chalcopyrite with minor amounts of marcasite, tetrahedrite, bismuthinite, bismuth, silver, electrum, chalcocite, covellite and digenite.

On the basis of the mineralogy and textural features of ore samples it is inferred that the deposit is of Kuroko-type.

## A PROBABLE MISSISSIPPI VALLEY-TYPE LEAD-ZINC DEPOSIT AT COOLEMAN PLAINS, SOUTHERN NEW SOUTH WALES

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The Mount Black lead-zinc deposit at Cooleman Plains, southern New South Wales, occurs in the uppermost part of the moderately folded, weakly metamorphosed, Upper Silurian Cooleman Limestone. A joint controlled collapse-breccia zone interpreted as a palaeokarst structure has been partly replaced by quartz, sphalerite with a low to moderate Fe content, Ag-poor galena, and a little chalcopyrite, pyrite, marcasite, tetrahedrite, arsenopyrite and mackinawite. These minerals show evidence of having encrusted and replaced limestone fragments in the breccia. Oxidic Zn, Pb, Cu and Fe minerals have formed by the near-surface oxidation of the sulphides.

Field, petrographic and fluid inclusion data suggest that the quartz and sulphides precipitated from saline solutions (possibly diagenetically expelled connate brines) in cavities, probably at low temperature at shallow depth. Many features of the Mount Black deposit are similar to typical Mississippi Valley-type lead-zinc occurrences.

## COPPER MINERALISATION AT THE BASIN CREEK NO. 1 PROSPECT, TUMUT, NEW SOUTH WALES

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The Basin Creek No. 1 prospect is located in the Snubba Range 14 km south of Tumut. The host rocks are phyllites and intermediate metavolcanics of the (?) Middle Silurian Blowering Beds. Locally, these are about 1000 m thick and form a thin slice, striking 340°M and with near vertical dips, sandwiched between sediments of the (?) Lower-Middle Silurian Bumbowlee Creek Beds on both the east and west. The western boundary is a fault contact, but in the east the Blowering Beds lie conformably on the Bumbowlee Creek Beds. Regionally, these rocks form part of the western limb of a major south-south-east trending anticline that plunges steeply to the south.

At Basin Creek, the Blowering Beds are tightly folded into two major south plunging drag folds with numerous superimposed parasitic folds. The rocks are highly deformed with strong cleavage and foliation developed parallel to the fold axial planes. Two fault directions are recognized. The earlier, which includes the major fault along the western boundary of the Blowering Beds, trends at 350°M. The later one, which includes several minor faults and shear zones, trends between 250° and 280°M.

Detailed stratigraphic correlation is not possible due to the highly lenticular nature of the lithological units. Broadly, however, the Blowering Beds at Basin Creek can be divided into two essentially similar sedimentary sequences above and below a volcanic unit.

The sedimentary sequences, each about 200 m thick, consist of grey to green phyllites, tuffs and greywacke (in part conglomeratic). Locally, a red to chocolate coloured phyllite is also present at the base of the lower sequence. The volcanic unit is a massive fine-grained rock consisting of microscopically fine albite laths in a dark chloritic matrix (?meta-andesite). Irregular veinlets of epidote/chlorite/quartz are common, and, in places, these minerals also infill well-rounded vesicles. Locally the rock is brecciated and/or intensely sheared. Several intercalations of chloritic phyllite occur within the sequence, the whole thickness of the unit being about 60 m.

The mineralisation consists predominantly of chalcopyrite, either disseminated in fine quartz/sulphide veinlets or concentrated in massive sulphide shoots. Abundant fine-grained magnetite and specular hematite are commonly present and microscopic evidence suggests that much of the magnetite has formed from the hematite. Bornite and sphalerite occur in minor amounts together with minor pyrite and traces of galena. The deposit is zoned with sphalerite, pyrite and galena occurring mostly in low-grade disseminated mineralisation to the south of the copper-rich shoots. Some of the pyrite exhibits a framboidal texture. Bornite is restricted to a small lens within one of the massive chalcopyrite shoots. It occurs massive and also as disseminations interstitial to massive chalcopyrite.

Electron microprobe analyses indicate that there is little variation in the composition of the chalcopyrite. The Cu/Fe ratio averages $0.95 \pm 0.02$ and the metal/sulphur ratio falls in the range 0.94 to 1.03, with a suggestion that the more sulphur rich grains are associated with bornite. Sphalerite has very low iron content in the range 0.2 to 1.4 wt%, the higher values occurring towards the south, and contains about 0.3 to 0.5 wt% cadmium.

Preliminary analyses of $^{34}S/^{32}S$ isotopic ratios (mostly for the chalcopyrite) indicate values that range from −0.4 to +4.0, but are generally close to zero.

A 3-D geological model based on mapping and drill-hole data shows that the mineralization is closely associated with the volcanic unit and immediately overlying phyllite. Two main chalcopyrite-rich shoots occur, both structurally controlled mainly by axial shearing. One, in the north, is clearly localised at the intersection of two shears. The other, to the south, includes the copper-rich bornite lens and is essentially conformable with phyllite intercalations within and close to the top of the volcanic unit. Further south the mineralisation consists of lenses of sparsely disseminated sulphides, in which sphalerite generally predominates, occurring within conformable intercalations of phyllite at a (?) facies change from volcanics to sediments. Some of these sulphides are finely laminated and some of the pyrite is framboidal.

Overall, the geological setting indicates that mineralisation occurred at a time of relatively quiescent extrusive volcanism during development of an explosive andesitic volcano. It is believed to be of exhalative origin, related to hydrothermal activity following extrusion of the lavas, with the sulphides precipitating preferentially in the hot muds close to the flows. Much of the hydrothermal activity was presumably oxidising and accompanied by precipitation of abundant specular hematite. Locally, however, sulphides were precipitated where reducing (solfataric) conditions developed, and where this occurred much of the hematite was reduced to magnetite. Subsequent metamorphism and folding has remobilized much of the chalcopyrite into shears to form the high grade shoots.

## GOLD AND PYROPHYLLITE MINERALIZATION IN THE DEVONIAN ACID VOLCANICS OF THE YALWAL-EDEN BELT

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The acid volcanics occur mainly at the base of a gently folded sequence of continental sediments and basic volcanics.

Mineralization of the Yalwal Goldfield is developed in both acid volcanics and the adjacent metasediments. The rocks have been intensely altered to siliceous, aluminous compositions. Auriferous pyrite and rare free gold occur mainly in siliceous alteration zones. Andalusite-rich assemblages represent essentially isochemical contact metamorphism of the altered rocks by a nearby Carboniferous granite. Most of the gold has been won from oxide-clay-rich material near the present topographic surface or a pre-Permian erosion surface.

The pyrophyllite-rich rocks at Back Ck. (and elsewhere in the Pambula district) form lenticular, elongate bodies, near vertical and cross cutting local stratigraphic layering. Host rocks are mostly rhyolitic breccias. A central (commonly schistose) pyrophyllite-rich zone is succeeded outwards by zones dominated by the following assemblages: qtz-Kmica (± pyrite), Kmica-qtz-alb., grading into weakly altered volcanics (qtz-Kspar-alb.-Kmica-chlorite ± epidote). Sulphides are developed in the siliceous-Kmica zone.

Intense local alteration, responsible for the aluminous, alkali-depleted compositions, has occurred prior to the deposition of the overlying sediments and volcanics. Near surface conditions (in the kaolinite stability field) may be inferred for the alteration akin to those presently operative in geothermal/hot spring systems in young volcanic terrains. Large volumes of aqueous solutions passing through fracture zones in the more permeable rocks have produced the alteration zoning by progressive reaction with wall rocks. Cooling and boiling of the solutions as well as oxidation of sulphur-bearing species have influenced the solution chemistry and deposition of auriferous pyrite and gold. Gold has probably been derived from both the acid volcanics and underlying sediments.

The pyrophyllite-bearing assemblages formed during later regional alteration of prehnite-pumpellyite grade ($\sim 300^\circ$C, 1 kb, $a_{H_2O} > 0.3$), the high geothermal gradient involved resembling those of modern regional geothermal systems. Economic gold deposits resulted from supergene processes.

## CHEWTON GOLDFIELD AND WATTLE GULLY MINE: A MODEL FOR GOLD-QUARTZ MINERALIZATION IN SLATE BELTS

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The Mt Alexander-Chewton-Fryerstown mineralized belt occurs in a L-Mid Ordovician turbidite sequence ($\sim$ 600 m thick) comprising quartz-rich sandstones, greywackes and slates. On the basis of detailed structural and stratigraphic mapping the region is divided into three N-S trending structural blocks bounded by high angle reverse faults. The strongly deformed western block is characterized by tight folding, strong development of slaty cleavage and numerous westerly dipping reverse faults on eastern anticlinal limbs. This block contains the goldfields.

Pre-granite, auriferous fault- and spur-quartz reefs occur around Chewton, with saddle reefs and spurs more abundant in the older rocks near Fryerstown. The Wattle Gully Mine (Chewton) is developed on massive quartz veins in a steeply west-dipping reverse fault system. Quartz bodies are most voluminous and gold values high where the fault system abuts black, carbonaceous slates. Wall rock alteration is minimal, and assemblages developed (Kmica-chlorite-ankerite) are similar to those in the adjacent slates.

Deposition of quartz and gold from aqueous solutions traversing the fault system has been influenced by mixing with solutions derived from wall rocks — these having relatively high $P_{CO_2}$, $P_{CH_4}$ etc. due to equilibration with carbon. In this fashion quartz is deposited by decrease in $a_{H_2O}$, aqueous gold (? chloride) species by reduction, and sulphides through increased activity of sulphide species. Aqueous solutions were close to equilibrium with Kmica-chlorite-ankeritic carbonate.

Metamorphically-layered slates of the district have suffered substantial loss of $SiO_2$ and redistribution of other components during cleavage development and prehnite-pumpellyite grade regional metamorphism. It seems probable, then, that $SiO_2$, Au and base metals in the quartz reefs have been derived from the sedimentary sequence through deformation and regional metamorphism, with aqueous transport and deposition controlled by dilative structures (reverse faults, fold hinges) and lithological units such as carbonaceous slates.