Cobar Deposits – Structural control

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SUMMARY

The Cobar Superbasin is located in the Central Subprovince of the Lachlan Orogen in the central part of New South Wales, about 700km northwest of Sydney. The Cobar Superbasin is the most mineralised Palaeozoic sedimentary basin in Lachlan Orogen. It has an estimated pre- mining resource of 202 t of Au, 4.597 t Ag, 2.5 Mt Cu, 4.8 Mt Zn and 2.8 Mt Pb metals.

The term '*Cobar Superbasin'* is introduced to refer to a series of deep-water troughs/basins, inferred to have formed as half graben and shallow water shelfs. Its northern portion is dominated with siliciclastic sedimentary sequences whilst the southern portion comprises sediments, volcaniclastics, volcanic rocks, granites and minor limestone. The basin formed in the Early Devonian by NE-SW transtension and was closed by NW transpression in Late and Middle Carboniferous. The overall inversion structural style is NW-SE folding, overprinted by NE-SW trending and NNW-trending eastwards oblique left-lateral reverse faulting, in a combined thick- and thin-skinned tectonic environment. The Cobar Style mineralisation is a common name for mineral deposits hosted in the Cobar Superbasin and includes massive sulphides (VMS), clastic hosted Pb-Zn mineralisation and epithermal gold.

In the Cobar Superbasin, the primary location of mineral deposits is controlled by basement architecture and then overprinted and modified with secondary controlling factors of inversion tectonics.

Primary control is related to the location of mineral deposits within basin architecture and directly depends om major basement structures such as:
- basin marginal growth fault;
- intersection of growth and transform/transfer faults; and
- intersection transform/transfer faults.

Secondary control is related to deposit geometry and is direct consequence of invasion tectonic such as:
- intersection termination and deflection of strike-slip faults;
- overlap of en-echelon strike-slip; and
- junction of major faults.

Cobar Style mineralisation occurs in form of sheeted veins characterised by narrow width (5m - 10m), short strike (50m – 10m) and a significant depth extension (> 2000m). The deposits occur as a group of lenses in an en-echelon array with a steep plunge.

Key words: Mineral endowment; Cobar mineralisation; Basement architecture, Basin inversion, Structural control, Inversion tectonic.

INTRODUCTION

The first mineral deposit in the Cobar region was discovered in 1870, at the site of the Great Cobar Copper Mine (Clelland, 1984). Subsequently, gold was discovered during the late 1880's at a number of different localities: New Occidental, New Cobar, Chesney, Mt Boppy, Mt Drysdale and Peak Mines (Stegman and Stegman, 1996). The mining in the Cobar Goldfield underwent three periods of intensive activity. The first mining period, 1873-1919, was initially based on Cu and soon after Cu-Au and Au mining. The second period of sustained mining, based on Au production, started with the reopening of the New Occidental Mine (1935) where mining continued until 1952. Between 1943 and 1952, the New Occidental Mine was the largest Au producer in NSW (Stegman and Stegman, 1996). The third period, the modern mining era in the Cobar region, commenced in 1962 with the opening of the CSA Mine (Cu, +/-Pb-Zn-Ag) which was subsequently followed by Elura (1979) and the Peak Gold Mine (1993). Currently, in the Cobar Superbasin, there are four operating underground mines: The Peak Gold Mines (Perseverance and New Occidental - Au), CSA Mine (Cu), Endevour (Elura) Mine (Zn-Pb-Ag) and Hera Mine (Au-Zn-Pb).

The Cobar Superbasin contains a genetic range of mineral deposits related to different tectonostratigraphic units from the Late Silurian to the Early Devonian (from rift-phase to sag-phase of basin evolution). Mineral deposits occur subsequently through stratigraphy as volcanic associated massive sulphide (VMS) including Cobar-Style (Glen 1987b, 1995; Suppel and Gilligan, 1993; Gilligan and Byrnes, 1994; Lawrie and Hinman 1998, Stegman 2001; David, 2005), epithermal deposits, clastic hosted base metal deposits (David, 2005) and Mississippi Valley Type deposit (MVT), (David, 2005; Downes et al. 2011, 2013, 2016).

Major mineral deposits with associated mineralisation style, tectonostratigraphic settings host lithology and pre-mining deposit size are listed in Table 1.

DEPOSIT NAME	Tectonic-stratigraphic setting	Mineralisation style	Host lithology	Main Commodities	Deposit size
Elura	Northern Cobar Trough margins (growth fault)	Carbonate hosted base metal	Transition unit - open platform carbonates - deep water turbidite	Zn, Pb, Ag	45Mt@8.6%Zn, 5.5%Pb and 60g/t Ag
CSA	Cobar Trough/Eastern margins	VMS (Cobar style)	Turbidite sequence of the Lower Amphitheatre Group	Cu, Pb, Zn, Ag	51Mt@3.21% Cu; 0.2% Pb; 0.8% Zn and 22g/t Ag
Great Cobar	Cobar Trough/Eastern margins	VMS (Cobar style)	Turbidite sequence of the Lower Amphitheatre Group	Cu, Au	12Mt@1.5g/t Au, 1.9%Cu,
The Peak	Cobar Trough/Eastern margins	VMS (Cobar style)	Turbidite sequence of the Lower Amphitheatre Group	Au, Cu, Pb, Zn	5.2Mt@9.1g/t Au, 0.8%Cu, 1.1% Pb and 1% Zn
New Occidental	Cobar Trough/Eastern margins	VMS (Cobar style)	Turbidite sequence of the Lower Amphitheatre Group	Au (Cu)	5.4Mt@8.8g/t Au, 0.2%Cu
Hera	Cobar Trough	VMS (Cobar style)	Sediments deposited on the wave base boundary	Au, Cu, Zn, Pb	2.7 Mt@4.12g/tAu, 3.67% Pb, 4.86% Zn and 34 g/t Ag
Nymagee	Cobar Trough	VMS (Cobar style)	Turbidite sequence of the Lower Amphitheatre Group	Cu	96,000t Cu; 27,000t Pb; 53,000t Zn; 2.2 MOz Ag
Mallee Bull	Cobar Trough	VMS (Cobar style)	Turbidite sequence of the Lower Amphitheatre Group and Shume Formation	Cu (Pb,Zn)	6.76 Mt@1.8%Cu, 31g/t Ag, 0.6g/t Au, 0.6%Pb and 0.6%Zn
New Cobar	Cobar Trough/Eastern margins	VMS (Cobar style)	Turbidite sequence of the Lower Amphitheatre Group	Au, Cu	4.1Mt @ 4.6 g/t Au, 0.5%Cu,
Chesney	Cobar Trough/Eastern margins	VMS (Cobar style)	Turbidite sequence of the Lower Amphitheatre Group	Cu, Au	6Mt @ 0.8g/t Au, 1.9%Cu,
Manuka / Wonawinta	Winduck Shelf	Carbonate hosted (MVT)	Boot Limestone (rudstone - poorly washed biosparite)	Zn, Pb, Ag	10.8Mt@1.5% Zn and 1.5% Pb and 75 g/t Ag
Mt Boppy	Mineral Hill Canbelego Rift Zone	Epithermal	Basal unit: conglomerate and sandstone/siltstone	Au, Cu, Pb, Zn	13 790kg of gold produced
Mineral Hill	Mineral Hill Canbelego Rift Zone	VMS	Ignimbrite, mudstone, rhyolite, siltstone	Au, Cu, Pb, Zn	806,000 t@2.9 g/t Au and 1.5%Cu
Nymagee	Cobar Trough/Eastern margin	VMS	Fine-grained sediments deposited	Cu, Pb, Zn (Au)	43,710t of Cu metal produced + resources
Wagga Tank	Mt Hope Trough	VMS	Fine-grained distal turbidite with tuff and cherts	Au, Cu, Pb, Zn	1.25Mt@0.66 g/t Au, 69 g/t Ag, 0.81%Cu, 1.84%Pb and 3.29% Zn
Pipeline Ridge	Mineral Hill Canbelego Rift Zone	Epithermal	Siltstone, tuff, and vitric tuff	Au, Cu, Pb, Zn	2.8Mt@2.4g/t Au (resource)
McKinnons Tank	Winduck Shelf	Epithermal (stockwork)	Sediments deposited on clastic shelf above wave base boundary	Au	2.2Mt@1.91g/t Au
May Day Prospect	Mt Hope Trough	VMS	Mudstone, crystal tuff, lithic tuff, felsic volcanics	Au, Cu, Pb, Zn	325,000 t@2.21g/t Au, 15.5g/t Ag, 1.3%Cu and 0.3% Pb
Mt Hope Mine	Mt Hope Trough	VMS	Sandstone and siltstone with rhyolite and tuff	Cu, (Ag, Au, Pb, Zn)	Produced 10,559 t of Cu metal

Table 1. Major mineral deposits in Cobar Superbasin with pre-mining resources (data derived from David, 2005, company annual reports and ASX reports).

For successful exploration, which would lead to a new discovery of major orebodies, it is necessary to identify major controlling parameters on a distribution of mineral deposits. If these controlling parameters are mappable using geology and/or geophysics, explorers would be able to narrow down prospective exploration fields and focus exploration activities to produce higher success rates.

GEOLOGICAL SETTING

The Cobar Superbasin is one of several intracratonic, siliciclastic/volcanic half-graben basins developed during the Silurian/Devonian time in the Central Lachlan Orogen of Eastern Australia, (Glen, 1995). The superbasin underwent half-inversion by a *thin-skinned* tectonic locally involving *thick-skin* (Glen, 1990; David, 2005) during Late Devonian and Early Permian (Scheibner, 1989; Suppel and Scheibner, 1990; Glen 1990, David 2005). The geology comprises Ordovician metasedimentary basement intruded by S-type Silurian granites, Late Silurian – Early Devonian basin sequence and Late Devonian post orogenic cover.

The term Cobar Superbasin is introduced to refer to a series of deep-water troughs, inferred to have formed as half graben and shallow water shelfs occupied by the Late Silurian – Early Devonian Cobar Supergroup (David, 2005). The depositional environment is characterised with siliciclastics (Cobar Basin) and volcanic-volcaniclastics-siliciclastics (Mt Hope Trough and Rast Tough) of deep-water troughs and flanking (Kopyje Shelf, Winduck Shelf) and intrabasinal shelfs (Wiltagoona, Walters Range Shelf). Et the east, the remains of the Mineral Hill-Canbelego failed rift continue in siliciclastic Melrose Trough in its southern portion. (Figure 1).

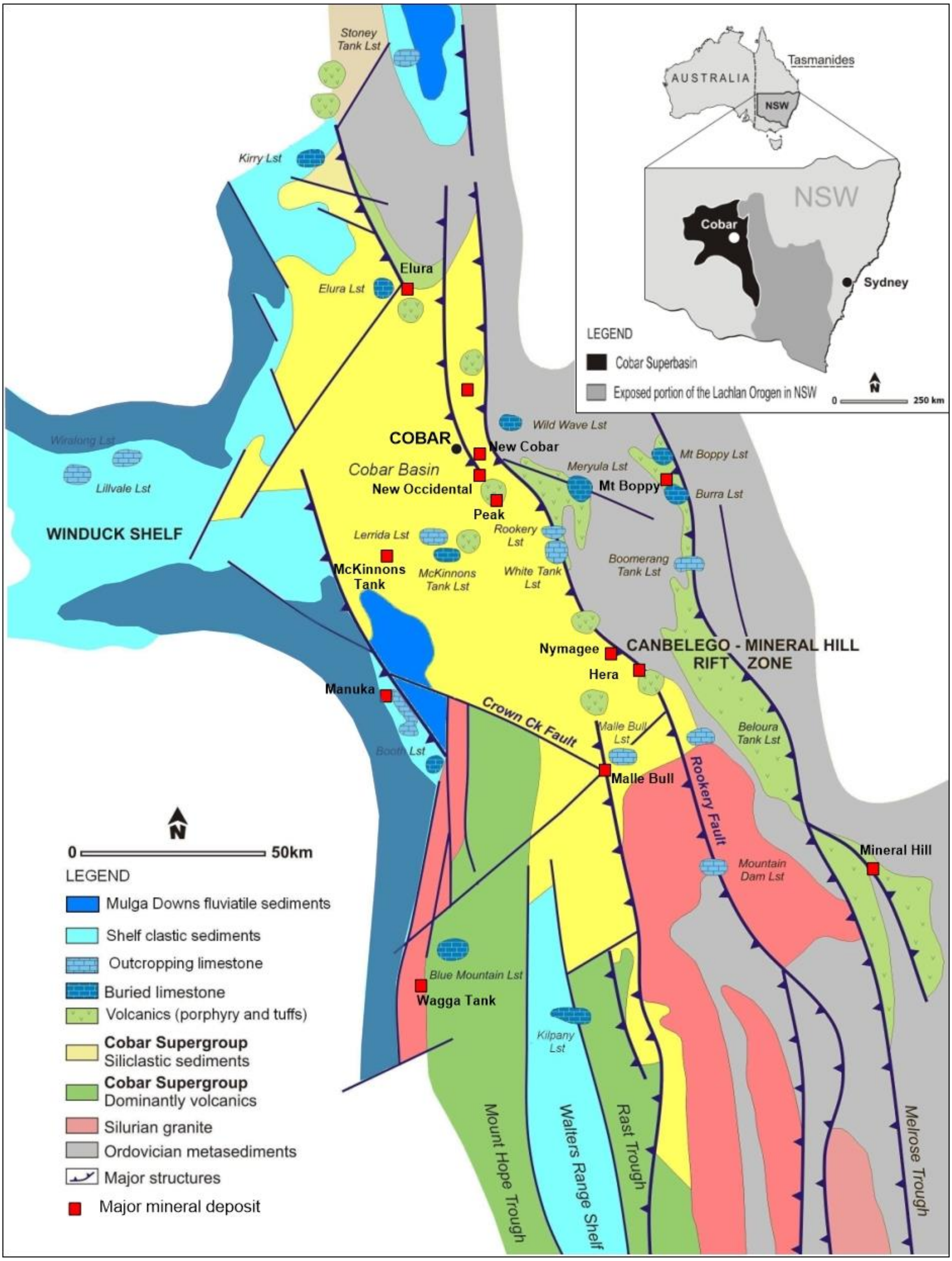

Figure 1. Cobar Superbasin simplified geology with tectonostratigraphic units and major mineral deposits. Occurrences of limestone lithology (outcropping and buried) is shown on map. Major known volcanic rocks in siliciclastic basin are also shown.

The northern part of the Cobar Superbasin comprises dominantly sequences of siliciclastic sediments (up to 9km thick). Rift sequence comprises immature clastic sediments grading from outwash fans to deep-water turbidites intercalated by reef limestone and volcanics along major marginal faults. The sag sequence comprises mature clastic sediments intercalated with open platform limestone (David, 2005).

The southern portion of Mt Hope and Rast troughs is comprised of S and I-type granites, bimodal volcanics (rhyolite – dacite - andesite) derived from several volcanic centres (Schneiber, 1987, Downes et al., 2016). These are overlayed by volcaniclastics, turbidites and shallow water sag phase sediments of Broken Range Group (Schneiber, 1987). Limestone occurs on the marginal growth faults (Figure 1) in the form of reef associated lithofacies.

The Canbelego–Mineral Hill Rift Zone which developed between the eastern Cobar Basin margins and Gilmore Suture was filled with siliciclastic sediments, volcaniclastics and felsic volcanics deposited during the rifting phase of basin evolution. The southern extension grades into sediments of deep-water Melrose Trough (Pogson, 1982, 1991; MacRae, 1984).

In Cobar Superbasin, limestone outcrops are poorly preserved. However, porous reef facies can be recognised by well-developed calcrete in outcrop. Micritic facies generally forms gently undulating low-relief sub-crop. Limestone occurs in a discontinuous N-S trend along the deep-water trough margins and on the Winduck Shelf. The shallow-water fossil assemblages (conodonts, brachiopods, molluscs, bryozoans, crinoids, corals and ostracods) in limestone (David, 2005) indicate the existence of a continuous reef with associated lithofacies. The largest area of limestone outcrop is the Booth Limestone (Figure 1). Early Devonian limestone was deposited in places with insufficient deposition of terrestrial material along basin margins and on the open platform environment. The distribution of different carbonate lithofacies: *in situ* reef carbonates on the basin margins (Elura, Rookery, White Tank, Mt Boppy) and basement high Wild Wave, Blue Mountains, and olistolith blocks deeper in the basin (Elura, Lerida) infers on the existence of large carbonate platform. This carbonate platform subsequently broke- down during the advanced rifting forming patchy carbonate rifts along the eastern basin margin (David, 2005). During basin inversion, limestone reefs acted as rigid buttresses (tectonic barriers) creating an important chemical and physical depositional trap for mineralised fluid.

The post orogenic fluviatile sediments of the Mulga Downs Group cover the southwest and northwest Cobar Superbasin margins and do not host known mineralisation (David, 2005).

Major mappable and observed structural features in Cobar Superbasin are associated with basement architecture related to the extensional faults framework and their selective reactivation during basin inversion. The basin architecture was controlled by NNW-trending marginal listric faults and associated NE-trending transform/transfer faults. These listric faults were active during initial transtension (growth faults with facies change across) and then reactivated during transpression into reverse oblique left-lateral faults (reverse stratigraphic off-set). The occurrences of Early Devonian felsic porphyry intrusive and volcanic rocks are spatially associated with junction of the NNW-trending listric fault set and the NE-trending transfer faults. The seismic sections section across the basin shown that the flat faults steepen upward with a greater movement with depth (Glen *et al.*, 1994). Other major structures are mesofolds developed in the hangingwall of the reactivated growth faults (Rayner, 1969, Robertson, 1974 and Glen, 1987, 1990, 1995), and a penetrative N-S trending cleavage.

During basin formation, Silurian granites were the margins of the deep- water troughs and behaved as tectonic buttresses that controlled basin opening and basin inversion. Cobar Superbasin was formed by NE- SW transtension and closed by NW transpression. The overall structural style of the Cobar Superbasin is NW-SE folding overprinted by NE- SW folding and NNW-trending eastwards oblique left- lateral reverse faulting (David, 2005). Cobar Superbasin sequences were inverted by combined *thick-* and *thin- skinned* tectonics in the Late Early Devonian and Middle Carboniferous by Kanimblan Orogen (Glen, 1995, David 2005).

MINERALISATION

The Cobar Superbasin hosts several different mineralisation styles associated with different metal association. These mineralisation styles are characterised by different tectonostratigraphic settings, host lithology and accumulated finite strain. The dominant common alteration features for mineral deposits is presence of silicification (vein or pervasive) and chloritic alteration halo. Chlorite alteration can be determined as an early Fe-rich chlorite and later Mg-rich chlorite. The later Mg-rich chlorite alteration occurs along the shear zones close to mineralisation and probably forms during tectonic transposition and metamorphism. In addition, several deposits are characterised by carbonate alteration (siderite and ankerite) in form of porphyroblasts (Elura, McKinnons Tank) or as beds where coarser lithology is replaced by carbonate (David, 2008).

Based on mineralogy, ore texture, host lithology and structures, mineral deposits in Cobar Superbasin can be related to the following genetic styles of mineralisation:

- Volcanogenic massive sulfide deposits (VMS) including those of tectonically transposed and metamorphosed deposits known as Cobar Style. This mineralisation style includes mesothermal, structurally controlled deposits dominated by Cu-Au mineralisation (Glen, 1987; Lawrie and Hinman, 1998; Stegman, 2001) and it is controlled by right-stepping deflections within the *Rookery imbricate fan* accompanied by reverse oblique left-lateral movement. In this group comprises major Cobar Superbasin mineral deposit contain more than 70% of known metal pre-mining resources (*e.g.* CSA deposit, New Cobar, Great Cobar, New Occidental, Chesney, Peak Gold Mine, Nymagee, Hera, Mallee Bull, and less modified deposits such as Wagga Tank and Shuttleton and May Day). The common properties are host rift sequence lithology and sheeted-vein geometry associated with high strain zones.
- Turbidite and carbonate base metal mineralisation dominated by Zn-Pb-Ag metal associations and replacement/cavity fill mineralisation textures (Irish Type and MVT) in the open-platform reef limestone at the margins of the deep-water troughs (Elura) and shallow-water shelf limestone (Wonawinta).
- Epithermal gold mineralisation occurs in proximity to intrusion bodies *e.g.* McKinnons Tank Gold Mine deposit (Forster and Seccombe, 1999) and Mt Boppy) and Pipeline Ridge Gold is hosted by quartz and sulphide stockwork veins.

- Intrusion related mineralisation occurs in the southern portion of Cobar Superbasin - in the Mt Hope Trough: Mt Allen Mine (Au, Fe) and Double Peak Mine (Au, Cu). It is characterised by gold-bearing haematite-magnetite lenses and haematite-magnetite-quartz-pyrite stockwork veins within chloritic siltstone and associated with the I-type Mt Allen Granite (Suppel, 1979).
- Gold-bearing quartz vein mineralisation – orogenic gold (David, 2005; Dowens et al. 2016). These deposits include Gilgunnia hosted by Early Devonian turbidites and at Mt Drysdale hosted by basal Early Devonian sediments (Gilligan and Suppel, 1978; Suppel and Gilligan, 1993).
- Au-Cu porphyry mineralisation and skarn mineralisation which occurs on the basin marginal faults such as Kilpany magnetite skarn (Aberfoyle Exploration, 1980) and part of Hera materialisation (Fitzherbert et al., 2017).

The Cobar Style mineralisation represents the major deposits in the Cobar Basin. The mineralisation is characterised by discontinuous, narrow, short strike *en-echelon* siliceous or massive sulphide lenses. Mineralisation of massive sulphides is overprinted by regional cleavage, which implies post-mineralisation cleavage formation.

In addition, the Cobar Style mineralisation is characterised by an early alteration halo of pervasive silicification, chloritisation and carbonate alteration (siderite and ankerite). The early mineralisation is overprinted by a metamorphic-tectonic halo of Mg-chlorite, stilpnomelane, talc and biotite identified by Stegman (2001) as later alteration. The Mg-chlorite, stilpnomelane, talc and biotite occur in the shear zones or on the sheared contacts between massive sulphides and host rocks inferring syn-tectonic origin. The Cobar Style deposits display regional metal zonation: Cobar Goldfield (Au, Cu) → CSA deposit (Cu, Zn, Pb) → Elura deposit (Zn, Pb, Ag). The metal zonation is also notable between the individual lenses in deposits *e.g.* CSA deposit, Hera, Peak and Mallee Bull deposit. The ore textures display brittle and ductile deformation, foliation, pressure shadows, dissolution under pressure, and recrystallisation - coarsening in grain size (Marshall and Gilligan, 1993; Brill, 1989 and 1991; David, 2005).

In the basement granitode bodies intrusion-related Sb, W and Mo mineralisation is also present (Dowens et al., 2016).

DEPOSIT GENESIS

The genesis of mineral deposits can be observed through primary deposit formation and their subsequent modification by diagenesis, deformation, regional metamorphism and supergene alteration. In the Cobar Superbaisn deposit genesis is a consequence of basin development:

- The early mineralisation formed during the *syn-rift phase* characterised by characterised with extensional tectonics. Early mineralisation comprises VMS deposits, intrusion related epithermal deposits gold deposits, (porphyry style and intrusion related), skarn and carbonate hosted Pb-Zn deposits.
- The late mineralisation formed during the *inversion phase* characterised by subsequent tectonic modification and metamorphism of precursor VMS - forming specific Cobar Style deposits, quartz-vein hosted Au deposits and MVT deposits.

The lead isotopic data (David, 2005) suggests a continuum of mineralisation from Au-rich deposits, through Cu-rich deposits at the eastern margins to Pb-Zn rich deposits at the northern basin margin and Winduck Shelf. However, the $^{40}Ar/^{39}Ar$ dating of the sericite alteration assemblage at the Peak deposit (Perkins *et al.*, 1994) indicates the main (early) mineralisation stage occurred at 384 $\pm$ 1.4 and the later mineralisation stage at Ma 401.5 $\pm$ 1.0 Ma.

EARLY MINERALISATION

The initial mineral deposits formed during the *syn-rift phase* on the eastern basin margins characterised by growth faulting, rapid terrain subsidence and elevated geothermal gradient followed by felsic to intermediate volcanism.

Major mineral deposits formed in junction zones of transfer/transform faults and basin margin faults. These zones extended deep into the basement creating pathways for deep fluids sourced from igneous rocks and/or metasedimentary basement. The main fluid flow mechanism was thermal convection produced by elevated geothermal gradient and fluid overpressure caused by rapid terrain subsidence and sediment compaction. The basement-derived fluid was discharged along the damaged zones (faults) and mixed with basin-derived fluids most likely before reaching the sea floor. The deposits formed by such processes were those of epithermal intrusion related, sediment VMS and Irish-Type (Figure 2).

The syn-rift phase mineralisation in the Mt Hope Trough comprises sediment and volcanic-hosted VMS deposits (Wagga Tank, May Day, Mt Hope), intrusion related deposits (Mt Allen Au-deposit) and epithermal gold deposits (McKinnons Tank). Skarn deposits were formed locally on the basin margins within limestone (part of Hera and Kilparney).

The deposits formed in the Mt Hope Trough still preserve initial structural and ore texture characteristics. The preserved deposit geometry and ore structures are results of low-grade of greenschist metamorphism and moderate finite strain.

LATE MINERALISATION

Late mineralisation is characterised with subsequent modification and metamorphism of pre-deformational deposits and with formation of new deposits (syn-tectonic ore emplacement). The formation of new deposits and remobilisation of pre-deformational deposits are largely overlapping processes (Marshall and Gilligan, 1993). These processes are capable of producing the same or similar types of geometric relationships, fluid chemistry, and metal and sulphur sources.

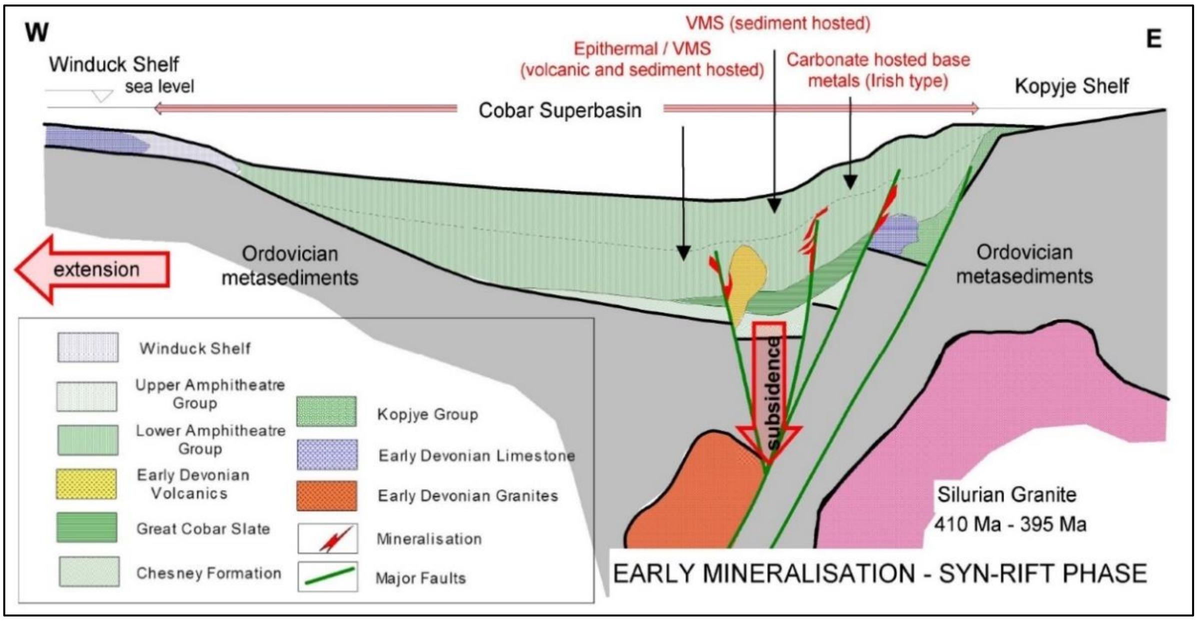

Figure 2. Early mineralisation, formed during Basin Inversion.

The late mineralisation *basin inversion phase* is characterised by modification of an early syn-rift mineralisation, formation of the Cobar Style mineralisation (CSA, New Cobar, New Occidental and Peak), quartz-vein hosted Au deposits (Gilgunnia Goldfield) and MVT deposits (Manuka), Figure 3.

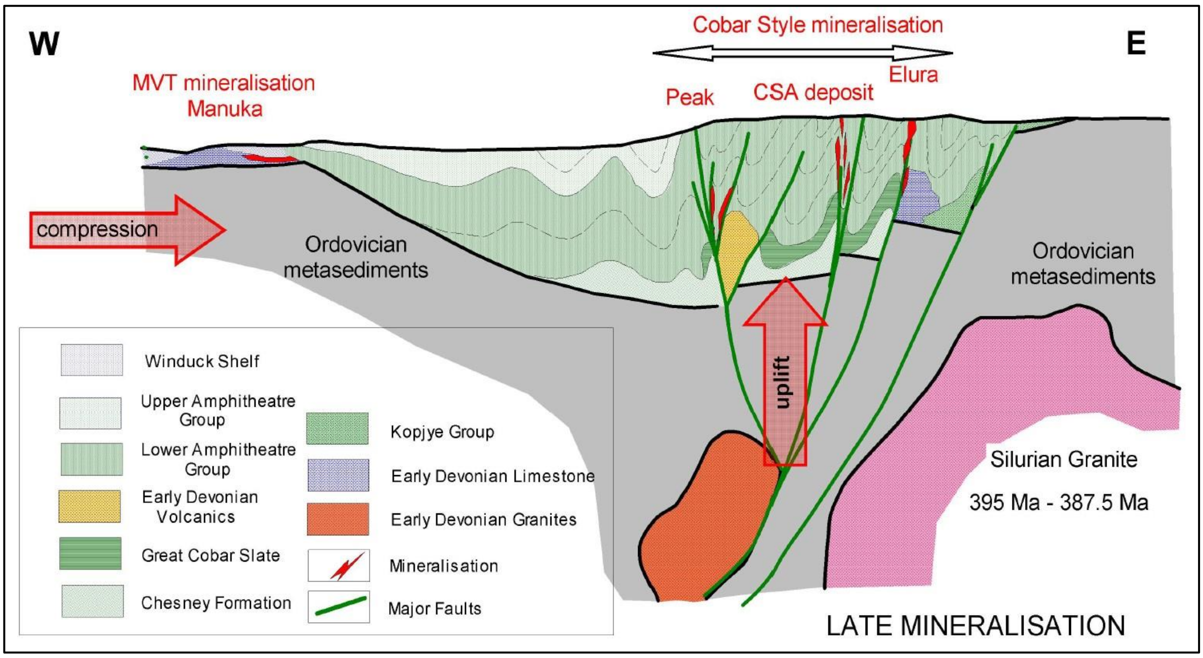

Figure 3. Late mineralisation, formed during Basin Inversion.

DEPOSIT GENESIS

A range of the contradictory genetic theories have proposed for the Cobar Style mineralisation. In this paper three overlapping and undistinguished models have been proposed.

- Remobilisation genetic model (deformation, transposition and greenschist metamorphism);
- Polygenetic model; and
- Syn-tectonic mineralisation model.

The remobilisation genetic model involves mechanical and chemical remobilisation of a precursor deposit into new deposit. The geometry resulting from mineralisation will be a function of the geometric relation to the precursor mineralisation and the degree, extent and nature of the deformation and remobilisation mechanism. According to Marshall and Gilligan (1987), remobilisation can be internal (gross relationships of the mineralisation to its host rocks is retained) and external (gross relationships of the mineralisation to its host rocks is modified and new mineralisation can be generated).

In addition, remobilisation of sulphides can be mechanical (solid-state physical transfer), chemical (liquid-state including solution, melting and wet diffusion) and mixed (solid- and liquid state). The morphology of mineralisation formed by mechanical remobilisation of massive sulphides is typically co-planar and co-linear with S-L fabric of silicate host rocks.

The deposits formed by polygenetic model involve syn-tectonic remobilisation of a pre-tectonic epigenetic mineralisation (subhalative) and possible reaction with syn-tectonic mineralisation formed during remobilisation (Marshall and Gilligan, 1993). This model engages indistinguishable overlap of syn-deformation and remobilisation models.

Syn-tectonic mineralisation is a type of hydrothermal mineralisation progressively emplaced by dilatational and/or replacement processes in structural and chemical sinks, which are integral part of deformation and metamorphism. The geometry of massive sulphide mineralisation is co-planar and co-linear with S-L fabric of silicate rocks as result of progressive deformations (Ramsay, 1967).

DISCUSSION

The Cobar Superbasin mineral deposits display strong structural control, which is demonstrated throughout the primary deposit genesis and later structural overprint during basin inversion and metamorphism. The occurrences and style of primary early mineralisation in the Cobar Superbasin are directly related to the basement architecture and subsequent lithofacies distribution.

The metal bearing fluids were focused by growth faults and associated transform/transfer faults into tectonic (blind faults, overlapping and deflected strike-slip faults) and stratigraphic traps (carbonates and sediments enriched in carbonaceous component) forming major mineral deposits. In relation to the interpreted basement architecture (Figure 4), the location of mineral deposits is controlled by the:

1. The proximity to major basin marginal faults (growth faults) with the maximum block down-throw (the intermediate size Au-rich (Cu) deposits: Cobar Goldfields, Peak,);
2. The proximity to the intersection of growth faults with transform/transfer faults. Deposits are mostly hosted in the siliciclastic sediments (largest base metal deposits (±Au) examples are CSA, Elura) and volcaniclastic and volcanics (small polymetallic deposits; Nymagee; Hera and Wagga Tank).
3. The proximity of major transform/transfer faults. These are related to the smaller size of polymetallic deposits such as McKinnons Tank, Mt Hope and May Day.
4. Stable basin margins (basement high) with open platform carbonate sequence MVT (Manuka).

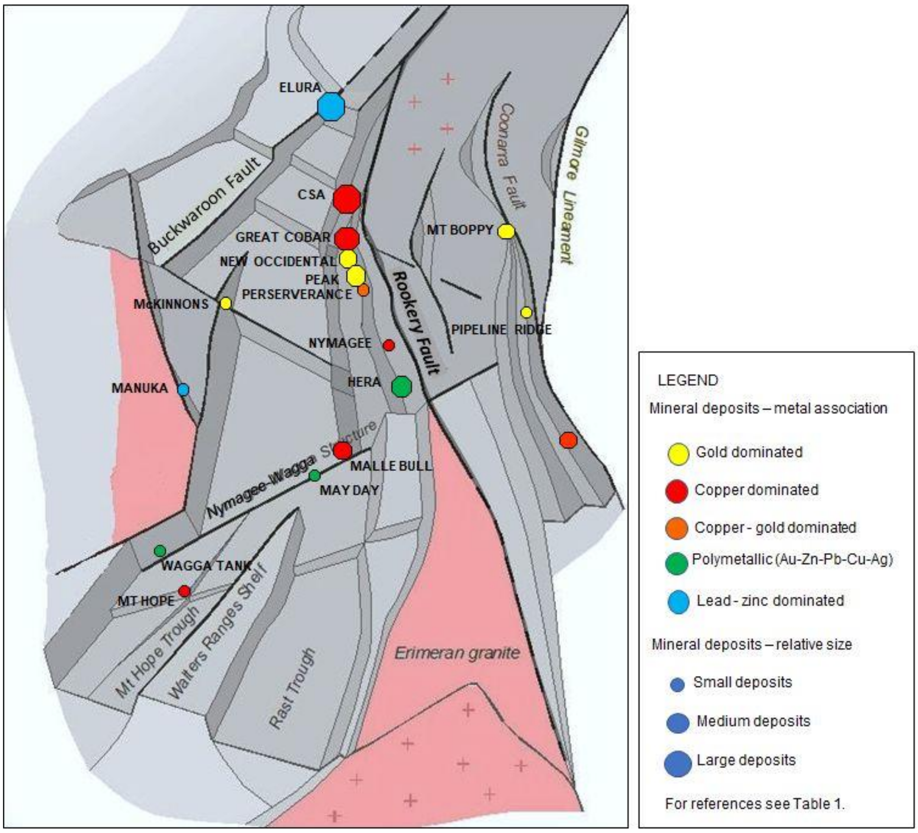

Figure 4. Cobar Superbasin basement architecture based on lithofacies distribution and field potential data modelling (modified from David, 2005).

The mutual reactivation of growth and transfer/transform faults and formation of new faults control final formation of major mineral deposits including their recent settings, geometry and mineralogy. Fault reactivation shows two senses of movement: an early reverse movement implying that the basin blocks moved up (reverse) and a later left-lateral movement implying the basin blocks moved in the direction 160/20º (David, 2005) implying steep southern plunge of mineralised lenses. The present-day deposit geometry of the mineral deposits is a result of inversion tectonics reflected through reactivation on the growth faults.

The mineral deposits in the Cobar Superbasin are transposed and accommodated in structurally favourable (dilatation) sites such as shown in Figure 5:

a) deflected strike slip structures (CSA),
b) intersection of reactivated growth and transfer/transform faults (Elura),
c) the end of major strike-slip faults (as results of differential displacement) – Peak and Perseverance,
d) overlap of en-echelon strike-slip structures (Cobar Goldfields; Rayner, 1969) and
e) junction of major faults (McKinnons Tank).

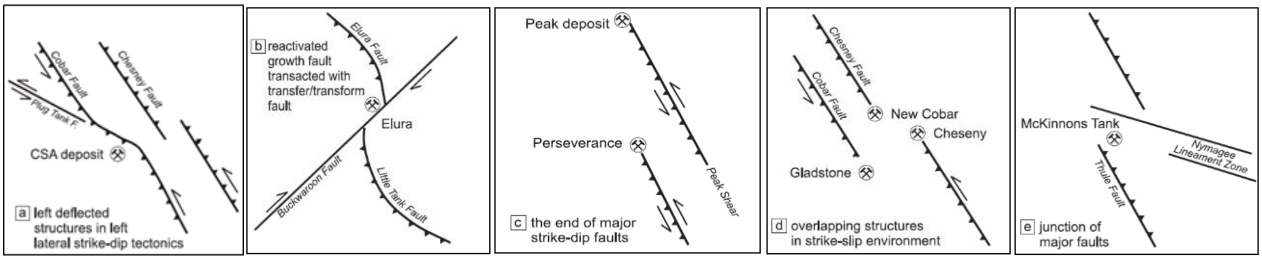

Figure 5. Structural control on mineral deposits in the Cobar Basin.

CONCLUSION

Cobar Superbasin mineral deposits display a complex structural control: primary and secondary. The primary control of mineral deposits associated with major basement structures such as marginal growth faults and transfers/transform is overprinted by latter inversional tectonics. Primary control is related to the location of mineral deposits within basin architecture and directly depends om major basement structures such as: basin marginal growth fault, intersection of growth and transform/transfer faults and intersection transform/transfer faults.

Inversion tectonic includes intense penetrative cleavage development, folding, reactivation of pre-existing basement faults and formation of new faults including duplex and leading imbricate fan structures.

This inversion tectonic represents secondary control which is responsible for recent deposit geometry. Geometry and structural setting are related to intersection, termination and deflection of strike-slip faults, overlap of en-echelon strike-slip and junction of major faults.

Cobar Superbasin mineralisation represent a dynamic mineralisation continuum including formation of early mineral deposits such as VMS and intrusion related deposits and their subsequent tectonic transposition and metamorphism forming Cobar Style mineralisation.

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