An update of exploration at Gladstone and Union Hills, Waihi

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Abstract

Mineralisation was identified at Gladstone Hill as far back as the late 1870s-early 1880s, shortly after the initial discovery of mineralisation at what is now the Martha Mine. Indeed, early recovery problems associated with the Martha mineralisation led to the preferred development of ore bodies within what is now the Union Hill Joint Venture tenement; ore bodies such as Silverton, Amaranth, and Union to name a few.

Gladstone Hill forms the basis of the Union Hill Joint Venture, a 50:50 joint venture managed by Auag Resources Ltd (a fully owned subsidiary of Otter Gold Mines Ltd), and Welcome Gold Mines Ltd (a fully owned subsidiary of the Normandy Group). The joint venture participants also operate the adjacent Martha Mine.

Mineralisation of Gladstone Hill, as with mineralisation at the adjacent Martha Mine, has been interpreted as a low sulphidation epithermal Ag-Au system hosted within hydrothermally altered andesites of the lower Coromandel Group.

Drilling in recent years has successfully identified extensive mineralisation associated with a number of vein sets throughout the tenement including the Gladstone Vein set, the Moonlight Lode and more recently along a north-easterly trend towards the historic Favona workings. A wide range of vein styles is apparent, ranging in character from thin stock works to broader lode-style banded chalcedonic to cherty quartz and have been interpreted as representing multiple phases of emplacement. At shallower levels mineralisation is often hosted by vein clasts within vent breccias. Visible gold is rare, with mineralisation generally associated with very fine-grained pyrite, arsenopyrite and minor electrum. Percentage levels of combined sphalerite-galena-(+/- chalcopyrite) have been intersected at depth however these have been gold poor to date.

The potential for the Gladstone Hill area remains to be clearly defined as drilling to date has yet to close off mineralisation both along strike and down dip. If further drilling is successful, the joint venture partners believe Gladstone Hill could contribute significantly to the economic future of current operations.

Introduction

The Gladstone Hill deposit is located on the southeastern boundary of the town of Waihi (lat 37^0 23' S, long 175^0 51'E) in the southern portion of the Coromandal Peninsular, New Zealand. The town is easily accessible by major sealed highways from Auckland, approximately 150 km to the northwest (Figure 1).

The project is geographically associated with a cluster of low hills rising some 80 m from the surrounding plain of the Waihi Basin. Land use in the area is a combination of residential, dairy and lesser horticulture.

The project is a 50:50 joint venture managed by Auag Resources Ltd (a fully owned subsidiary of Otter Gold Mines Ltd) and Welcome Gold Mines Ltd (a fully owned subsidiary of Normandy Mining Ltd). The joint venture participants are also partners in the adjacent Martha Joint Venture, operators of the Martha Mine.

Mineralisation at the Martha Mine includes the Martha Lode in addition to numerous other mineralised veins including Empire, Welcome, Grand Junction and Edward. For the purposes of this paper all mineralisation at the Martha Mine is collectively referred to as Martha mineralisation.

Early exploration and mining history (1870s-1970s)

Initial exploration for gold in the Waihi area was carried out by Daniel Leahy and Scott O'Neill in 1876 who examined the Rosemont-Silverton reefs (approximately 300 m north of Gladstone Hill) with little success. Likewise, Corbett and Merriman, who followed shortly after, also explored the area with little success. Both groups ignored the outcropping

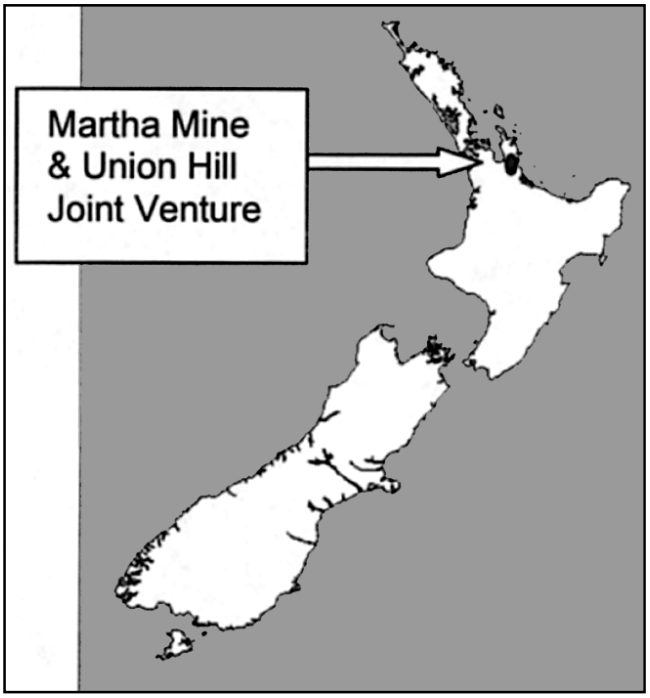

Figure 1. Location of Gladstone Hill and Martha Mine, North Island, New Zealand.

Martha Lode describing it as 'buck' or barren looking (McAra, 1988). This is in contrast to McCombie and Lee who, in 1878, sampled and recovered gold from almost all samples from the Martha Lode and so started the Waihi field.

By the early 1890s mining of the Silverton, Rosemont, Union, Amaranth and Mascotte reefs was under way, as was the dominant producer, Martha. Over time the Waihi Gold Mining Company came to dominate the area, relying upon the recently invented cyanide extraction process (introduced in 1894) to increase recoveries from the Martha Lode (McAra, 1988). Limited success at the other peripheral operations resulted in their closures throughout the latter part of the 1890s, however, underground mining continued along the Martha and associated lodes until 1952.

Recent exploration (1970s-2000)

During the 1970s interest in the Coromandel Peninsula as a gold province increased, leading to the re-opening of the Martha Mine (1988) plus discovery and subsequent development of the Golden Cross mine by 1991. As part of this renewed interest in the region, attention was also drawn to the relatively under-explored old workings of Union, Silverton, Rosemont, Mascotte and Amaranth. This area evolved to form the Union Hill Joint Venture (Figure 2).

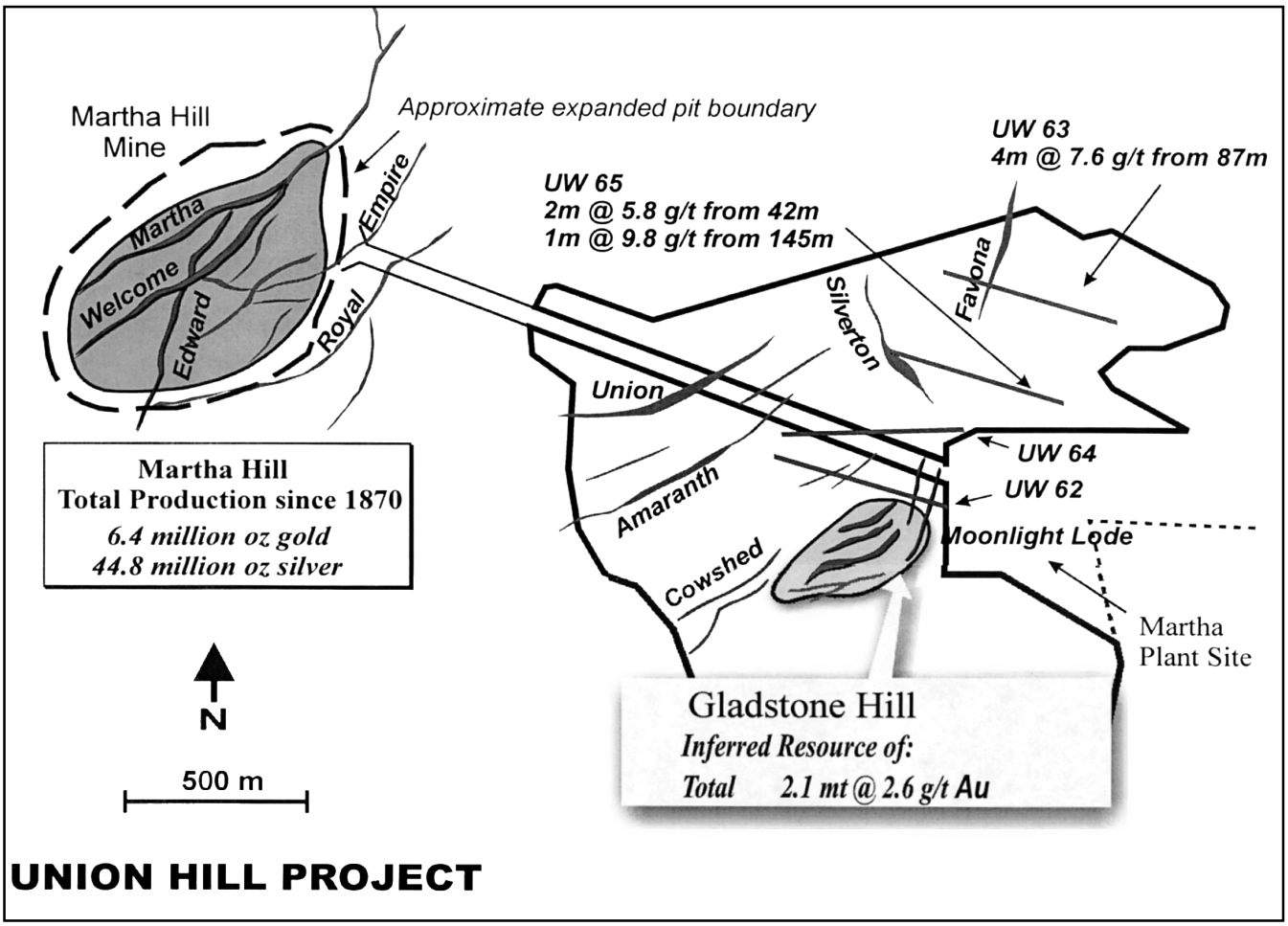

Figure 2. Plan view of the main mineralised veins within the Waihi area, in particular within the UHJV tenement boundary. Location of recent drill holes (March to May 2000) included.

After initial reconnaissance work in the area attention gradually focused on a small hill, locally referred to as Gladstone Hill. Several drilling programmes have been undertaken to date, culminating in delineation of the Gladstone Vein set and the adjacent buried and higher grade Moonlight Lode. In addition, zones of banded auriferous quartz veining mineralised clasts within vent breccias have been intersected in two drill holes some 600 m to the northeast of Gladstone Hill. This mineralisation coincides with a northeasterly trending geophysical and geochemical anomaly and may represent an extension to the structure hosting the Moonlight Lode mineralisation.

Regional geology

The Gladstone Hill deposit falls within the 1:50,000 Waihi map coverage, an area incorporating a portion of the southern Hauraki Goldfield, an economically significant epithermal gold-silver province associate with the Miocene to Pliocene Coromandel Volcanic Zone (CVZ), (Christie and Brathwaite, 1986). In the Waihi area the Coromandel Volcanic Zone is represented by the Early Miocene to Pliocene Coromandel Group which is dominated by andesite and dacites, and the overlying Late Miocene to Pliocene Whitianga Group rhyolite and ignimbrites (Brathwaite and Christie, 1996).

Structurally, geophysical data suggests the area around Waihi represents a NE-SW orientated fault angled depression with steep dipping faulted northern and western boundaries (Figure 3), while the eastern and southern are more shallow dipping. Infilling by lake sediments and ignimbrite sheets to a depth of approximately 1.5 km has resulted in the typical basin topography of low rounded hills set in gently undulating plains against a perimeter of steeper hills to 600 m.

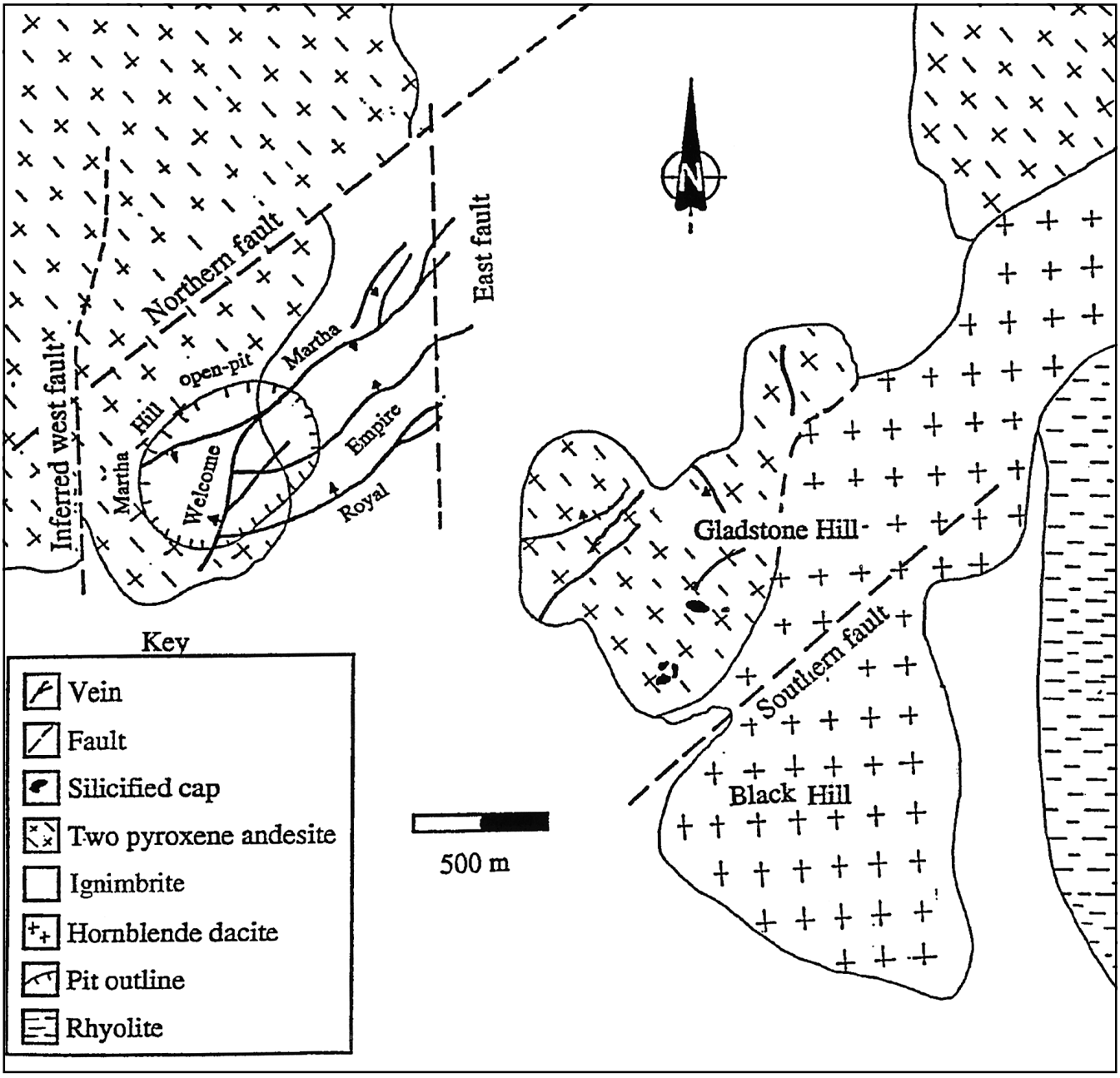

Figure 3. Geology and structure of the Waihi area (Brathwaite and McKay, 1989).

Project geology

A distinctive feature of the UHJV project area are the small hills (eg. Union, Gladstone, Winner and Silverton) rising above the surrounding plains. These hills represent windows of altered Late Miocene Waipupu Formation andesites, part of the Waiwawa Subgroup, which are in part overlain by dacites of the Uretara Formation of which Black Hill to the southeast of the project area is an example (Brathwaite and Christie 1996).

Recent ash and alluvium/eluvium of the Tauranga Group dominate the valleys and flanks of the hills.

Waipupu Formation andesites

The Waihi mineralisation is hosted in Late Miocene Waipupu Formation andesites. These are predominantly two-pyroxene andesite flows with lesser intercalated pyroclastic rocks and minor carbonaceous intervals. In the vicinity of the project area the andesites are commonly fine grained to porphyritic, with minor intercalated pyroclastic units. Extensive brecciation, hydrothermal alteration and quartz veining are also common.

These rocks are poorly exposed at Gladstone Hill, generally represented by surface outcrops of an intensely silicified sinter-like cap on the crest of Gladstone and Winner Hills. Similar sinter-like rocks were intersected in drilling to the northeast, concealed beneath post-mineralisation ignimbrites and lake sediments. Close inspection demonstrates the intensely silicified nature of the rock, outlining and preserving the original ground mass voids (after feldspar) giving rise to a somewhat porous appearance. Assay results are typically low grade in the order of 0.1-0.2 g/t Au.

With increasing depth silicification rapidly gives way to intense clay alteration which, while preserving the original structure and fabric, results in complete clay replacement. Thin section petrographic studies of relatively fresh andesite from holes UW 20 (Brathwaite and Christie, 1986; Oldfield, 1990) and UW 24 (Oldfield, 1990) revealed a porphyritic texture containing hypersthene, augite and plagioclase phenocrysts in a plagioclase dominated groundmass.

It is worth noting that the andesites are the preferred host to mineralisation in the area, allowing the development of extensive vein structures at both Martha Hill and within the Union Hill Joint Venture. At the Martha Mine, the andesite host to a substantial proportion of mineralisation and vein development is unusual in that it contains quartz phenocrysts to several millimeters in diameter. This unit is yet to be identified at Gladstone Hill, however, based on regional stratigraphy, it is interpreted to exist at depth.

Hydrothermal explosion breccias occur as float across the flanks of Gladstone Hill, with drilling demonstrating a thickening wedge of variably silicified and pyritised fragments extending in a broad hemisphere roughly centered around the eastern portion of the hill. The breccias display a range of textures from angular fragments of several centimetres to sub angular-rounded fragments of chalcedonic quartz (1-20 mm) in a fine grained quartz-clay matrix to rounded milled fragments. The milled fragments are interpreted as representing fluidised hydrothermal explosion breccias deeper within the system (Figure 4).

Uretara Formation

The outcropping dacites on Black Hill to the southeast of Gladstone Hill have been correlated with the Uretara Formation and are represented by unaltered hornblende and biotite bearing dacite. The contact between these and the underlying Waipupu Formation is unconformable and has been interpreted by Oldfield (1990) as representing a fossil weathering surface.

Mineralisation and veining

Host lithology

A broad overview of the geographical relationship of the various mineralised veins is presented in Figure 2.

There is increasing evidence that the andesite flow units (quartz phenocryst rich or not) are the preferred host units to mineralisation at both the Martha Mine and Gladstone-Union Hill. Andesite intersected during drilling at Gladstone Hill and from mapping of historic workings are typically fine to medium grained porphyritic with minor pyroclastic and sedimentary intercalations. Extensive hydrothermal clay-pyrite alteration and phreatic brecciation are common throughout the immediate area.

Recent drilling at Gladstone Hill demonstrates a change in lithology from fine to medium grained andesite to a pyroclastic unit (interpreted as an andesite tuff breccia from drill core) coinciding with relatively poor vein development and corresponding low gold grades immediately along strike from earlier high grade Moonlight Lode intersections. Preliminary interpretation suggests a rheology contrast between the two units may be responsible for the diminished vein development within the pyroclastic unit.

Mineralisation is also associated with banded quartz vein clasts hosted within near surface vent breccias. These clasts show a strong resemblance to mineralised banded quartz veins intersected at depth in the same area.

Vein characteristics

With over one hundred years of mining and exploration over what is now the joint venture tenement, several auriferous vein sets have been identified. In recent years the exploration focus has concentrated upon the following areas.

The Gladstone Vein Set, which has a drill determined strike length of at least 250 m about a strike of 075^0, remains open

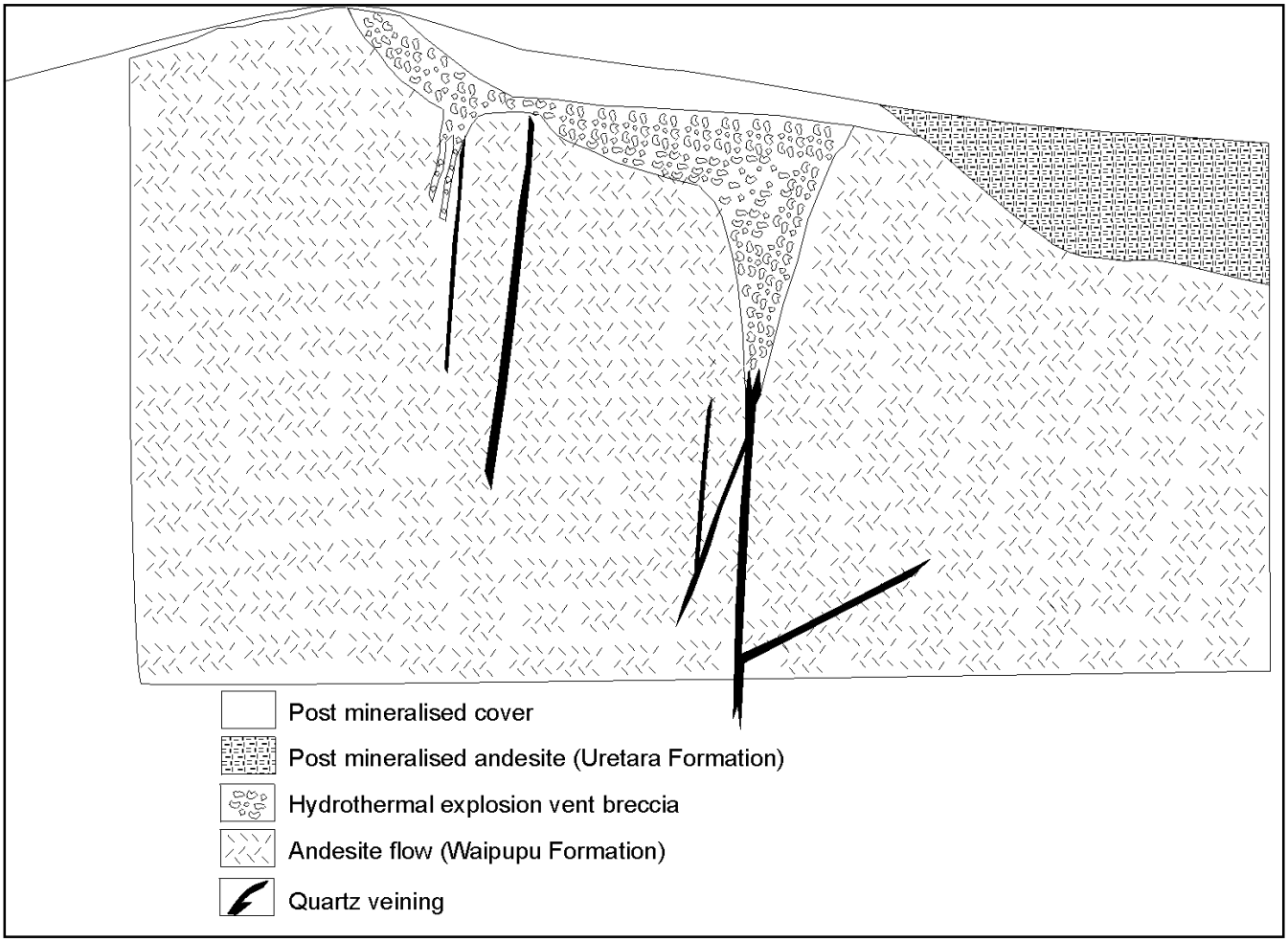

Figure 4. Stylised cross-section through Gladstone Hill showing the conceptual relationship between veining, brecciation and post mineral cover.

at depth with drilling to greater than 200 m below surface. The vein set generally has a near vertical dip. At least eight individual veins can be traced across drill sections although three tend to dominate the system. Vein width range from centimetre scale to several metres, reflecting a spectrum from fine stockworks in the upper and peripheral levels to more lode style with depth. Intense shear/crush zones are commonly associated with veining. Vein characteristics tend to be dominated by crustiform to colloform grey-white-black banded cherty to chalcedonic quartz, typically hosting fine to very fine sulphides (pyrite, arsenopyrite, silver sulphosalts) and electrum. Visible gold is extremely rare while Au:Ag ratios are typically 1:3. Towards the eastern end of the deposit, banded cherty to chalcedonic veining tends to give way to a fluidised hydrothermal breccia with decreasing depth. Gold grades throughout the Gladstone Vein set tend to be greater immediately below the fluidised breccia zone, possibly reflecting the effects of rapid pressure change and boiling.

The Moonlight Lode, intersected during drilling in 1997, demonstrates many common features with the Gladstone Vein set, including the fine sulphide banding within the cherty to chalcedonic quartz veins and discrete intense shear/crush zones with clay gauge. However, the significant differences to be noted are the northerly strike (015^0), the general higher tenor of mineralisation (5-15 g/t) and the broader, more coherent nature of the veining. Mineralisation attributed to the Moonlight Lode has now been recorded over a strike length of approximately 125 m, however the depth extent remains unclear as a deep hole drilled during March 2000 deviated off its design. This hole traversed a broad zone of chaotic quartz veining and hydrothermal brecciation from 474 m to the final depth at 577.4 m and may represent a down dip extension of the Moonlight structure. Veining within this interval is notably different to that of shallower Moonlight veining in that there is a significantly greater amount of open vuggy veins with coarse crystalline quartz to several millimetres. A significant feature of this particular interval is the presence of abundant galena-sphalerite - (+/- chalcopyrite), with a combined base metal content to 4.3%. The presence of abundant base metal sulphides is intriguing as their presence at the nearby Martha Mine is often associated with high gold grades whereas these were uniformly gold poor. Base metal sulphides at Martha may be differentiated into two groups based upon their grain size with the coarser group (~0.5 mm) tending to be gold poor. The coarser range is a similar size range as that intersected. Table 1 provides a comparison between Moonlight (UW 62) and Martha mineralisation.

Martha	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)
Fine	19	73	0.005	0.07	0.14
Coarse	0.1-2.0	5-70	0.1	0.5-1	1-2
UW 62	<0.5	<13	0.02-0.18	0.02-0.8	0.05-3.4

Table 1.

From the table the similarities in the grades between the coarse base metal sulphides at Martha and Moonlight are apparent. At Martha the coarser base metal sulphides tend to occur at depths of 700-800RL whereas at Moonlight the depth is comparatively shallower from –250RL. The relationship between the Moonlight Lode and the base metal mineralisation is unclear, however, preliminary interpretations have it representing either an earlier mineralising phase or alternatively a deeper level within the system.

Recent drilling during the first half of 2000 also investigated the presence of mineralisation since referred to as the Favona Trend. This trend is highlighted by a well defined geophysical anomaly which extends from Gladstone Hill for at least 800 m along a northerly trend parallel to the 015 Moonlight trend. Two exploratory diamond drill holes drilled to test the coincidence of this trend with surface gold anomalism returned multiple mineralised vein intersections. Mineralised veining was represented as centimetre to sub-centimetre scale alternating white and dark chert, millimetre scale pyrite dominant laminations, and internal silica matrix breccia and limited quartz after platy calcite. Clasts of similar vein material are present within vent breccias intersected at shallow levels. Based upon visual observation and comparison of drill core, the laminated vein material from along the Favona Trend is very similar in appearance to that of the deeper levels of the Gladstone Vein Set and the majority of the Moonlight Lode.

Common to all veins is evidence of multiple episodes of vein emplacement and cross-cutting vein development, including comb, banded chalcedonic and microcrystalline veinlets. The high proportion of re-cemented breccia within the vein margins further complicates this complexity and interaction. Breccias typically display textures ranging from monomict angular jigsaw fit to well rounded polymict fragments in a silica matrix.

Quartz replacement of platy calcite is common throughout the system, preserving the calcite rhomb form. Residual calcite is rare.

Alteration and fluid inclusion data

Alteration at Gladstone Hill demonstrates a strong structural control and zonation about veining. Several stages can be recognised and an alteration sequence established as follows (Brathwaite and Christie, 1986; Oldfield, 1990).

Early propylitic alterations represented by chlorite, calcite and adularia relicts gives way to quartz/adularia (argillic alteration). Fluid inclusion data from vein quartz indicates temperatures in the range of 240-260^{0}C in the deeper portions to 200^{0}C in the shallower zones with periods of boiling. This stage is believed to be associated with formation of the banded chert to chalcedonic quartz veins.

The quartz/adularia alteration coincides with hydraulic fracturing and subsequent filling with chalcedonic quartz, formation of argillic alteration of wall rock, brecciation and fluidisation of the chalcedonic quartz and formation of breccias' clay matrix.

A mechanism for the later overprint of acidic (kaolinitic) alteration has been suggested by Brathwaite and Christie (1986) and Oldfield (1990) as possibly resulting from a single stage of mixing of ascending deep acid-chloride fluids with acid-sulphate steam condensates.

Based on the alteration products, style of veining, shallow emplacement levels and near neutral alkali-chloride fluids (Oldfield,1990), the Gladstone Hill system is interpreted as a low sulphidation system.

Martha mineralisation comparisons

With the close proximity of the Martha mineralisation (some 1500 m to the west), any exploration of the Union Hill Joint Venture draws heavily upon concepts and understanding developed there. The Martha deposit is regarded as a classic example of a low sulphidation epithermal gold-silver deposit. Precious and base metal mineralisation is hosted in a NE-SW trending steep dipping, extensively braided and anastomosing quartz vein network.

Oldfield (1990) sets out a summary of the relationship between Martha mineralisation and that of Gladstone Hill, outlining the strong similarities and potential evolutionary path of both deposits.

Essentially the similarities can be set out as shown in Table 2.

Acknowledgments

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Gladstone/Moonlight		Martha Hill	
Gladstone	~ 075^0	Martha, Welcome	~ 070^0
Moonlight	~ 015^0	Edward	~ 020^0
Strike extent	~ 250 m		~700 m
Lithology: Andesite		Andesite	
Alteration: Broad propylitic alteration Quartz/adularia envelope around veining Late stage calcite overprinting at depth		Broad calcite-chlorite propylitic alteration Quartz/adularia envelope around veining	
Mineralisation: One stage recognised Quartz, illite, adularia, pyrite electrum, arsenopyrite		Three stages: 1. Deep – quartz, calcite, adularia, pyrite, chalcopyrite, spalerite, galena electrum 2. Intermediate – quartz, calcite, illite, electrum +/- sphalerite, +/- galena, +/- chalcopyrite. 3. Shallow – quartz, illite, adularia, pyrite electrum	
Depth extent of mineralisation: Deepest mineralisation Remains open at depth	~ 230 m	Mining to 600 m	

Table 2. Gladstone Hill mineralisation comparison with the Martha mine mineralisation.

and D McKay are thanked for their input as part of the Union Hill Joint Venture. In addition S Rabone is thanked for his valuable contribution in recent years to exploration on and around Gladstone Hill.

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