TOMINGLEY EXPOSED – Changes in geological interpretation once opened up

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ABSTRACT

This review of the Tomingley Gold Project provides an update from a presentation given at Mines & Wines in September 2013 before production commencing January 2014. Four years later, two, of four, open cuts have been exhausted, Caloma (for a reconciled 2.95 million tonnes grading 1.80 g/t gold for 170,807 ounces of gold) and Wyoming Three (for a reconciled 0.66 million tonnes grading 2.1g/t gold for 44,489 ounces gold) forming part of an overall initial global resource of 14.29 million tonnes grading 2.0g/t gold for 921,000 ounces of gold before mining.

The Tomingley Gold Project currently comprises the Wyoming One, Wyoming Three, Caloma and Caloma Two Deposits, the historic Myalls United Gold Mine and several tenements covering Ordo-Silurian volcanic and sedimentary rocks with minor intrusives.

The eastern Lachlan Orogen in southeastern Australia is noted for its major porphyry-epithermal copper-gold deposits hosted in Late Ordovician volcanics. While many small quartz vein hosted or orogenic lode-type gold deposits are known in the region, the discovery of the Tomingley gold deposits has demonstrated the potential for larger lode-type mineralisation hosted within the same Ordovician volcanic stratigraphy.

Outcrop within the project area is limited with the Ordovician sequence obscured by up to 60 metres of clay-rich cover of probable Quaternary to Miocene age. Regional aeromagnetic data is obscured by the maghemite bearing cover sequence but still weakly defines a north-south trending linear belt interpreted to represent the Ordovician andesitic volcanic sequence within probable Silurian pelitic sediments.

Extensive drilling has identified economic mineralisation associated with sericite–carbonate (ankerite)-albite-quartz-(± chlorite ± pyrite ± arsenopyrite) alteration focused within feldspar ± augite phyric andesitic intrusions and adjacent volcaniclastic metasediments. The Wyoming and Caloma deposits appear to have formed as the result of a rheological contrast between the porphyritic volcanic sill hosts and the surrounding volcaniclastic sediments, with the sills showing brittle fracture and the sediments ductile deformation, and many similarities to well documented lode-style gold deposits. East-west compression followed by an initial sinistral transpression structural regime has been important in the formation of the mineralisation. A later dextral wrench system has further realigned the stratigraphy.

Since the commencement of mining the Tomingley deposits only minor changes to the geological interpretation have been made. Mine reconciliation with the exploration model has been neutral at Wyoming One, in comparison to Wyoming Three and Caloma Two where there has been an increase of +30% in grade and total ounces. The Caloma geology and subsequent block model was reconfigured resulting in a decrease of approximately 5% in grade and total ounces.

REGIONAL GEOLOGICAL SETTING

The Tomingley deposits are located near the eastern margin of the Junee-Narromine volcanic belt, just east of the interpreted Parkes Thrust. This structure separates the flat lying Ordovician Goonumbla volcanic complex from a thin slice of north-south trending andesitic volcanics identified by regional aeromagnetic data and interpreted to be the Late Ordovician Mingelo Volcanics (Figure

1). The Tomingley Gold Project covers the entirety of this interpreted north-south belt extending north approximately 25 kilometres from Trewilga to Tomingley and being about 2 kilometres in width. Drilling north of Tomingley village has not intersected the Ordovician volcanics and is interpreted to be faulted out along a major northwest structure.

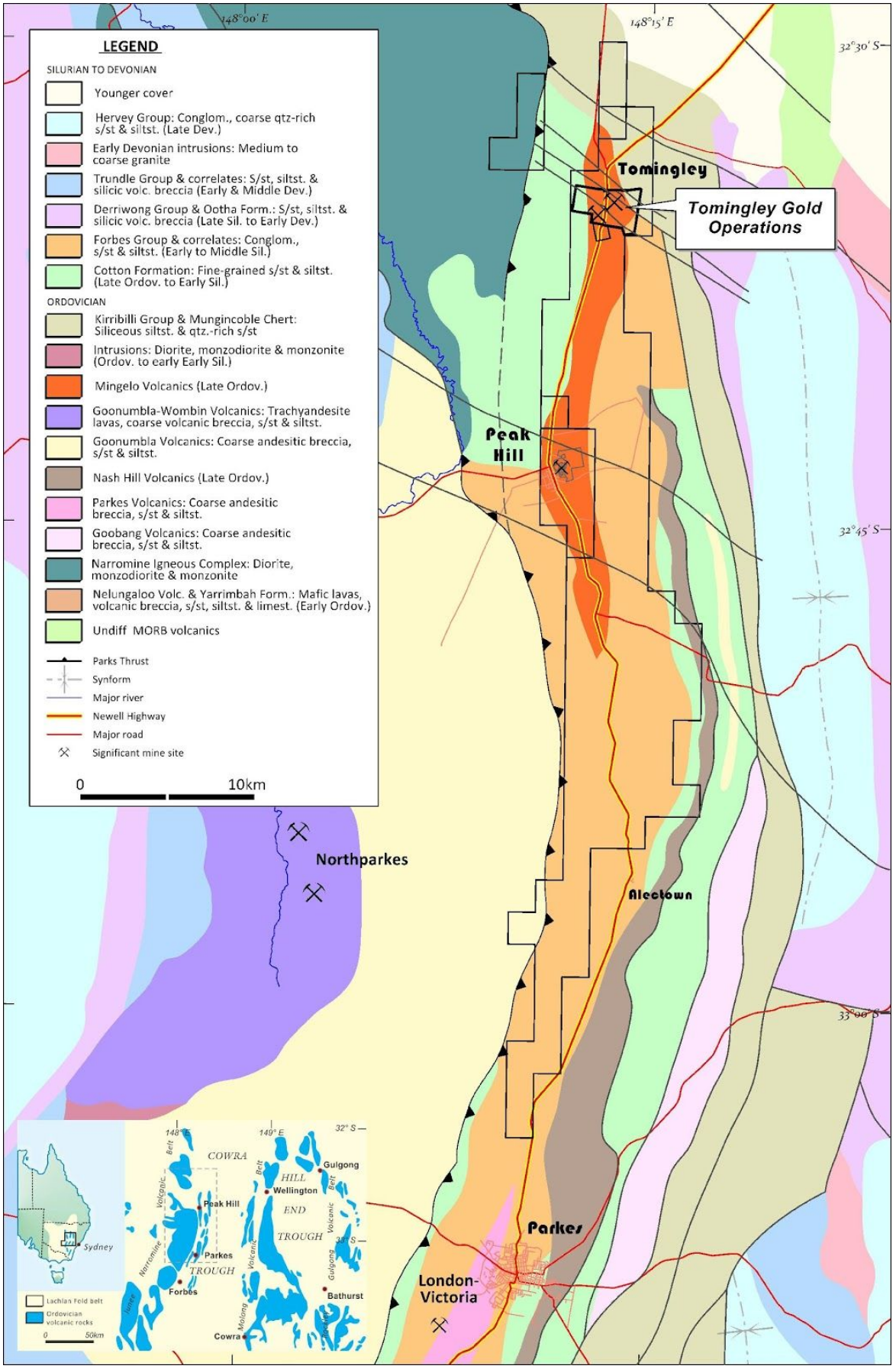

LEGEND
SILURIAN TO DEVONIAN
Younger cover
Hervey Group: Conglom., coarse qtz-rich s/st & siltst. (Late Dev.)
Early Devonian intrusions: Medium to coarse granite
Trundle Group & correlates: S/st, siltst. & silicic volc. breccia (Early & Middle Dev.)
Derriwong Group & Ootha Form.: S/st, siltst. & silicic volc. breccia (Late Sil. to Early Dev.)
Forbes Group & correlates: Conglom., s/st & siltst. (Early to Middle Sil.)
Cotton Formation: Fine-grained s/st & siltst. (Late Ordov. to Early Sil.)
ORDOVICIAN
Kirribilli Group & Mungincoble Chert: Siliceous siltst. & qtz.-rich s/st
Intrusions: Diorite, monzodiorite & monzonite (Ordov. to early Early Sil.)
Mingelo Volcanics (Late Ordov.)
Goonumbla-Wombin Volcanics: Trachyandesite lavas, coarse volcanic breccia, s/st & siltst.
Goonumbla Volcanics: Coarse andesitic breccia, s/st & siltst.
Nash Hill Volcanics (Late Ordov.)
Parkes Volcanics: Coarse andesitic breccia, s/st & siltst.
Goobang Volcanics: Coarse andesitic breccia, s/st & siltst.
Narromine Igneous Complex: Diorite, monzodiorite & monzonite
Nelungaloo Volc. & Yarrimbah Form.: Mafic lavas, volcanic breccia, s/st, siltst. & limest. (Early Ordov.)
Undiff MORB volcanics
Parks Thrust
Synform
Major river
Newell Highway
Major road
Significant mine site
0
10km
148°00' E
148°15' E
32°30' S
32°45' S
33°00' S
Tomingley
Tomingley Gold Operations
Peak Hill
Northparkes
Alectown
Parkes
London-Victoria
COWRA
HILL END TROUGH
Peak Hill
Parkes
Forbes
Wellington
Gulgong
Bathurst
Cowra
Sydney
Lachlan Fold belt
Ordovician volcanic rocks
0
50km

Figure 1: Regional geological setting

The Mingelo volcanics are overlain by sediments thought to be equivalents of the Ordo-Silurian Cotton Formation. Although Sherwin (1996) suggest that the Cotton Formation may have been contemporaneous with deposition of the Mingelo Volcanics, Squire et al (2006) suggest that differences in detrital composition and biostratigraphy mean the units are distinctly separate, and are perhaps part of the Silurian Forbes group. Drilling data at Tomingley supports Squire et al with an observed angular unconformable contact and the sediments consist of well-bedded fine quartzose sandstone and laminated siltstone with a diagnostic basal quartz-rich conglomerate.

The Ordovician rocks west of the Parkes thrust are weakly deformed, with broad open folds and sub-greenschist metamorphic assemblages (Sherwin, 1996). In contrast, the Ordo-Silurian sequences east of the fault, including the rocks hosting the Tomingley deposits, exhibit tight to isoclinal folding, strong axial planar cleavage with greenschist metamorphic assemblages.

Northwest trending transverse structures are also evident in regional magnetic and gravity data, and rarely as faults mappable in outcrop. These structures appear to be long lived fundamental crustal breaks that were irregularly reactivated throughout the geological development of the Eastern Belt. They also show a relationship to intrusive centres and mineralisation where the structures intersect and occasionally offset the arc parallel structures (Squire et al., 2003).

TOMINGLEY GEOLOGY

The Tomingley deposit area is almost entirely covered by alluvial sequences of clays, sand and gravel up to 60 metres thick. The transported regolith sediments are thought to have been deposited and weathered at different times, with the lower clayey unit representing a wetter climate, probably during the Middle Miocene to Middle Pliocene, and the upper sandy units indicating drier conditions beginning from the Middle Pliocene to the present (Mann 2009). The maghemite bearing cover sequence has made exploration using geophysical techniques problematic and exploration has been primarily completed through drilling and geochemistry.

The gold mineralisation is hosted within volcaniclastic metasediments, and porphyritic sub volcanic intrusions and lavas of the Middle to Late Ordovician Mingelo Volcanics (Figure 2). The volcanic units are of andesite to basaltic-andesite composition. The Wyoming Three, Caloma and Caloma Two sills that host mineralisation are all correlative but are chemically distinct from the Wyoming One and Myalls United mineralised sills (Mesthos, 2012).

The volcaniclastic metasedimentary rocks, with very rare detrital quartz, are dominated by well bedded sandstones and siltstones with minor conglomerates and graphitic mudstones centred at Wyoming One, reducing in grainsize to be dominated by graphitic mudstones and siltstones at Wyoming Three and Caloma. The volcaniclastic metasediments are intruded by and interbedded with numerous coarse plagioclase ± augite porphyritic bodies which commonly show peperitic contacts and are interpreted as shallowly emplaced sills.

A narrow, marginally discordant, chlorite-talc schist has also been located by drilling just to the east of the sills at Wyoming One. This likely represents a mafic-ultramafic precursor, similar to olivine rich lavas (picrites) described in the Molong Belt (Crawford, 2003).

The western boundary of the volcanic sequence is defined by an angular uncomfortable contact overlain by well foliated metasiltstones interpreted to correlate with the latest Ordovician to early Silurian Cotton Formation. The eastern margin of the volcanic sequence is uncertain.

Narrow tholeiitic dolerite dykes, of apparent varying ages, crosscut the entire sequence and post-date mineralisation. Also crosscutting the sequence are thin quartz + K-feldspar phyric rhyolitic dykes which are dated from Caloma at 381.8 ± 2.1 Ma (Bodorkos et al, 2010).

TOMINGLEY STRUCTURE

A deformational history of the Tomingley deposits has been developed from empirical observations recorded from orientated drill core with 3D modelling of structural data and gold assay values. This

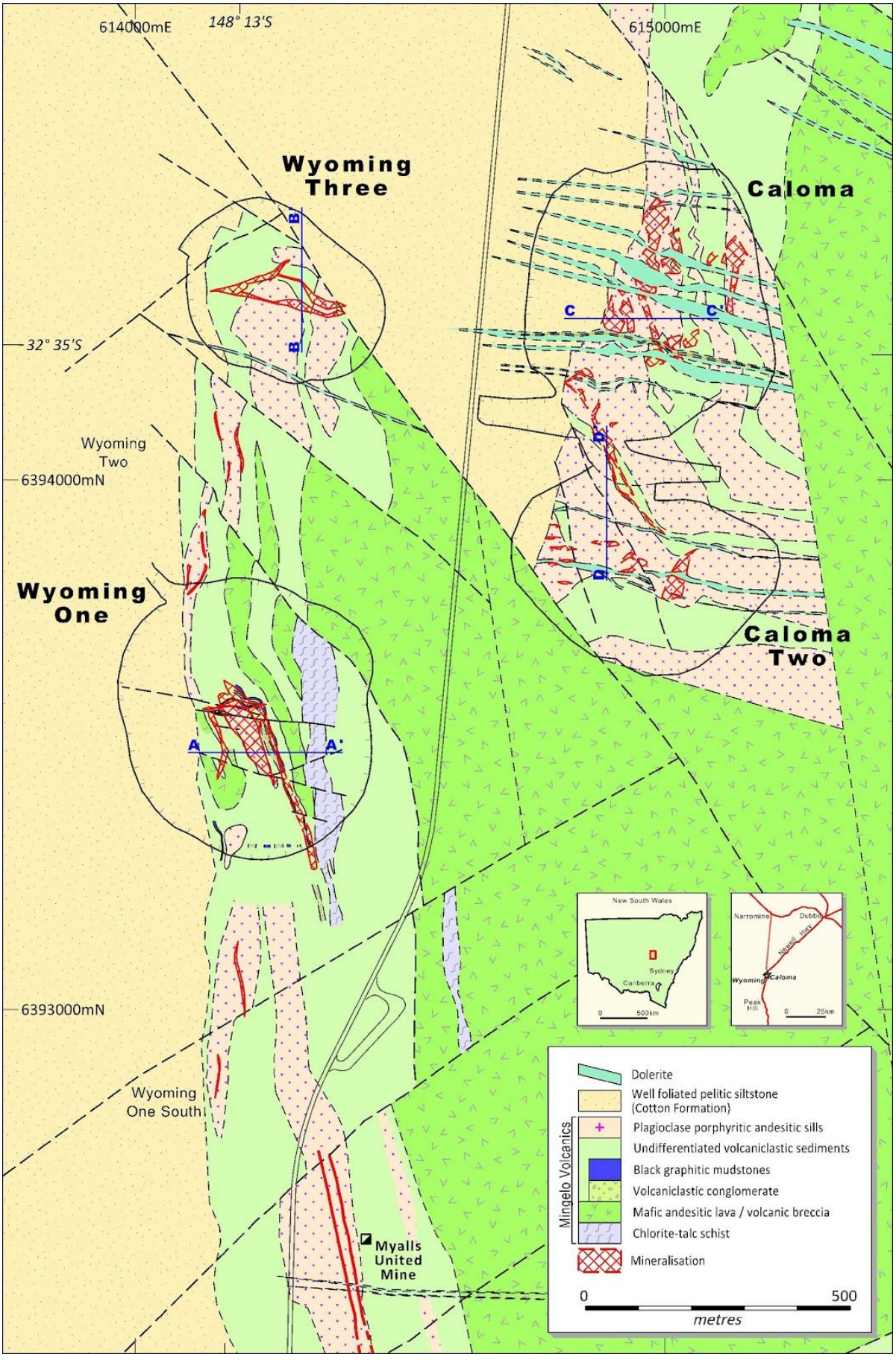

614000mE
148° 13'S
615000mE
Wyoming Three
Caloma
32° 35'S
Wyoming Two
6394000mN
Wyoming One
Caloma Two
6393000mN
Wyoming One South
Myalls United Mine
A
A'
B
B'
C
C'
New South Wales
Sydney
Canberra
0 500km
Narromine
Dubbo
Newell Hwy
Wyoming
Caloma
Peak Hill
0 25km
Dolerite
Well foliated pelitic siltstone (Cotton Formation)
Plagioclase porphyritic andesitic sills
Undifferentiated volcaniclastic sediments
Black graphitic mudstones
Volcaniclastic conglomerate
Mafic andesitic lava / volcanic breccia
Chlorite-talc schist
Mingelo Volcanics
Mineralisation
0
500
metres

Figure 2: Mine site geology with pit shell outlines

was combined with 3D numerical modelling which tested the effects of east-west compression, dextral transpression and sinistral transpression (Schaubs et al., 2013).Reconstructing the structural history of the Tomingley area indicates early east-west compression which is expressed by dominantly north-northwest striking stratigraphy with sub-parallel regional foliation, and minor folds. The reverse sense of movement in shears and vertical fibres in the mineralised veins give support to this event controlling the formation of mineralised veins. At Wyoming One sinistral transpression was modelled as an important stress regime in developing high gold grade cross structures. Empirical observations of the stratigraphy at Wyoming Three and Caloma Two also support an early sinistral transpression event.

Subsequent major dextral wrenching post mineralisation has caused further realignment of stratigraphy including a 1 km southeast offset to the volcanic belt. The regional steep east dipping stratigraphic orientation has been realigned to form a moderately west dipping stratigraphy on the eastern side of this offset. At Wyoming Three and Caloma Two significant folding has realigned the stratigraphy and existing mineralisation with the southeast orientation of the strike slip dextral structure.

Intermittent periods of extension from the early Silurian to at least the Middle Devonian led to various episodes of dyke emplacement.

TOMINGLEY MINERALISATION

The Tomingley deposits show many similarities to orogenic gold deposits such as alteration, mineralisation and vein style and composition. Each of the deposits has its own structural nuances however mineralisation is dominantly hosted within the sub-volcanic sills or along their immediate contacts with volcaniclastic metasediments.

Exploration has identified mineralisation at a number of locations within the volcanic belt but to date four deposits (Wyoming One, Wyoming Three, Caloma and Caloma Two) have been identified (Figure 2), all of which are in the mine schedule.

Alteration appears multiphase with repeated cracking, crushing, veining and sealing, leading to heterogeneous, patchy alteration and discontinuous narrow veinlets. Alteration is characterised by a bleaching white mica (muscovite)–carbonate (ankerite)–albite-silica-(± chlorite) as pervasive replacement of the host rock around strong quartz + carbonate (ankerite) + pyrite + arsenopyrite ± albite veining. The veining typically forms sub parallel sheets up to 10 m thick and spaced approximately 20 - 30 m apart within the sills and along their contacts. The upper portions at Wyoming One appear more stockwork in nature.

Multiple phases and recrystallisation of pyrite and arsenopyrite occurs early in the paragenesis. Late fractures in earlier pyrite and arsenopyrite have served as nucleation sites for the precipitation of gold which occurs within or disseminated near the selvages of the quartz - ankerite vein assemblage. Rare sphalerite and chalcopyrite are syngentic with gold mineralisation (Cherry, 2013).

Total resource inventory of the four deposits totalled 14.29 million tonnes grading 2.0g/t gold at a 0.5 g/t cutoff for 921,000 ounces of gold before commencement of mining.

UPDATE TO GEOLOGICAL INTERPRETATION OF THE TOMINGLEY DEPOSITS

Wyoming One

Gold mineralisation at Wyoming One is distributed both around and within a small (40 metres by 100 metres near surface, broadening at depth), roughly elliptical, sub-vertical, feldspar ± augite

phyric sill. The deposit has been separated into distinct mineralised zones: the ‘porphyry’ zone; contact zone; hangingwall zone; and the ‘footwall’ zone (Figure 3a).

The hangingwall zone appears stratigraphically controlled by a thin fine-grained carbonaceous mudstone striking north-northwest and is the only defined mineralisation not having a close spatial relationship with a porphyritic sill host. The high grade mineralisation appears to have a strong ore shoot control plunging 40^{o} to the south-southeast. Parasitic fold axes measured in drill core parallels this direction. Underground feasibility drilling is underway targeting these high grading gold ore shoots.

The footwall zone is an apparent extension of the hangingwall zone on the western fold limb. The zone of mineralisation is characterised as poddy quartz veining up against the Cotton Formation contact. The gold mineralisation does not extend into the Cotton Formation.

The ‘376’ and ‘831’ zones were originally interpreted as east-west high grade gold zones truncating and transecting the sill. The ‘contact’ zone was interpreted as a zone of mineralisation focused on the north-eastern contact of the sill. There is currently no evidence from pit mapping for the separation of ‘831’, ‘376’ and ‘contact’ structures as interpreted from exploration data. Grade control has now combined all three zones as a high gold grading ellipse shaped ‘contact’ zone wrapped and focused on the north and north-eastern margin of the sill.

The ‘porphyry’ zone of mineralisation is dominated by a stockwork-like vein system of irregular silicification (locally described as ‘mushy quartz’) however planar veins have a pervasive west-northwest strike.

Wyoming Three

Wyoming Three is characterised by two discrete zones of sub-vertical veining striking about 105° focused on a sill positioned within a steeply plunging anticline thought to be associated with the nearby major northwest trending structure (Figure 3b). The initial sense of movement on the northwest structure is likely sinistral, as observed by the folding at Wyoming Three. The structure has been significantly reactivated with late dextral movement dislocating the stratigraphy approximately one km to the southeast. The deposit is structurally complex with numerous variously timed faults displacing the porphyritic sill before and post mineralisation. A thick dolerite dyke and thin quartz + K-feldspar phyric rhyolitic dyke transect the Cotton Formation north of the northwest trending structure.

Caloma

The Caloma deposit is hosted within two moderately west dipping (steepening at depth) porphyritic sills up to 60 m thick separated by thin metasiltstone units. Gold mineralisation is focused within a shallow to moderate west dipping sheeted vein system that approximately parallels the strike of local stratigraphy (Figure 3c). The lodes terminate at the Cotton Formation contact in the west and tends to ‘horse-tail’ when in contact with the volcaniclastic sediments in the east. The sheeted veins are dislocated by an east-west dyke swarm transecting the deposit, slightly rotating the stratigraphy and mineralisation in between dykes. The Caloma mineralisation to the north is terminated near a north-northwest trending structure where sheeted veining is rotated to moderately north dipping. To the south mineralisation has rotated 30^{o}, striking northwest along a porphyritic sill – metasediment contact. Mineralisation linking Caloma with Caloma Two appears to be restricted within or adjacent to a narrow, steeply southwest dipping volcaniclastic sediment unit and is poddy in nature.

Caloma Two

Stratigraphy at Caloma Two has a distinctive east-west orientation in contrast to the north-northwest orientation at the adjacent Caloma deposit. This dramatic change in trend is

interpreted to be associated with folding along the major northwest trending fault which dislocates stratigraphy from Wyoming Three to Caloma Two. The linking stratigraphy between Caloma and Caloma Two dips steeply to the southwest, aligning itself with this major structure to the south. Two dolerite dykes cross cut the stratigraphy and mineralisation and also have late off sets. Synformal folding has been observed within the oxide zone of the recently opened Caloma Two pit.

The mineralisation at Caloma Two is constrained to the east by shallow west dipping sheeted veins and to the west by moderately north dipping en echelon vein sets. Mineralisation appears to dilate when in contact with a northern bounding volcaniclastic sediment unit. At depth there is evidence for a reverse saddle reef like structure associated with the closure of a moderately west plunging synform (Figure 3d).

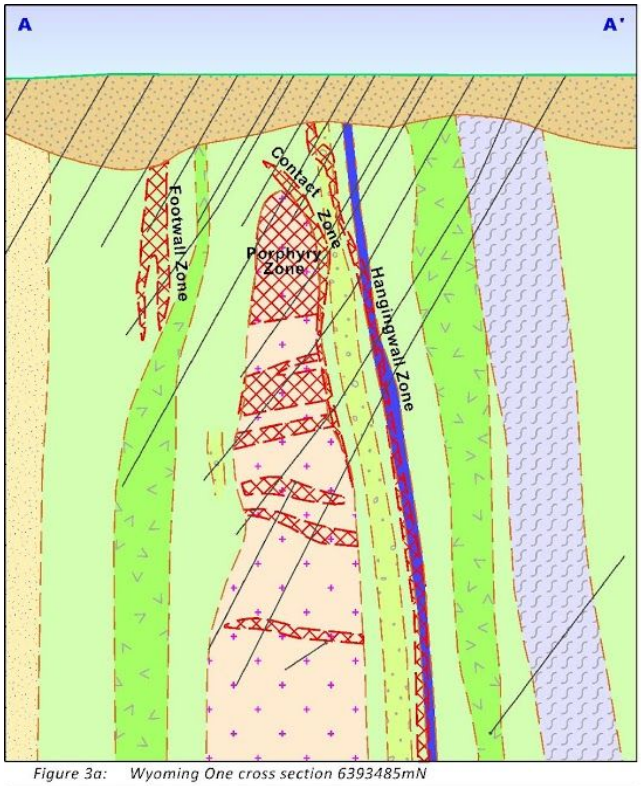


Figure 3a: Wyoming One cross section 6393485mN

Figure 3b: Wyoming Three cross section 614315mE MGA

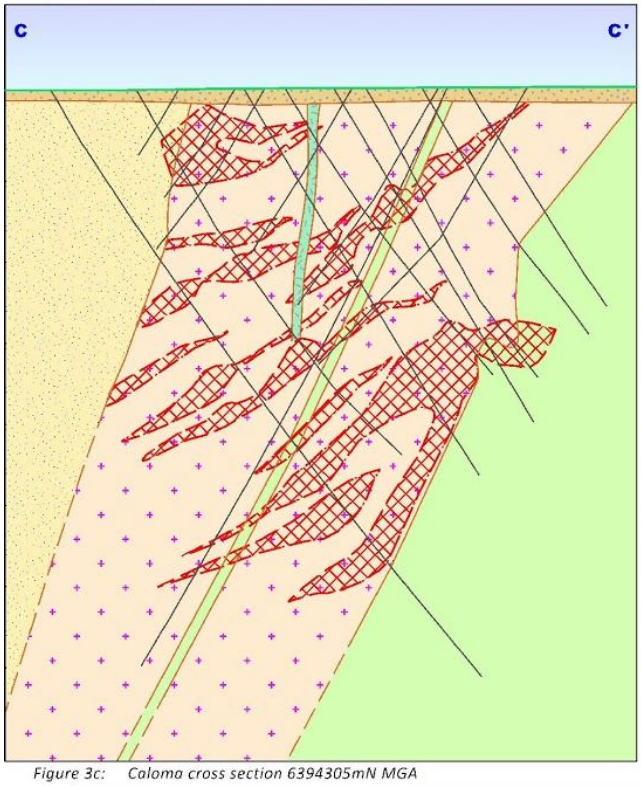


Figure 3c: Caloma cross section 6394305mN MGA

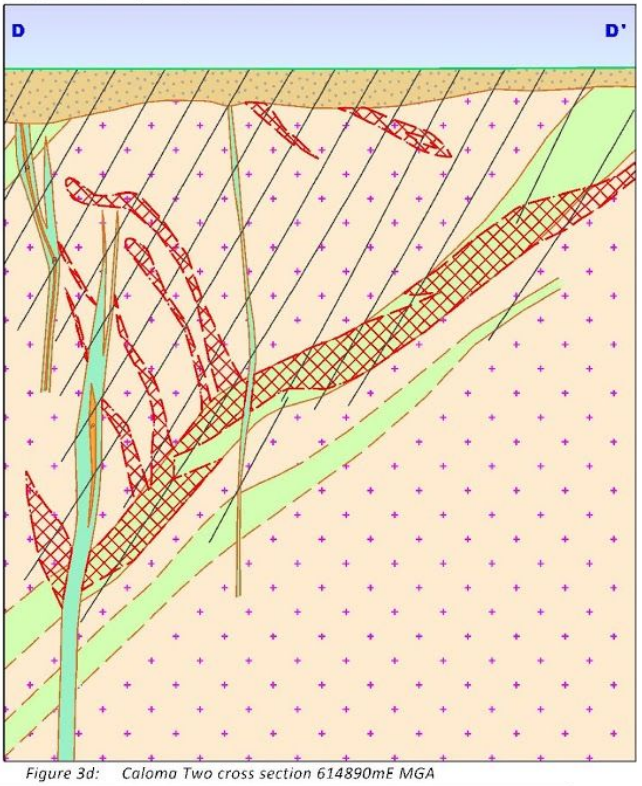
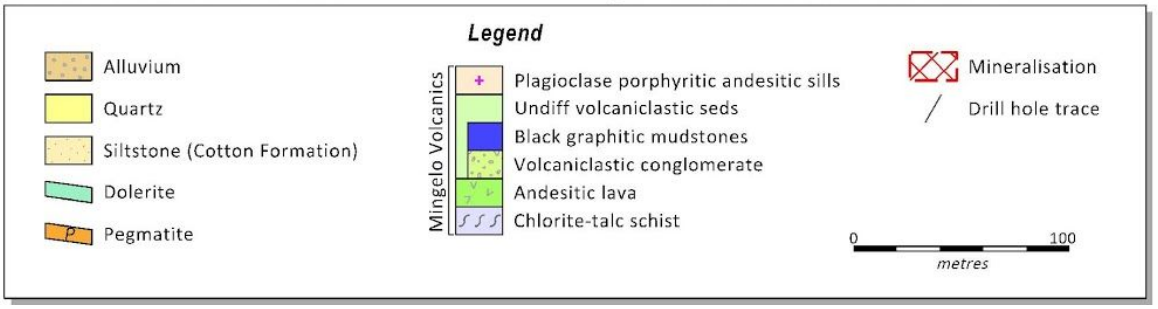


Figure 3d: Caloma Two cross section 614890mE MGA



EXPLORATION RESOURCE MODEL VS MINE RECONCILIATION

Wyoming One

Mining of ore from Wyoming One commenced in January 2016 and reconciliations have shown that the resource model is performing well within expectations. Close spaced grade control drilling together with pit mapping had justified a change in modelling parameters and estimation techniques from ID2 to Ordinary Kriging for the open pit grade control block model. Since the start of mining the reconciliation versus the resource model are -3% for tonnes, -2% for grade and -5% for reduction in ounces. Based on the reconciled results and mining practices being implemented the resource model is deemed to have a high level of accuracy.

Wyoming Three

Mining of ore from Wyoming Three commenced in January 2014 and was finalised in November 2015. The resource model was not altered over the mining period with a final reconciliation showing -2% for tonnes, +32% for grade and +30% in total ounces. This significant increase in ounces and grade is explained by a positive ‘nugget’ effect particularly in the oxide material.

Caloma

Mining has been ongoing from the Caloma open pit since January 2014 and was exhausted recently in August 2017. In June 2015, the geological model was slightly modified based on pit geological mapping and logging of grade control drill holes. A slight rotation of the eight mineralised domains positioned between the post mineralisation dolerite dykes was observed. A parent block size of 5m x 2.5m x 2.5m with 2.5m x 1.25m x 1.25m sub-blocking was used in the block model. The estimation method was changed from ID2 to Ordinary Kriging and the reconciliation process was reviewed and modified. Since the change the Caloma pit grade control model has reconciled very well with the new estimation process, with +7% tonnes, -5% grade for +1% increase in ounces. The unconfigured block model would have resulted in approximately -3% tonnes, -3% in grade for a -5% decrease in total ounces.

Caloma Two

Mining began at the Caloma Two open cut in February 2017. Infilling grade control drilling to a 10 m x 10 m grid from the exploration 20 m x 20 m grid has realised an increase in grade by +41% and total ounces by +39% for a -1% reduction in tonnes from the exploration model. The tighter drill spacing has substantially nullified an apparent ‘nugget’ effect with the grade control vs mill reconciliation currently running at +17% tonnes and +0% grade for +18% increase in total ounces.

CONCLUSIONS

The mineralisation style and associated sericite-carbonate-albite-quartz alteration assemblage at Tomingley is typical of orogenic lode style gold deposits. Many smaller orogenic quartz vein lode type occurrences are known to exist in the region, including in the Parkes-Forbes district, however the discovery of the Tomingley deposits proves that economically significant mineralisation of this style exists within the Ordovician volcanics of the eastern Lachlan Orogen.

At all four Tomingley deposits, the mineralised fluids are interpreted to have been focused by differential strain in and around the feldspar-pyroxene porphyritic sills due to the rheological competency contrast between the sills and the bounding volcaniclastic sediments. The brittle nature of the sills often leads to the development of shear hosted sheeted vein deposits. Regional east-west compression with sinistral transpression has structurally prepared the Tomingley area for significant orogenic gold mineralisation. A late major dextral transpression event has rotated and repositioned the stratigraphy and mineralisation. The hangingwall zone at Wyoming One is the only

economic stratabound lode at Tomingley and the thin graphitic mudstone strata appears to have been a focus for shearing and a chemical trap for gold.

Overall changes in the geological interpretation have been subtle since mining began at Tomingley. The Caloma mineralised domains have been slightly rotated in orientation between dolerite dykes. At Wyoming One the ‘376 and ‘831 structures have been merged together with the ‘contact’ zone forming an ellipse shaped mineralised domain over the northern and northeastern porphyritic sill contact with the metasediments.

Mine reconciliations have varied from neutral at Wyoming One and Caloma to significantly positive at Wyoming Three and Caloma Two open cuts. Wyoming Three and Caloma Two are positioned in close proximity to the major northwest dextral structure which may influenced the ‘nugget’ effect at these open cuts.

ACKNOWLEDGEMENTS

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The petrology of Tony Crawford has provided valuable insight into the mineralogy and alteration of the Tomingley region. Core logging and numerical modelling by Peter Schaubs (pmd*CRC) has added significantly to the understanding of the structural setting of the Tomingley deposits. Honours theses by Bamford and Mann have aided characterisation of the overburden within the project area. An honours thesis by Mesthos on geochemistry of the host volcanics has defined and characterised three groups of porphyritic intrusions within the belt hosting mineralisation. The paragenesis of mineralisation at Wyoming One and Caloma Two was formulated by Alex Cherry in his Honours thesis.

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