FURTHER COMMENTS ON THE

CONTROLS TO Au-Ag MINERALISATION

AT THE CERRO MORO PROJECT

ARGENTINE PATAGONIA

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SUMMARY
Cerro Moro represents a high priority exploration project in need of continued evaluation by continued geological mapping and sampling, as well as definition drilling of known prospects. Because of the generally low level of erosion many veins are poorly exposed in a fossil hydrothermal system, which is strongly vertically zoned. Additional blind and intact mineralised veins might be identified by further prospecting in the northern portion of the project, which appears to host several poorly eroded prospects. At the south, Doris stands out as a high priority exploration target which covers a large area and displays features indicative of a level in an epithermal system above mineralisation and also features a possible acid cap and MnO stain, both consistent with environments where mixing reactions provide elevated Au-Ag grades.

The controls to low sulphidation mineralisation at Cerro Moro include:
- Competent host rocks, especially silicified permeable felsic tuffs, provide ideal vein hosts and at Escondida contribute towards the development of a horizontal ore shoot.
- Dilatant veins present as EW trending flexures in generally NW trending structures are ideal settings for enhanced fluid flow and ore shoot formation (Escondida, Carlita, Doris). Some targets are highlighted by the application of a pull-apart basin model to the existing ground magnetic and resistivity data.
- The style of Au-Ag mineralisation discernible as the transition from intrusion-related low sulphidation polymetallic Ag-Au to epithermal Au-Ag which typically displays bonanza Au-Ag grades, especially where entire vein systems are preserved as at much of Cerro Moro.
- The mechanism of Au-Ag deposition contributes towards the development of elevated Au-Ag grades such that rapidly cooled ores in which high temperature chalcopyrite occurs with low temperature white sphalerite and local marcasite, have deposited elevated precious metal grades from rapidly cooled fluids. Throughout much of Cerro Moro the presence of kaolin (including the hydrated form, halloysite) with electrum and native Au provides evidence that elevated Au-Ag have resulted of the mixing of ore fluids with low pH waters derived from acid sulphate caps. Such a cap may occur at Doris.

Best Au-Ag mineralisation, as wider veins with higher Au-Ag grades, occurs where many of these controls coincide.

Several features which might vector towards mineralisation or aid in exploration include:
- Resistivity studies have worked well in other deposits of this style to identify mineralised faults as subtle linear breaks in the resistivity.
- Epiclastic rocks such as the P4 arkose have been deposited in the hanging wall to normal faults which are later sites of mineralisation, in a pull-apart basin model, and so are indicators of prospective settings for further exploration (Escondida).
- Acid sulphate caps characterised by bleaching and the presence of kaolin-alunite, as may occur at Doris, lie above mineralised portions of many low sulphidation vein systems and mixing with ore fluids of the acid waters responsible for this alteration will promote bonanza grade Au-Ag deposition (Doris).
- MnO stain at surface, derived from weathered Mn carbonate, is indicative of the mixing of bicarbonate waters with ore fluids as another mechanism for the development of elevated Au-Ag grades in polymetallic vein systems (Doris).
- Celadonite clays are common in polymetallic vein systems and may provide an indication of prospective environments (Lala, Doris).
INTRODUCTION

At the request of Glen van Kertvoort and Bryce Roxburgh 6 days were spent at the Cerro Moro project in November 2007. The brief for this work was to:

• Further delineate the controls to Au-Ag mineralisation as an aid to continued definition drilling underway at the time of this visit, which follows an earlier inspection in January 2007 (Corbett, 2007a),
• Comment on the stratigraphy,
• Delineate additional targets.

Lectures were presented on site to discuss some of the geological concepts used in the evaluation of this project as well as the conclusions reached herein. The assistance is gratefully acknowledged during this work of Glen van Kertwoort and Fernando Chakon and the remainder of the Exeter Resources team at Cerro Moro.

Priority

Exploration projects are rated with priorities to proceed with the planned work program to take them to the next decision point. Any such a grading might include a number of projects at widely differing stages of evaluation, some with substantial data bases, while others might be unexplored, but may display considerable untested potential. Priorities are based upon the data to hand at the time of inspection, and subject to change as increased exploration provides improved and additional data. Projects are categorised as:

A – Of highest interest such that the proposed exploration program should be carried out immediately. However, early stage projects with untested potential might be rapidly down graded from this stage by completion of the planned work program.

B – Of some interest and should be subject to further work if funds are available, often with a smaller components of continued exploration expenditure than higher priority targets.

C – Of only little interest and subject to further work at a low priority if funds are available, but not to be relinquished at this stage.

D – No further interest and should to offered for joint venture or relinquished.

CONTROLS TO LOW SULPHIDATION Au-Ag MINERALISATION

Cerro Moro represents intrusion-related low sulphidation epithermal Ag-Au mineralisation gradational between the epithermal of the polymetallic end members and locally grades to higher crustal level low sulphidation chalcedony-ginguro Au-Ag mineralisation, which hosts elevated Au-Ag grades in the absence of the more substantial Pb-Zn-Cu present in the polymetallic veins (figure 4). Of interest is that the epithermal end member of polymetallic Ag-Au deposits in this transition between to chalcedony-ginguro style may display bonanza Au-Ag grades as locally previously recognised at Cerro Moro (Corbett, 2007a) and elsewhere (Corbett, 2007b).

Many low sulphidation Au-Ag deposits, polymetallic Ag-Au veins in particular, host most of the economic mineralisation within ore shoots or clavos, characterised by higher precious metal grades and wider veins, formed where several controls to mineralisation coincide and are best developed. These controls have been defined from studies of many deposits (Corbett, 2007b) as:

Lithology, (host rocks) mostly as competent rocks which are required to promote throughgoing fracture formation,
Structure, as dilatant zones which promote fluid flow and host elevated metal grades and wider veins as well as sites of fluid mixing at structural intersections,

Style of Au-Ag mineralisation as the epithermal end member in the uppermost portion of to these deposits host elevated Au-Ag grades, while the deepest portion and earlier quartz-sulphide portion of the paragenetic sequence display lower precious metal grades and lower Ag-Ag ratios (more Au relative to Ag),

Mechanism of Au-Ag deposition promotes bonanza Au-Ag grade formation typically by the mixing of ore fluids with collapsing near surficial waters such as low pH acid sulphate waters, bicarbonate waters or oxygenated ground waters.

Dilution by non mineralised quartz veins deposited from meteoric dominant waters and the effects of near surficial supergene Au enrichment must also be taken into account.

Best Au-Ag mineralisation, typically as widest and highest precious metal grade veins, occurs within ore shoots (clavos) where many of these factors are coincident.

Host Rocks

Competent host rocks fracture well as vein hosts. In epithermal veins developed in volcanic terrains where inter layered rock sequences contain both competent and incompetent host rocks, drilling must target the host structure where it transgresses the competent host rocks. This relationship contributes towards the development of sub horizontal ore shoots hosted in only the competent host rocks. In some districts veins are constrained below poor host rocks such as andesitic lapilli tuffs which commonly display clay alteration (Hishikari), whereas quality hosts might include andesite flows (Vera Nancy, Waihi, Golden Cross, Aracta), basement metamorphic rocks (Hishikari, Konami) felsic to intermediate domes (El Penon, Sado, Asacha, Ares), or welded members of felsic sequences (Cerro Vanguardia) and silicified very brittle non reactive rocks such as sandstones (Chatree, Palmarejo) or felsites (Cerro Moro).

The Escondida prospect at Cerro Moro demonstrates the influence of host rock competency upon vein development. In cross section Escondida 30475E where P4 arkose occurs in the hanging wall to the mineralised structure, while the footwall contains the conformable contact between underlying L1 andesite and overlying P2 felsic tuff, which is permeable and has undergone intense silicification (figure 1). The throughgoing Escondida fault dilates as it passes upward from the andesite into the competent silicified felsite and therefore hosts mineralisation only in the overlying very competent silicified felsite. Subsurface sedimentary structures (photo 1) and pre-mineral quartz after platy calcite textures deposited from a boiling hydrothermal fluid (photo 2), developed as the base of the mineralised portion of the Escondida fault, provide evidence of the pronounced dilation which promoted mineralisation within only this portion of the structure. Such a lithological structural control has contributed towards the development of a sub horizontal ore shoot.

Pre-mineral down drop on the Escondida fault has provided a local basin environment into which epiclastic rocks have been deposited. Many other epithermal districts occur in regions where pre-mineral down drop on mineralised structures, including within pull-
apart basins (Corbett and Leach, 1998; figure 6), is evidenced by the development of epiclastic rocks and the normal faults with greatest displacement are often better mineralised.

An understanding of the stratigraphy will be important to delineate blind silicified competent host units which are preferred vein hosts and epiclastic rocks as indicators of prospective environments. The development of veins within outcropping incompetent host rocks could vector towards mineralisation in buried competent hosts.

Figure 1. Conceptual cross section for Escondida section 30475, showing the competency control to mineralisation and entry of acid ground waters as a mechanism for the development of elevated Au-Ag grades.

At Escondida and elsewhere (Carla) pre-mineral silica flooded breccias have acted as plumbing systems for the introduction of massive amounts of silica which has provided intense silicification to permeable host rocks such as felsic tuffs to render them as favourable competent host rocks for mineralisation. The major structures which have been activated later as vein hosts contain fluidised breccia plumbing systems for the introduction of massive silica (photos 3-5). The silica flooded breccias are therefore characterised by milling of accidental rock clasts and in situ fracturing of wall rock material, as well as fluid streaming textures associated with the introduction of silica to the wall rocks which are brecciated during the silicification process (photo 6 & 7) adjacent to the feeder structures. Drill holes should not be stopped within silicification, which may occur as pre-mineral halo to mineralisation, as both may have utilised the same structure.

In conclusion, pre-mineral silicification at Escondida controls the formation of mineralisation where the mineralised structure is in contact with a competent silicified former permeable host rock and the resulting development of a sub horizontal ore shoot.
**Structure**

Dilatant structural zones represent sites of preferred hydrothermal fluid flow and so host ore shoots or clavos in epithermal vein deposits. Styles of deformation (figure 2) which contribute towards the formation of ore shoots in epithermal deposits include:

- **Extension** characterised by normal or listric faults, in which generally flat plunging ore shoots occur in steeper dipping portions of inclined faults or intersections with hanging wall splays.
- **Transpression** characterised by dominantly strike-slip faults in which steep plunging ore shoots occur in flexures (dilatant bends) in throughgoing structures or fault jogs formed by the change of fault movement between adjacent structures,
- **Compression** in which flat plunging ore shoots develop in flatter dipping portions of reverse faults or thrusts.

![Diagram showing structural styles and formation of ore shoots](image)

**Figure 2.** Structural styles and formation of ore shoots showing plunge orientations.

The structural grain of the Deseardo Massif is dominated by conjugate dominantly NW and lesser NE fractures and also NS and EW structures of lower importance. In response to roughly NS oriented extension, a component of sinistral movement is interpreted for the dominantly extensional (normal fault movement) NW trending structures which host most mineralisation (figure 3) and dextral movement on the NE structures which appear to be of lesser importance at Cerro Moro. Consequently, best Au-Ag mineralisation is hosted in dilatant fault portions developed as EW trending flexures within the generally better developed NW trending structures. Steeper dipping faults are expected to be better mineralised than moderate dipping structures and host ore shoots (figure 2). Escondida occurs as one such dilatant fault portion and a smaller flexure is present as Escondida Far West. Similarly, Carlita where inspected occurs in an EW fault portion and another EW fault portion is noted at Carla. Several EW trending veins were also recognised in outcrop at Doris. By contrast NW trending structures without EW flexures might not host such high quality ore shoots (Lala, Gabriela).
Figure 3. Development of EW oriented ore shoots at Cerro Moro by a component of sinistral strike slip movement on NW structures.

Figure 4. Pull-apart basin – negative flower structure model in which normal faults which previously facilitate the deposition of epiclastic rocks, such as the Escondida P4 arkose, are later remobilised to host mineralised veins.

The development of dilatant vein-hosting faults such as that at Escondida may be considered as part of a pull-apart basin model (Corbett and Leach, 1998; figure 4). In this model, a cross over in movement between two adjacent strike-slip faults results in the development of a dilatant fault jog which may be considered in 3 dimensions as a negative flower structure (figure 4). The strike slip structures occur as controlling
structures (NW fractures at Cerro Moro) and the dilatant subsidiary fractures within the fault jog form normal faults (EW fractures are Cerro Moro), which importantly are mineralised at depth, such as the Escondida fault. A pull-apart basin develops at the surface and is progressively filled with epiclastic sediments such as the P4 arkose at Escondida and syn-depositional collapse on the normal faults results in an increase in sediment thickness within the pull apart-basin. Down-dip the normal fault host epithermal fissure veins, and then splay faults may localise porphyry intrusions at depth, as part of the negative flower structure. Of interest to the explorationist is that the normal faults with pronounced movement and changes in rock type, particularly epiclastic rocks in the hanging wall, are more likely to be mineralised (figure 4). Structures which do not displace different rock types are less likely to be mineralised (Gabriela).

Continued prospecting should seek, as a highest priority, to identify steep dipping EW portions of the NW structures as favoured sites for ore shoot formation (figure 3).

**Style of Au-Ag mineralisation**

Au-Ag mineralisation at Cerro Moro is classed as of the intrusion-related epithermal low sulphidation polymetallic Ag-Au style (in the classification of Corbett and Leach, 1998; Corbett, 2004), which displays considerable zonation in time and space (figures 5 & 6). As discussed earlier (Corbett, 2007a) low sulphidation veins are deposited from a variety of fluid types with varying metal contents dependent upon the source of those fluids (meteoric, meteoric-magmatic or dominantly magmatic waters) and so veins at Cerro Moro may display highly variable components with consequent effect on precious metal contents. Some veins are dominated by pre-mineral silicification while others contain clean white barren quartz deposited from circulating meteoric waters, and others contain sulphides with which precious metals are associated (photo 8). Au-Ag grades also vary with type of sulphides.

The spatial and temporal zonation in polymetallic vein deposits (figure 6) provides several mineralisation style end members:

- Quartz-pyrite-chalcopyrite is commonly deposited early and at deeper crustal levels and corresponds to the low sulphidation quartz-sulphide Au-Cu epithermal style in the classification of Corbett and Leach (1998; figure 5) and generally contains little precious metal.

- In some dilatant settings an early quartz-sulphide event may rise to elevated crustal settings as an early ‘grey-black silica’ event which is weakly precious metal anomalous and may vector to deeper mineralisation (Arcata, Peru). At Cerro Moro some mineralised dark silica is interpreted to have developed as quenched mineralised fluids and may locally host elevated precious metals (photos 9 & 10).

- The major part of polymetallic vein deposits comprise quartz, pyrite, galena and sphalerite which varies in Fe:Zn ratio and colour from black Fe>Zn high temperature, typically at deeper crustal levels, through brown, red, yellow to white Fe<Zn low temperature sphalerite (photo 11), formed at elevated crustal settings with associated carbonate and accessory argentite and Ag sulphosalts, in particular the Ag tetrahedrite, freibergite. There are two end members of Ag minerals in addition to electrum, discernible as argentite or freibergite and Cerro Moro belongs to the former group which generally displays improved metallurgical characteristics.
Late in the paragenetic sequence and at elevated crustal settings the epithermal end member of polymetallic Ag-Au comprises white sphalerite with cubic pyrite and locally abundant argentite with local electrum and free Au. Much of the higher grade mineralisation at Cerro Moro is characterised by white sphalerite and so is of this style (photos 11-13).

Electrum and free Au developed as the last stage of mineral deposition represent the transition to low sulphidation epithermal mineralisation locally discernible cutting earlier minerals (photo 12-13). In strongly dilatant settings with an input of meteoric water this mineralisation passes upwards to chalcedony-ginguro Au-Ag vein systems to complete the vertical zonation in low sulphidation epithermal Au-Ag styles (figures 5 & 6).

Elevated Au-Ag grades are deposited from rapidly cooled ore fluids (photo s 9 & 10). At Escondida the ore mineral assemblage comprises pyrite-marcasite (photo 15), galena white to yellow sphalerite, chalcopyrite argentite-acanthite, electrum and local free Au. While marcasite, white sphalerite and acanthite all develop in very low temperature conditions and predominate in the uppermost portions of many polymetallic Ag-Au vein systems, the locally abundant chalcopyrite is more typical of the deeper levels in polymetallic deposits. The coincidence of low and high temperature minerals (ie electrum with chalcopyrite) is indicative of mineral deposition by cooling of the ore fluid in a hydrothermal system which has been telescope inwards over a short vertical distance, rather than vertically attenuated as may dilatant vein systems (photo 16). Such telescoping contributes towards the formation of elevated Au-Ag grades. At Escondida development of mineralisation over a short vertical distance results from the coincidence of competent host rocks over a short depth overlying less favourable hosts and Au-Ag deposition by mixing of ore fluids with collapsing low pH waters (figure 1).

Figure 5. Conceptual model for the styles of magmatic arc Cu-Au-Ag mineralisation using terminology discussed in Corbett, 2004, 2007b).
At Cerro Moro elevated Au grades occur in the presence of late stage electrum and free Au (photo 13). Electrum commonly overgrows quartz crystals as the last even of open space filling and cross cuts earlier polymetallic mineralisation within fractures typically with kaolin (photos 16). This mineralisation is therefore interpreted to represent a transition from polymetallic to truly epithermal style, and would be expected to evolve into chalcedony-ginguro style mineralisation in the strongly dilatant vertically attenuated
settings with the introduction of considerable chalcedony deposited from circulating essentially barren meteoric waters (figure 6).

Cerro Moro therefore lies in an ideal setting in the vertically zone styles of low sulphidation Au-Ag mineralisation at the upper limit of polymetallic Ag-Ag where bonanza Au-Ag ores are likely to occur. Veins are strongly vertically zoned in a poorly eroded fossil hydrothermal system and commonly do not display evidence of bonanza mineralisation at the surface (Escondida).

**Figure 7. Different fluids discussed in the text which contribute towards the development of banded low sulphidation epithermal veins.**

**Mechanism of Au-Ag deposition**

Much of the Au-Ag mineralisation has been deposited from a cooling fluid. Coarse grained minerals such as cubic pyrite develop in settings of slow cooling and typically display low precious metal grades but with good metallurgical characteristics. On the other hand, very fine grained mineral assemblages result from the rapid cooling of an ore fluid, such as fluid quenching by contact with cool wall rocks (photos 9 & 10), and may provide higher precious metal grades but commonly with questionable metallurgy.

At Cerro Moro bonanza Au grades result from the mixing of rising ore fluids with collapsing low pH ground waters, possibly derived from now eroded acid sulphate caps, evidenced by the presence of kaolin, typically halloysite as hydrated kaolin, discernible as white soapy material deposited last in the paragenetic sequence and so present infilling
open space or developed on fractures (Corbett, 2007a). The low pH waters oxidise and destabilise the complexes carrying Au-Ag and so promote precious metal deposition. Several instances were recognised in the drill core of very high Au-Ag grades where electrum and free Au occur in contact with kaolin (photo 17). It is important to note the primary control to this mixing related high Au-Ag grade is the collapsing low pH waters and so Au-Ag grades might be expected to decline below the level of collapse of the acidic waters. That is, these bonanza ore zones display a floor of lower limit.

At the Doris Prospect, bleaching (photo 18) may be indicative of a partly eroded acid sulphate cap developed by the interaction with host rocks of low pH waters and prominent MnO derived from the weathering of Mn carbonate (rhodochrosite) is also discernible at the surface, as elsewhere at Cerro Moro. Many polymetallic Ag-Au deposits comprise considerable carbonate which varies in a manner similar to the carbonate-base metal Au deposits of the SW Pacific rim from high level Fe through mixed MnMnCa to Ca carbonate at depth (Corbett and Leach, 1998; Corbett, 2007b; figures 5 & 6). This carbonate is deposited from bicarbonate waters formed by the condensation of CO$_2$ volatiles typically evolved from cooling felsic-intermediate domes. Mixing of the weakly acidic bicarbonate waters with ore fluids is an effective mechanism of Au-Ag deposition and rhodochrosite is a common carbonate, which weathers to surficial MnO as evidence of these ore systems.

Continued prospecting should seek to identify settings where surficial kaolin or MnO may provide evidence of evolved waters which might mix with rising ore fluids to promote the deposition of elevated Au-Ag grades.

**Dilution**

As discussed earlier (Corbett, 2007a; figure 7) banded low sulphidation epithermal veins are deposited from a variety of hydrothermal fluids including:

- Shallow circulating meteoric waters deposit essentially barren clean quartz,
- Meteoric waters circulate to deeper crustal levels and entrain a magmatic component to form meteoric-magmatic waters which deposit quartz with disseminated sulphides interpreted to yield low precious metal grades.
- Sulphide-rich veins are deposited from a fluid derived directly from the magmatic source at depth and so contain most Au-Ag mineralisation.

Many veins at Cerro Moro are dominated by clean white quartz derived from circulating meteoric waters and so are essentially barren (Corbett, 2007a). Only the sulphide portions of these or other veins is expected to host significant Au-Ag mineralisation (Corbett, 2007b).

**Supergene enrichment**

Low sulphidation quartz-sulphide Au + Cu mineralisation is generally deposited early in the paragenetic sequence, at relatively deep crustal levels, from an intrusion derived fluid. Gold, which occurs on pyrite and chalcopyrite grain boundaries, is easily liberated during weathering and may concentrate in the supergene environment, especially in steep dipping veins. Although some quartz-sulphide Au mineralisation is no doubt present at Cerro Moro (Corbett, 2007a), most mineralisation is of higher crustal level styles (polymetallic to epithermal) and so supergene enrichment may not be a concern.
DISCUSSION

Indicator features

Several features may provide vectors to mineralisation during continued prospecting:

The silicification, which predates mineralisation and provides valuable ground preparation increases the host rock competency prior to vein formation and occurs as an envelope of locally black silica flooding marginal to the controlling mineralised faults. The presence of these silicified haloes could be used as an indication of nearby mineralisation and so drill holes should not be terminated within silicification. The feeder structures for silicification occur as distinct milled and fluidised matrix supported breccias, herein given the descriptive term silica flooded breccias (photos 3-5), which are recognisable as indications of the ore environment and grade to marginal less strongly brecciated silicified rocks (photos 6 & 7).

The early silicification also includes prominent pink adularia-silica developed as pre-mineral host rock preparation which provides increased competency which is expected to occur as a halo to the mineralised faults, and so may also vector towards mineralisation.

Celadonite alteration characterised by and apple green micaceous-clay material (photo 19) is common in polymetallic Ag-Au ore systems throughout Central and South America. It was recognised in several prospects in this review (Escondida, Lala, Doris) and is locally abundant, possibly as a prospect scale halo to mineralised veins. The presence of wall rock celadonite could vector towards mineralisation.

Acid sulphate caps characterised by bleached areas of cristobalite, kaolin and local alunite alteration occur in the near surficial portions of many low sulphidation vein systems and are associated with an important control to mineralisation. These caps develop by reaction with wall rocks of acid waters developed by oxidation of H₂S condensates above the water table. These low pH waters may collapse to deeper levels in the hydrothermal system and react with ore fluids as an important mechanism of Au deposition (above). Recognition of acid caps (clay blooms) may not only vector towards ore systems but veins which are capable of hosting elevated Au-Ag grades by mixing reactions.

An understanding of the stratigraphy may provide a valuable aid to prospecting. Faults with more substantial normal movement are more likely to be mineralised and in many settings faults active during pre-mineral sedimentation host later mineralisation. This is especially true in the pull-apart basin model (Corbett and Leach, 1998) where normal faults host later mineralisation. The P4 arkose at Escondida represents an epiclastic rock deposited in the hanging wall to such syn-sedimentary normal faults. Continued prospecting should be mindful that other epiclastic rocks could be indicative of similar ore settings.

Faults in which more substantial offsets are more likely to be well mineralised, and so ore hosting structures which represent rock type changes from the footwall to hanging wall, represent preferred ore environments. Similarly steep dipping EW trending portions of NW trending structures represents the ideal setting for ore shoot formation. Steep dipping normal faults are generally more dilatant and better mineralised than flatter dipping extensional faults.
Prospecting techniques

Resistivity could prove to be a valuable tool to prospect for fault controlled vein mineralisation. In other deposits of this style, it has proved useful to prospect breaks in the resistivity pattern as indicators of fault traces which may host veins. In an example such as Escondida it is likely that rocks on both sides of a mineralised fault will be silicified (P4 and P2), but the mineralisation-hosting fault will be defined by a subtle change in resistivity as the permeable P2 felsic tuff is expected to be more silicified than P4. Elsewhere, normal fault movement on mineralised faults is expected to place rocks of varying resistivity against each other. Several breaks of this style have been highlighted on the data to hand for further investigation (figure 8).
In areas of silica caps such as Virginia, resistivity studies may aid in the identification of structurally controlled feeder zones to the pervasive alteration, which might host mineralised veins.

**COMMENTS ON INDIVIDUAL PROSPECTS**

**Escondida**

P4 represents locally well bedded andesitic arkose to greywacke interpreted to have been derived from the erosion of the L1 andesite. It occurs on the south side of Escondida, in what might be interpreted as a down faulted block. This normal fault may therefore have been active during sedimentation and so promoted deposition of the arkose in a local basin (figure 1). It is important to note this stratigraphic package might therefore be restricted to this area, although other normal faults may localise different epiclastic rocks elsewhere at Cerro Moro, but different epiclastic rocks may occur at other prospects.

P2 occurs as a felsic tuff, which as a permeable rock unit, has commonly undergone intense silicification. It varies from fiamme rich to dominated by locally silica-pyrite altered sub rounded lithic rock clasts. Coarse grained locally flow banded quartz feldspar porphyry clasts are common, and this rock varies to a breccia character, locally with fluidised structures associated with the introduction of pervasive silicification. At least one vertical tuffisite dyke was also recognised.

L1 andesite displays conformable contacts with overlying felsic tuff and commonly takes on a clastic tuff like character, and elsewhere varies to massive flows. Brecciation with infill of silica-pyrite (photos 6 & 7) might be mistaken as autobrecciation, but is clearly post mineral as the silica infill locally contains sulphides including pyrite, white sphalerite and galena. This brecciation is best developed at the contact with the silicified tuff, adjacent to major structures, which locally contain silica flooded breccias (photos 3-5). Elsewhere the andesite is weakly clay altered and so represents a poor vein host.

**Section 26497E 6E0 Escondida Far East** occurs in a small EW flexure in a generally NW trending structure where a vertical ore shoot has been identified.

Drill hole MD 206 intersects a faulted contact between rock types consistent with better mineralisation developed within normal faults with recognisable displacement. Mineralisation comprises quite modest Au-Ag grade oxidised chalcedony vein/breccia at a low angle to the core axis.

MD216 intersects the vein 80 metres below the surface and 50 metres below the DDH206 intercept, with a several metre wide halo of intense pervasive silicification. Polyphasal black silica breccia (photo 19) with coarse sulphides contains lesser portions of massive sulphide polymetallic vein material which is expected to be well mineralised. While deeper drilling is recommended on what appears to be a steep plunging ore shoot, caution is urged as the flexure which hosts the ore shoot displays only a restricted strike length on the data to hand.

**Section 30475E 6E0 Escondida** occurs in the central portion of a prominent EW flexure in the NW structure and is therefore in the most dilatant portion of that ore shoot. This cross
section is therefore expected to be well mineralised. As discussed above, P4 arkose and
greywacke occur on the south side of the structure (hanging wall), while P2 felsic tuff
overlies L1 andesite in the north side (footwall). The permeable P2 felsic tuff is intensely
silicified, whereas the andesite is only silicified where brecciated and infilled by silica-
sulphide and elsewhere remains relatively fresh or weakly clay altered. Mineralisation
occurs where the fault transgresses the more competent silicified tuff and has dilated as a
vein host (figure 1). In the deeper intercept (DDH MD82) within the silicified felsic tuff
close to the contact, sub surface sedimentary structures (photo 1) provide evidence of a
strongly dilatant fault, and in the overlying intercept (DDH MD98) quartz after platy
calcite developed after main silicification indicated by milled silica flooded breccia and
prior to mineralisation, provides evidence of substantial dilation which has promoted
mineralisation. Precious metal mineralisation occurs in black silica-sulphide breccias
within the overlying drill holes (MD98, 17 & 64; photo 17), in company with late stage
halloysite (hydrated kaolin) as an indication of Au-Ag deposition by the mixing of ore
fluids with collapsing low pH waters (figure 1). Bonanza Au-Ag grades occur where
electrum and free Au occur in contact with kaolin (photo 17).

**Escondida Far East**

Escondida Far East was briefly reviewed in the field prior to drill testing as an area of
outcropping silicification in association with an EW portion of a NW structure. The
vertical zonation evident at Escondida provides encouragement that further drill testing
could identify blind mineralisation at depth.

**Carla**

Several Carla drill holes examined provide an indication of style of mineralisation and ore
environment. At 31.5m, DDH MD66 hosts high grade Au-Ag (40 g/t Au, 1040 g/t Ag)
within a black silica-sulphide fluidised breccia deposited from a rapidly cooled ore fluid
(photo 10). Pyrite-white sphalerite occur as clasts in this breccia. Down hole (31-32 m) a
breccia comprising early clean white quartz clasts set in a black silica-sulphide matrix
host discernible electrum, typical of epithermal mineralisation which might be expected
to develop at a higher crustal level and later than the more typical polymetallic
mineralisation and display elevated Au-Ag grades. Pyrite-marcasite veins further down
hole are indicative of the high crustal level of formation. The quartz feldspar porphyry
clast rich tuff down hole contains spherulites suggesting a close relationship with a dacite
dome.

Drill hole MD81 bores through a unit which might be considered as P1, from the fiamme
content. However, the fiamme all occur in clasts in a polymictic breccia and some other
clasts display clear rebrecciated breccia characters (photo 20). In some places silica
flooded breccias contain milled clasts and fluidised silica flooding. Consideration should
be given to an origin of this rock as a breccia resulting from the violent venting of
volatiles from an underling dome. Down hole this rock is cut by a late stage open space
milled breccia which in turn displays a sharp contact with a quartz eye porphyry
interpreted as a dyke. An intensely silica pyrite lithic tuff occurs at the base of the drill
hole. DDH MD73 intersects a similar suite of rocks passing from andesite up hole which
is locally cut by late stage breccia bodies with celadonite altered clasts, and enters a major
silica flooded milled breccia from 60-77m with silicification of the wall rocks. Below this
breccia a similar breccia to that in DDH MD81 contains fiamme bearing clasts and is cut
by silica flooded milled breccia into which a quartz eye rhyolite dyke has been emplaced.
Many quartz eye bearing clasts in this and the similar breccia in DDGMD81 display a ragged appearance consistent with having been molten at the time of eruption. If these silica flooded breccias are derived from fluids venting from underlying domes, then the quartz eye porphyry dykes might display endogenous relationships with the breccias and have been derived from buried domes. Breccias with phreatomagmatic appearance were previously noted at Cerro Moro (Corbett, 2007a).

In conclusion, Carla Au-Ag mineralisation is typical of that which might be expected at an elevated epithermal crustal setting and displays locally bonanza precious metal grades. Some of the volcanic rocks warrant further consideration as breccia origins may be possible and such an origin could account for the intense silicification within these matrix rich clastic rocks. The fault displacements on the available cross sections provided to account for the failure to intersect additional mineralisation at depth, seem reasonable.

**SE Esperanza**

Drill hole MD99 from SE Esperanza contains varied fragmental host rock locally dominated by quartz feldspar porphyry clasts, and elsewhere silica-pyrite altered lithic clasts. At about 55m a large 30cm block of quartz feldspar porphyry is fractured as an expansion breccia and is cut by fluidised breccia. Some other quartz feldspar porphyry clasts display a ragged appearance consistent with juvenile clasts within phreatomagmatic breccias and which were molten at the time of eruption. A model of formation these rocks as phreatomagmatic breccias could account for the intense silicification of these matrix supported breccias.

**Doris**

The Doris prospect lies south of the Dolly veins and occurs as a large area of bleaching (photo 18) consistent with development of an acid sulphate cap in the near surficial portions of a fossil low sulphidation epithermal system. Exposures created by trenching and preparation of drill platforms should be checked by PIMA or XRD for kaolin-alunite. Scree of silica-jarosite are indicative of an original strong pyrite content and local but very well developed MnO surface stain is indicative of weathering of primary Mn bearing carbonate, a feature commonly associated with the development of elevated Au-Ag grades in low sulphidation polymetallic Au-Ag deposits (above; Corbett, 2007b). Considerable massive celadonite alteration was recognised on the southern side of the bleached alteration, possibly developed as a wall rock alteration halo.

Several parallel EW trending veins with silicification and opal-chalcedony infill, varying from a few cm to almost a metre wide crop out over a 20 m wide zone, across strike. Sampling of these veins has not yielded any metal anomalism. However, in the model presented earlier (Corbett, 2007a), veins of this nature might have been deposited from dominantly meteoric waters and so would not contain any mineralisation, especially at an elevated crustal setting, evidenced by the low temperature silica (opal).

In conclusion, Doris exhibits many features typical of the near surficial levels of low sulphidation epithermal ore systems, which are not expected to be mineralised at this elevated portion. Of great interest is that any acid cap or MnO could be associated with mixing mechanisms responsible for the development of elevated Au-Ag grades in these deposits. Doris represents a priority A exploration target. Detailed geological mapping
(say 1:2,500 scale) should focus upon the identification of the veins and vein trends prior to drill testing. Resistivity studies might aid in the identification of non outcropping veins.

**Carlita**

An EW trending vein with well developed gossanous portions has yielded mineralisation to 300 g/t Au in surface sampling to date. This is likened to the Carla mineralisation which is well mineralised in shallow drill intercepts but appears to be faulted off and so did not continue to depth. Carlita represents a priority A drill target.

**Other target selection**

Cerro Moro is presently at a critical time in the project development and must be assessed for prospectivity and any new targets identified and prioritised for further work. Paramount in this evaluation will be the continued development of geological maps.

Some general comments are possible from this brief inspection of the available data.

- Targets for structurally controlled ore shoots occur as EW-WNW trending flexures in the NW trending structures (figure 3), identified on the resistivity (figure 8) or aeromagnetic (figure 9) data, and so a number of targets of this style have been highlighted for field follow up.

- The identification of another NW trending mineralised trend in the DT structural corridor would provide scope for an additional exploration target capable of providing considerable resources. The Lala prospect currently lies at the northern portion of this trend. DT refers to the NW structure which terminates the NE Deborah vein trend.

- Much of the work to date has focused on the southern portion of the project area where outcropping domes and exposed veins are indicative of considerable erosion. In the northern portion of the project prospects such as the Virginia silica cap and jasperoid at Florencia, not to mention the possible sinter at Moro, are all indicative of a much shallower degree of erosion. Here, preserved veins might overlie much more deeply buried felsic dome source rocks. It is important that the uppermost portions of polymetallic veins commonly host highest Au-Ag grades, and so any preserved veins of this nature represent attractive exploration targets. Resistivity studies are expected to aid targeting in this area of poor exposure.

- The identification of epiclastic rocks formed in the hanging wall to normal faults which may have been activated later as ore hosts may represent valuable prospecting tools. These occur in the pull-apart basin model noted in other epithermal deposits (Kelian, Indonesia; Waihi, New Zealand; Corbett and Leach, 1998; figure 4).

- Resistivity described above can provide a valuable exploration tool in areas of poor exposure where mineralisation occurs in association with silicification. Targets include EW trending breaks in the resistivity pattern which might represent normal faults with substantial displacement. Some potential targets have been highlighted in figure 8.
• Settings of substantial normal fault movement, including within pull-apart basins, as evidenced by the deposition of arkose, greywacke or other epiclastic rocks should be prospected carefully. The presence of epiclastic rocks could represent a targeting tool.

Figure 9. Exeter ground magnetic data annotated to illustrate some more NW structures and EW flexures which could represent exploration targets shown as ‘T’. No doubt other targets could be identified with further work.

CONCLUSIONS
Cerro Moro represents a priority A exploration project suitable for continued exploration expenditure.

As with most low sulphidation epithermal vein deposits, especially of the polymetallic Ag-Au style, best mineralisation occurs within ore shoots (clavos). The controls to ore shoot development occur as:

- Competent host rocks aid fracture formation are best developed at Escondida within a permeable felsic tuff which has undergone intense silicification, whereas the underlying andesite is essentially unaltered and the vein here is poorly developed there. Restriction of the mineralised vein to the competent silicified felsite provides a sub horizontal ore shoot.

- The dilatant structural control to ore shoot formation is provided by EW flexures in the generally NW trending normal faults which display a small component of sinistral strike slip deformation, and contributes towards the development of steep plunging ore shoots. Steeply dipping normal faults with considerable components of down drop movement are expected to represent superior ore environments and so favourable ore hosting structures are expected to offset contrasting rock types.

- The style of low sulphidation epithermal mineralisation transitional between the upper most portion of polymetallic Ag-Au and epithermal Au-Ag accounts for the elevated Au-Ag grades associated with discernible electrum, argentite and free Au in the drill core. Local chalcopyrite-white sphalerite-galena-marcasite-pyrite mineralisation is interpreted to have been deposited from a rapidly cooled ore fluid and host argentite-electrum mineralisation.

- The mixing of rising ore fluids with low pH waters, interpreted to have been derived from now eroded acid sulphate caps, represents an extremely effective of Au-Ag deposition and so accounts for much of the high Au-Ag grade mineralisation where electrum, free Au and argentite occur in company with halloysite, the hydrated kaolin, as evidence of the low pH waters. Similarly, surficial MnO is indicative of the reaction of rising ore fluids with bicarbonate waters as a mechanism for the deposition of elevated Au-Ag grades.

**RECOMMENDATIONS**

Continued drill testing of exploration targets generated using the controls to mineralisation describe above should proceed at a priority A. The recognition of EW trending flexures within the NW structures represents an obvious targeting technique, especially if silicification is recognised at the surface or interpreted from resistivity studies.

Several other prospecting tools and vectors towards favourable ore environments described herein include:

- Pervasive silica and silica-adularia halos developed marginal to ore hosting structures which provide valuable pre-mineral host rock competency.
- Celadonite wall rock alteration is recognised within many polymetallic Au-Ag deposits and may vector towards mineralised veins.
• Resistivity could be used to identify non outcropping silicification as an ore environment and importantly in other deposits of this style ore hosting structures occur as discernible breaks in the silicification.
• The presence of epiclastic rocks in the hanging walls to normal faults may be indicative of ore hosting pull-apart basin ore environments.

Doris stands out within the several prospects considered in this review as a priority A target of considerable size which is in need of immediate upgrade to identify drill targets.

REFERENCES CITED


Corbett, 2007a, Comments on the Cerro Moro and La Calandria Projects, Argentine Patagonia: Unpubl. report to Exeter Resources Limited.,

Corbett, G.J., 2007, Controls to low sulphidation epithermal Au-Ag: Talk presented at a meeting of the Sydney Mineral Exploration Discussion Group (SMEDG) with powerpoint and text on SMEDG website www.smedg.org.au


Photos

Photo 1. Subsurface sedimentary structures associated with fill of an open fault - DDH82 129.3m.
Photo 2. Quartz pseudomorphing platy calcite textures indicative of fluid boiling by rapid dilation of a structure, although not mineralised- DDH98, 81m.

Photo 3. Silica flooded breccia with fluidised character associated with silica introduction - DDH82 125.5m.

Photo 4. Black silica fluidised breccia of the style which accounts for silica flooding of wall rocks adjacent to mineralised structures - DDH112, 111.8m.
Photo 5. Black silica fluidised breccia typical of the mechanism of early silica flooding adjacent to the major structures - DDH104A, 170.6m.

Photo 6. Brecciation of the andesite and infill with black silica as part to the mechanism of silicification of wall rocks adjacent to major structures - DDH104A 177m.

Photo 7. Brecciation and infill of andesite with silica adjacent to a feeder structure - DDH104A 170.5m
Photo 8. Mineralised vein comprising initial sulphide deposition by rapid cooling of the ore fluid in contact with wall rocks followed by post-mineral coarse grained adularia and comb quartz from a slow cooled fluid - DDH82, 132m.

Photo 9. Black silica fluidised breccia developed from a quenched sulphide bearing fluid (2.7m @ 31.38 g/t Au & 22 g/t Ag) DDH90 68.7m.

Photo 10. Fluidised breccia of quenched sulphide mineralisation (40 g/t Au, 1040 g/t Ag) - DDH66, 27.5m.
Photo 11. Coarse grained white to pale yellow sphalerite (centre left of photo) overgrown by dark argentite (centre right of photo) as a progression from polymetallic to epithermal mineralisation (30 cm @ 904 g/t Au & 21077 g/t Ag) - DDH98 79.5m.

Photo 12. Mix of fine white sphalerite intergrown with argentite (32 cm 457 g/t Au, 20-90 g/t Ag) - DDH98 80m.

Photo 13. Electrum and free Au (30 cm @ 904 g/t Au & 21077 g/t Ag) - DDH98 79.5m.
Photo 14. Pyrite-chalcopyrite-argentite-electrum mineralisation overgrown by banded crystalline quartz which is cut by electrum vein fluid (56 cm @ 138 g/t Au, 11659 g/t Ag) - DDH112 102m.

Photo 15. Low temperature mineralisation characterised by chalcedony and bladed marcasite - DDH170.65.7m

Photo 16. Deposition of argentite and chalcopyrite grading to later comb crystalline quartz infilled by electrum interpreted to have been derived from a cooling ore fluid (56 cm @ 138 g/t Au, 11659 g/t Ag) - DDH112, 101.8m
Photo 17. High grade mineralisation interpreted to have been deposited by mixing of ore fluids with kaolin (68.44 g/t Au, 6157 g/t Ag) - DDH64, 38.4m.

Photo 18. Bleaching at the Doris prospect with quartz vein outcrop adjacent to the person.

Photo 19. Celadonite wall rock alteration cut by later quartz-adularia veins - DDH112 101.6m
Photo 20. Rebrecciated breccia containing clastic clast (DDH81, 111m).

Photo 21. Polyphasal black silica breccia with early quartz clasts – DDH216, 99.5m.