lakes orthogneiss (Murphy, pers. comm., 1997) which outcrop in the Fire Lake area. The youngest rocks in the area are Late Cretaceous (112 ± 1 Ma) biotite-muscovite granitic plutons (Murphy, 1997).

As a result of recent 1:50 000 mapping of the Grass Lakes area, Murphy (1997) has reinterpreted the stratigraphy of the Finlayson Lake area into four distinct units which are summarized below. Murphy (this volume) provides a more complete description of these units.

Unit 1: Layered strongly to moderately metamorphosed sediments,

Unit 2: Metamorphosed intermediate to mafic volcanics with lesser phyllite and quartzite,

Unit 3: Metamorphosed sediments (predominately phyllite) overlain by metamorphosed felsic volcanics,

Unit 4: Layered metamorphosed quartz-rich clastic sediments and lesser mafic and felsic volcanics.

Unit 1 is equivalent to the Lower unit of Mortensen and Jilson's (1985) Layered Metamorphic Sequence; while units 2, 3 and 4 are the equivalent to the Middle unit (Murphy, pers. comm., 1997). Murphy (1997) stated that deposition of unit 1 occurred during the lower to middle Paleozoic and that units 2, 3, and 4 were deposited between latest Devonian and mid-Pennsylvanian time. He proposes that the mafic volcanism and associated mafic and ultramafic intrusions which make up unit 2 occurred in a marine basinal setting with the Kona deposit occurring proximal to synvolcanic, basin-bounding faults. Note that the Kudz ze Kayah and Wolverine deposits occur within the meta-rhyolites that form the upper portion of Unit 3.

PROPERTY GEOLOGY

Volcanogenic massive sulphide mineralization of the Kona deposit is hosted within a strongly deformed succession of chlorite-quartz and chlorite-actinolite-quartz schists. These schists represent a series of mafic, to possibly intermediate, flows, tuffs, and fragmentals. The mafic schist is typically medium green in colour and very fine grained. The modal mineralogy is generally quite simple throughout: chlorite, biotite, and quartz have been identified from hand samples and drill core. Chlorite, which makes up a bulk of the groundmass, is rarely seen in crystals greater than 2 mm. Biotite most commonly occurs as 1 to 5 mm lenses that are concentrated to form 2 to 5 cm wide rough bands. Preliminary petrographic studies (Lietch, 1996) identified tremolite, plagioclase, potassium feldspar, muscovite, carbonate, and apatite crystals up to 1 mm long throughout the groundmass. The same study also noted that some of the biotite is green. One sample studied was composed predominately of fine grained amphibole suggesting that field descriptions locally overestimated the modal percentage of chlorite.

This volcanic package is overlain by a thick metasedimentary succession composed primarily of a finely laminated black to grey carbonaceous phyllite. In hand sample and drill core the fine grained minerals other than biotite and quartz are difficult to identify. The biotite commonly occurs as < 1 to 3 mm brown crystals that are concentrated into 1 to 4 mm wide irregular bands. The quartz occurs throughout as creamy to frosty white 1 mm to 5 cm wide bands. A preliminary petrographic study (Lietch, 1996) states that the rock is composed primarily of mica (muscovite and/or phlogopite), quartz, chlorite, and fine grained opaques (possibly carbon).

The phyllite contains 0.5 to 20 m thick sections of metamorphosed sandstones, volcanically derived sediments, cherts, and rare limestone. Volcanic-derived sediments differ from the mafic schists that host the mineralization because they contain 20 to 40% fine grained mica which gives the foliation surfaces a characteristic silvery to waxy green colour and can be scratched by a finger nail.

An intercalated unit of quartz-biotite +/- chlorite schists and chlorite +/- biotite +/- quartz schists marks the base of the metasedimentary succession. This has been termed the 'transition zone' (Fig. 3) as it is interpreted to represent an inter-fingering of terrigenous sediments and volcanically derived sediments and/or flows. In general, the thickness of the transition zone changes dramatically from east to west. It averages 6 -15 m thick over East Kona whereas it is between 10 and 200 m thick over West Kona (Fig. 3).

The entire hanging wall sedimentary sequence is at least 705 m thick in drill core but the thickness of the mafic volcanic package is unknown. Three drill holes within the Kona cirque were terminated within sediments — below the mafic schists. It is unclear whether these are structurally juxtaposed or represent a sedimentary sequence within the mafic volcanics.

The Finlayson Lake district has regionally undergone greenschist grade metamorphism. Throughout the Fyre Lake project area there is evidence that the rocks have undergone the same, if not a higher degree of metamorphism. In general, white quartz boudins, products of metamorphic segregation, make up 15 to 20% of the rock. Biotite is a common constituent in the volcanics and sediments where it is often concentrated in foliation parallel bands. Garnet occurs locally in the phyllite with quartz and epidote. Typically, the garnets are 1 to 4 millimetres in size, are sub- to anhedral and have a decrepit appearance. The presence of biotite and garnet indicate that P-T conditions reached the upper greenschist grade. Garnet porphyroblasts rimmed by chlorite suggest that later retrograde greenschist metamorphism overprints an earlier higher-grade phase (Sebert, 1997). Mortensen and Jilson (1985) observed that locally, metamorphism reached middle amphibolite facies because sillimanite was identified within the mafic volcanic rocks belonging to the middle unit of the Layered Metamorphic Sequence.

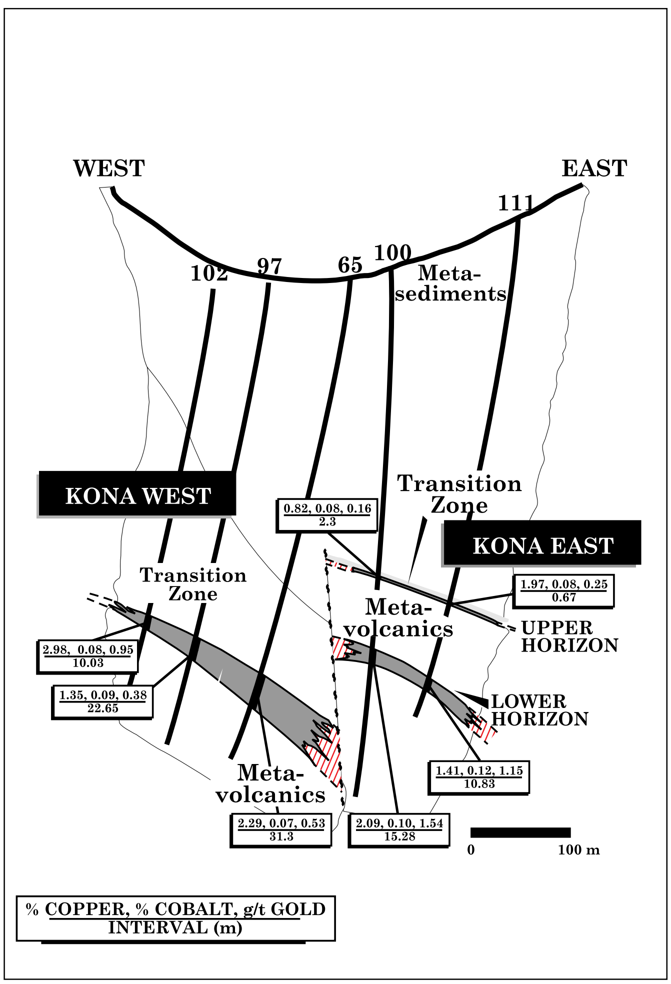

Figure 3. *Schematic cross section, looking northward, based upon drilling as shown. Shaded areas are volcanogenic massive sulphide layers.*

THE KONA DEPOSIT

The mineralization and geological setting of the Kona deposit has many similarities to that of 'Besshi-type' volcanogenic massive sulphide deposits. According to Franklin et al. (1981), the 'Besshi' group of massive sulphide deposits occurs in strata consisting of sub-equal amounts of clastic sedimentary rocks and basalt and their setting is commonly close to a tectonic boundary. The Kona deposit is located at a similar stratigraphic position. The Kona deposit is also similar to many Besshi-type deposits in that the mineralization is predominately pyrite, chalcopyrite and pyrrhotite with lesser sphalerite.

The Kona deposit is divided into two parallel trends of copper-cobalt-gold mineralization: East Kona and West Kona. Both trends have a moderate (20-40°) dip to the east and a shallow (5-15°) plunge to the south. East Kona and West Kona are separated by an inferred steeply dipping fault (Fig. 3). The horizontal separation of East and West Kona is inconsistent and increases towards the northern end of the deposit. At no point does there appear to be any overlap of the two zones. The vertical offset appears consistent along strike and averages approximately 100 m with the west side dropped, suggesting a reverse sense of movement. This measurement is based on the relative elevations of the metasediment/metavolcanic contact.

The geometry and geology of East Kona remains very similar to the interpretation in Blanchflower et al. (1997), whereas West Kona was interpreted during the off-season and expanded during the 1997 drill program.

EAST KONA

East Kona is made up of two distinct horizons: the Upper Horizon and the Lower Horizon (Fig. 4). The Lower Horizon is consistently 40 to 70 m below the Upper Horizon. The Upper Horizon has been drill-tested over a strike length of 630 m (between DDH's 96-21 and 97-100, see Fig. 2) and has an indicated width between 100 and 150 m. The Lower Horizon has been shown to be at least 870 m long (between DDH's 96-6 and 97-100, see Fig. 2) and has an indicated width of between 100 and 150 m. The Upper Horizon has been up-lifted to surface by a cross-cutting fault. Although massive sulphide of the Upper Horizon is not exposed, the underlying banded magnetite forms resistant outcrops. Grey to frosty white siliceous boulders with a sponge-like boxwork texture cover the ground in the immediate area of the magnetite-rich outcrops.

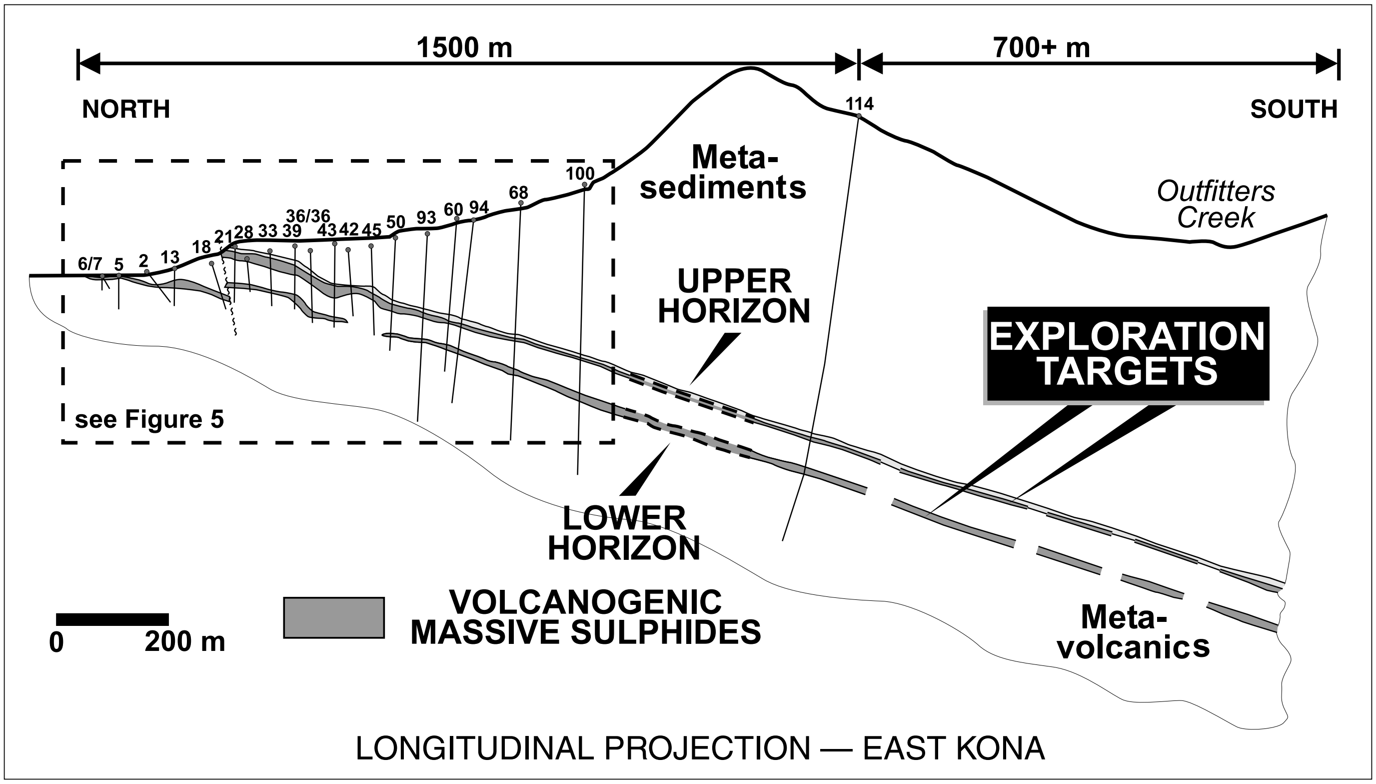

Figure 4. *Longitudinal projection of East Kona outlining the drill-defined mineralization (heavy shading) as well as the exploration potential. The inset area is shown as Figure 5.*

This material has been interpreted to represent the groundmass of the massive sulphides. The Lower Horizon does not outcrop but rather subcrops in the vicinity of the massive sulphide boulders of the original discovery.

The mineralization of the Upper Horizon is the more consistent of the two along most of its length. It has a thicker central portion that thins to the western and eastern margins. The mineralization of the Lower Horizon does not have a thickened central core and is locally open east of its thickest intervals. Through the northwestern and central portions of the deposit, the Upper Horizon is considerably thicker than the Lower Horizon, but it thins towards the southeast. In comparison, the Lower Horizon is more variable with regard to mineralization and thickness. Through its 900 m drill-indicated strike length, the Lower Horizon appears to actually thicken through its central axis (Fig. 5).

UPPER HORIZON

Mineralization belonging to the Upper Horizon has consistent characteristics throughout most of its strike length. The upper portion consists of 1 to 4 m of massive sulphides composed primarily of fine- to medium-grained pyrite with 2 to 7% very fine grained chalcopyrite and minor amounts of pyrrhotite and sphalerite. This, in turn, is underlain by 1 to 25 cm bands of sulphides and quartz within the strongly foliated dark green metavolcanics. This portion of the mineralization varies between 3 to 8 m and contains approximately 30 to 60% sulphides and 10 to 20% frosty white to grey quartz. Chalcopyrite is the dominant sulphide throughout this section and locally makes up 50% of the mineralization. Associated pyrite and pyrrhotite form irregular wisps and blebs about and within the chalcopyrite. Subhedral to euhedral magnetite porphyroblasts (0.5 to 1.0 mm) occur throughout the surrounding metavolcanics. The volume percent of metavolcanics gradually increases down-section as the amount of sulphides decrease. This change is also coincident with the increase in the amount of magnetite. Eventually, sulphide content drops below 10% and magnetite becomes more abundant than the sulphides. Throughout this lower portion of the Upper Horizon, magnetite occurs predominately as aphanitic to <1 mm grains concentrated into 1 to 10 mm wide bands. The magnetite also occurs within 2 to 20 mm wide grey siliceous bands. The sulphides throughout this section of banded magnetite occur predominately as <1 to 4 mm irregular wisps and elongated blebs. The banded magnetite consistently underlies the Upper Horizon and averages 6 to 8 m thick; locally it thickens to 17 m.

The southeastern (or thinned) portion of the Upper Horizon (south of DDH 96-60, Figs. 2, 5) contains little, if any, massive sulphides. The mineralization southeast of this point is primarily banded sulphides within the chlorite-quartz schist. Through these banded intervals, the majority of the mineralization is pyrrhotite, which makes up 40 to 70% of the sulphides. The pyrrhotite occurs as individual 2 to 8 mm long irregular blebs or as 1 to 3 mm thick bands. Chalcopyrite makes up 1 to 10% of the rock and occurs with the pyrrhotite. Throughout the mineralized intervals, magnetite occurs as 1 to 3 mm sub- to euhedral crystals. As with the rest of the Upper Horizon, the southeastern portion is also underlain by banded magnetite. The banded magnetite is much thicker than the sulphide-rich interval and locally thickens to approximately 24 m.

Drill hole 97-114 was collared 450 m to the southeast of 97-100 (Figs. 2, 4) and intersected 2.56 m of banded semimassive sulphides. This mineralization has been interpreted as belonging to the Upper Horizon as it occurs immediately below the intercalated volcanics and sediments of the transition zone. When combined with previous drilling (Fig. 6), the strike length of the Upper Horizon would be 1060 m.

LOWER HORIZON

In longitudinal projection, the mineralization of East Kona (Fig. 5) has an apparent 'gap' between the lower intersections in drill holes 96-43 and 96-50. Previous interpretations (Blanchflower et al., 1997) named mineralization north of the gap as 'Lower Horizon' and mineralization south of the gap as 'Middle Horizon.' Although there are distinguishable differences in the mineralization, the two are now believed to be joined and have been collectively termed the Lower Horizon. The 'gap' represents an apparent local eastward shift in the mineralization and the local appearance of a small magnetite-rich horizon.

The northern portion of the Lower Horizon is 4 to 16 m thick. It is comprised predominately of massive sulphides with the central core containing layers of massive magnetite mineralization. The uppermost massive sulphide layer, the thickest of the layers, averages 7 m thick. The sulphides are typically fine- to medium-grained and dominantly pyritic. Chalcopyrite content averages between 3 and 5%.

The massive magnetite layers are typically fine grained and magnetite makes up more than 90% with pyrite and chalcopyrite combining to make up approximately 5%. White carbonate and/or quartz forms the groundmass throughout and also occurs as 2 to 5 mm laminae and irregular clusters. The alternating massive magnetite layers that combine with the massive sulphide layers to form the base of this portion of the horizon tend to be thin and average only 1.0 m thick. The ratio of massive sulphide mineralization to massive magnetite mineralization is approximately three or four to one. The

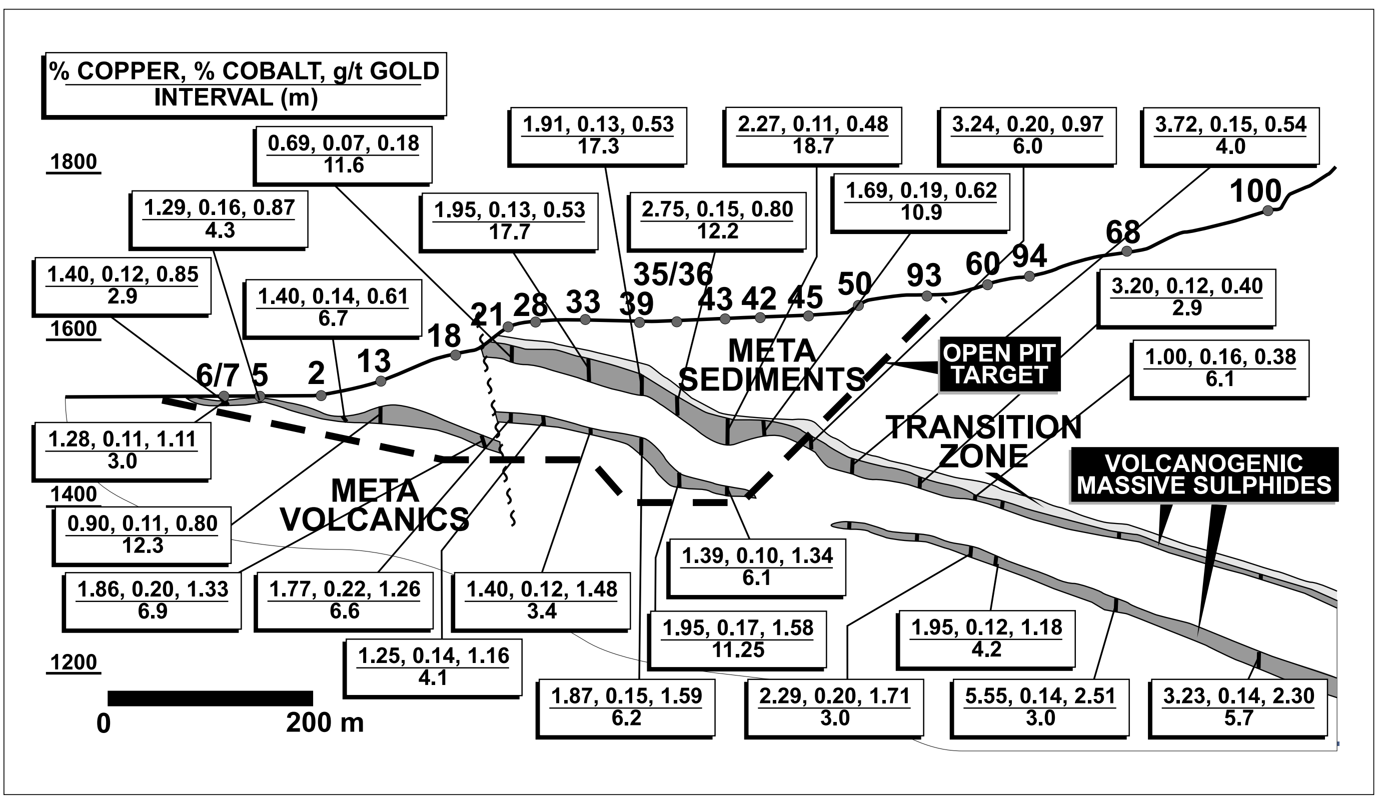

Figure 5. *Longitudinal projection of East Kona showing the geological units, VMS mineralization and drill-hole assays of the Upper and Lower horizons.*

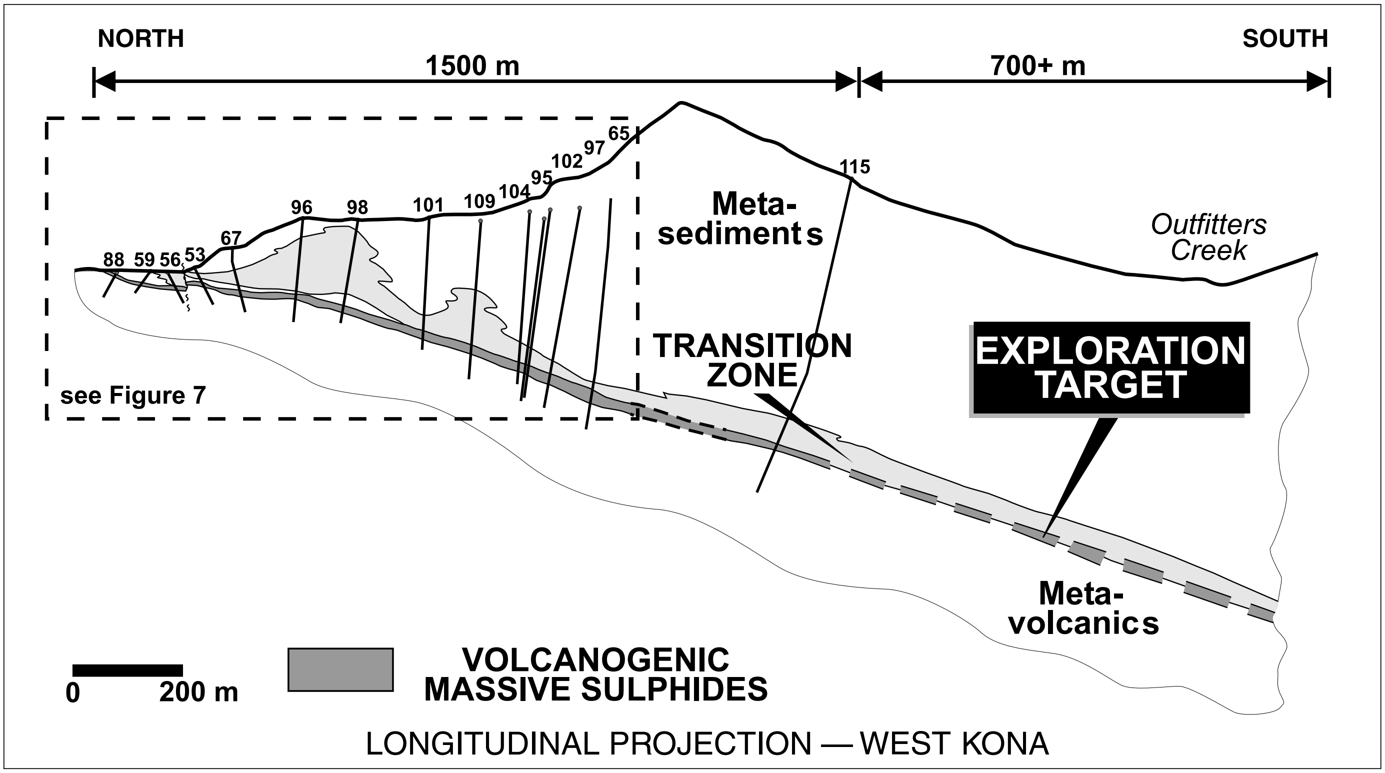

Figure 6. *Longitudinal projection of West Kona outlining the drill-defined mineralization (heavy shading) as well as the exploration potential. The inset area is shown as Figure 7.*

individual layers of massive magnetite do not correlate between drill holes and have been interpreted to be boudinaged lenses.

The styles of mineralization of the southern portion of the Lower Horizon are similar to that to the north of the 'gap' but disseminated to semi-massive banded magnetite overlie the sulphide mineralization. The upper 0.5 to 1.5 m of this portion of the Lower Horizon is typically 80% < 1 to 2 mm subhedral pyrite with 2 to 6% sphalerite as interstitial reddish-purple crystals that are locally concentrated into bands 1 to 2 cm thick. The underlying sulphides comprise layers of fine- to medium-grained, locally recrystallized, pyrite with local 3 to 6 m thick sections in which chalcopyrite and pyrrhotite are concentrated into 2 to 10 cm thick bands. The mineralization occurs over a thickness of 8 m and locally thickens to greater than 11 m. This portion of the Lower Horizon locally contains 0.5 to 3 m thick sections of banded semimassive sulphides. Laterally, the massive sulphides may grade into banded massive to semi-massive sulphides at the eastern margin of the mineralization.

WEST KONA

West Kona has been drill-tested over a strike length of 1420 m (between DDH's 97-88 and 97-115, see Figs. 2, 6) and has an inferred width of 75 to 125 m. A complete section has not been drilled through West Kona, hence information on the lateral characteristics of the mineralization has been drawn from sectional projections (see Fig. 3).

In general, the mineralization within West Kona is distinct from that within East Kona. The primary difference being that a majority of the mineralization of West Kona is hosted within a grey siliceous matrix. Laterally, the mineralization of West Kona changes from siliceous-hosted mineralization in the east to true massive sulphides in the west. The nature of this change is not understood and is assumed to be gradational.

The thickness of the mineralization within West Kona varies considerably across its width (Fig. 3) from 43.9 m in the east to less than 1 m thick at the western margin. Additionally, the thickness of mineralization within West Kona is also quite variable along its strike.

The siliceous-hosted style of mineralization, which makes up > 80% of West Kona, also changes from east to west. The mineralization throughout this portion of West Kona is predominately fine grained magnetite and pyrite. Magnetite occurs as disseminated subhedral to euhedral aphanitic to 1 mm crystals that are locally concentrated into 2 to 15 cm wide bands. Pyrite and chalcopyrite with lesser accessory pyrrhotite together generally make up 15 to 20%. The pyrite typically occurs as < 1 to 2 mm sub to euhedral crystals throughout and when concentrated into bands, locally form 1 to 8 mm long irregular blebs that are aligned with the dominant foliation. The chalcopyrite typically occurs as irregular < 1 mm to > 2 cm elongated blebs, while the pyrrhotite forms 1 to 5 mm long wisps. Locally in the magnetite-rich sections, chalcopyrite is the dominant sulphide in concentrations up to 30%. The percentage of sulphides increases to the west until the sulphide content exceeds that of magnetite. In general, the sulphide-rich portions are a mirror image of the magnetite-rich sections but with the oxide and sulphide portions interchanged. Through the sulphide-rich portions of West Kona, pyrite makes up 75 to 85% of the total volume of sulphides. Chalcopyrite occurs as 1 to 9 mm wide irregular blebs that are locally elongated parallel to the dominant foliation. Through these sections, sphalerite locally occurs as <1 to 5 mm irregular reddish-purple crystals and/or aggregates.

In the western portion of West Kona, the mineralization consists of true massive sulphides. The mineralization is made up of greater than 80% fine- to medium-grained subhedral to euhedral pyrite with 8 to 12% fine grained interstitial chalcopyrite. There is a noticeable lack of pyrrhotite in this portion of West Kona. Throughout the massive sulphides are 1 to 10%, 1 to 6 mm subrounded to rounded clear to grey quartz blebs. Locally, the massive sulphides appear to have a siliceous groundmass as the pyrite and chalcopyrite are surrounded by aphanitic white quartz. This style of mineralization appears to be isolated to the area surrounding drill holes 97-102 and 97-104 (Fig. 2) as massive pyrite and chalcopyrite has not been intersected. Intersections even further to the west consist of massive pyrrhotite. These intersections are typically less than 1 m wide and contain less than 5% pyrite and chalcopyrite that occur as rounded blebs and fracture fillings.

EXPLORATION POTENTIAL

The Kona deposit remains open for expansion, particularly to the southeast. The 2.6 m intersection in drill hole 97-114 (Fig. 4) is very significant in that it confirms that the mineralizing system deposited copper-rich 'East Kona'-style mineralization 450 m along strike to the southeast beyond previous drilling. Within the Kona cirque, the Lower Horizon occurs in every section in which the Upper Horizon has been intersected. This provides reason to believe that the Lower Horizon also occurs 450 m southeast of current drilling. This projected portion of the Lower Horizon combined with the 16.3 m thick intersection of West Kona in drill hole 97-115 (Fig. 6), indicate that the true size of the Kona deposit has yet to be fully realized. The weak coincident geophysical anomalies that are believed to define the deposit in the area of drill holes 97-114 and 97-115 continue 700 m further to the southeast.

Columbia Gold Mines has outlined a mineralized container of approximately 15 million tonnes for the Kona deposit. This mineralized container is 1500 m long and 250 m wide (Fig. 2) and encompasses all of the massive and semimassive

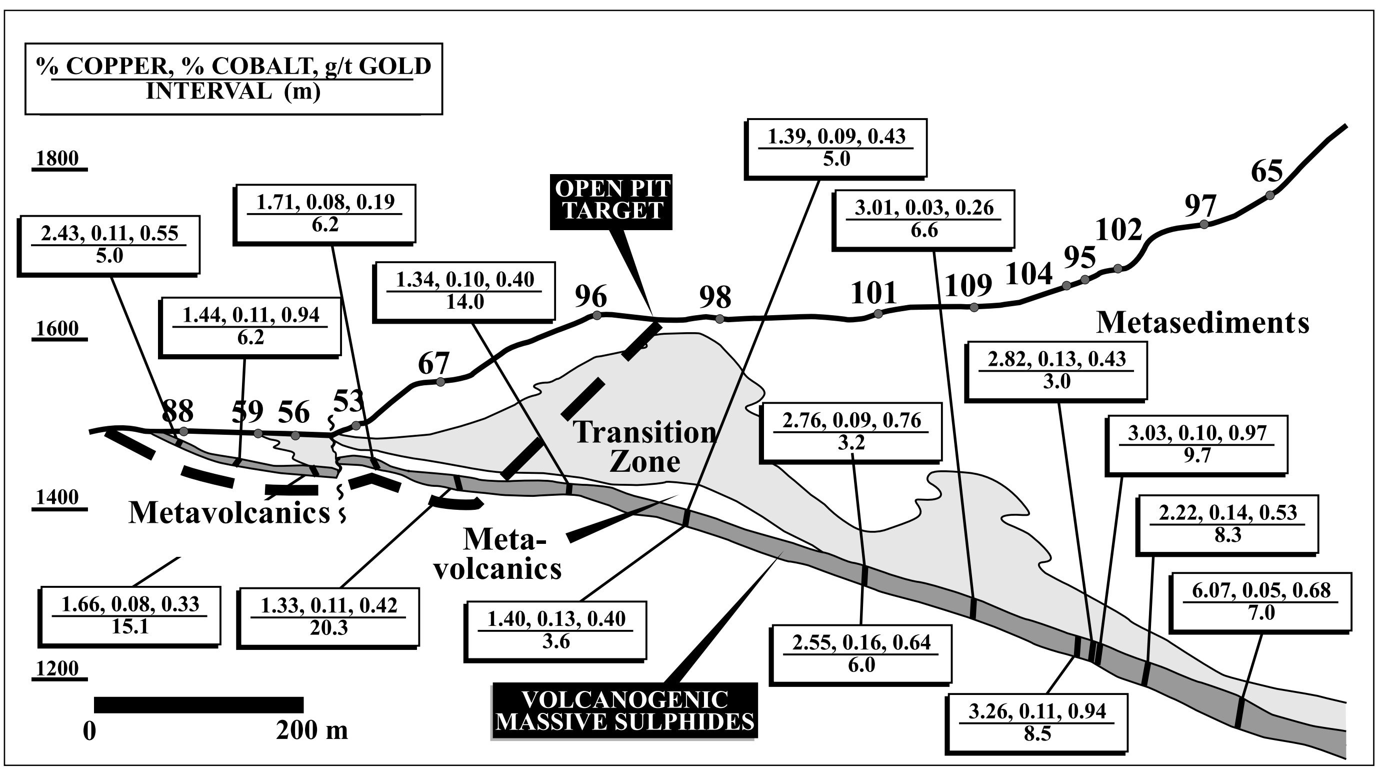

Figure 7. *Longitudinal projection of West Kona showing the spatial association of the geological units and the mineralization.*

mineralization intersected to date. Within this container, there is a near-surface, open pit target and a deeper underground target. The underground target is made up of 3.0 to 8.3 m thick enriched portions of the mineralization. Consistently throughout West Kona (Fig. 7) there are chalcopyrite-rich sections that generally have associated higher grade cobalt and gold values. These intersections, combined with the high-grade central portions of East Kona, form a target that is potentially mineable by modern underground methods. The northern, near-surface, portion of both East and West Kona (Figs. 4, 5) form the open pit target.

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