Mines and Wines seminar by PGJ.

Introduction

The Morning Star mine at Woods Point, Victoria has produced more than 850,000 oz of gold over its interrupted history. It is also the mine that gave birth to the Western Mining Corporation that began as a branch of Gold Mines of Australia. Gold mineralization at the mine occurs in quartz reefs hosted within a steeply, southwest dipping, lenticular dyke bulge that has a strike length of approximately 450 metres and a minimum width of about 100 metres. Northwest and southeast of the bulge the dyke is planar and less than 2 metres thick. The composition of the dyke is dominantly gabbro , however, multiple intrusive phases comprise the bulge. Morning Star Gold NL are currently exploring in their tenements for another Morning Star.

Location

The Woods-Point Walhalla gold province is located within the rugged central highlands in Gippsland, Victoria about 150km to the east of Melbourne.

The region was the scene of considerable mining activity from the middle of the nineteenth century up until World War 1. Subsequently, there have been brief periods of mining at a only few localities, principally the Morning Star and A1 mines. There are more than 200 mines in the province. In terms of Victorian gold production, the province is second only to the Ballarat-Bendigo gold province. Cohen's Reef at Walhalla was the single most productive reef in Victoria, producing more than 1 million ounces of gold (for those of you not familiar with the old imperial system, that is more than 30,000 kg).

Regional Geology

The Walhalla-Woods Point gold province is contained within the Walhalla synclinorium in the eastern part of the Melbourne Trough. The Walhalla synclinorium is bounded to the east by the Mt Useful Slate belt, and to the west by the Mount Easton Fault Belt. The province extends from Walhalla in the south to Jamieson in the north a distance of approximately 120km and the width of the belt is about 10-15km. Cropping out within the Walhalla synclinorium are NW trending Lower Devonian rocks belonging to the Walhalla Group.

Structural history

Rocks in the Walhalla synclinorium were deformed by the Middle to Late Devonian, Tabberabberan Orogeny that affected much of south-eastern Australia. Two tectonic stages have produced the dominant structural elements in the Walhalla synclinorium. The first tectonic stage was compressional and produced uplift and folding of the sediments. Resultant folds are tight to closed, angular folds with fold axes that plunge shallowly to the SE and NW.

There is little apparent change in fold style and orientation from the south to the north of the synclinorium.

The second tectonic stage appears to be transpressional and produced numerous NW trending, transform faults with the contemporaneous intrusion of magma along many of the faults to form the Woods Point dyke swarm.

The dyke bulges are coincident with inflections in dyke trends and are interpreted as having formed by episodic intrusions into dilational fault jogs that occur along some of the transform faults.

Dykes

There are several hundred dykes that intrude the Walhalla Synclinorium. These dykes trend sub-parallel to the regional strike and they are often several kilometres in length. The dykes vary in width from a few centimetres up to 100 metres or so in the so-called dyke bulges. Dykes are invariably bounded by faults. The dykes are thought to be Late Middle or Early Upper Devonian in age based on two Rb/Sr isotopic ages at the Shamrock and Loch Fyne mines by Mark Marsden in 1976.

The compositions of the dykes vary from ultramafic rocks containing abundant pyroxene and olivine through gabbros to rocks of diorite composition that show strong granophyric textures. Many dykes (and all of the large dykes) are composite, with a zonation defined by changes in composition for example, the Morning Star dyke bulge is more mafic towards the western contact (hanging wall) and contains magmatic sulphides (pyrrhotite and chalcopyrite). Towards the eastern contact the dyke rocks are more fractionated. Geochemical studies of the dyke rocks indicate that they could have formed from a similar parent magma composition. Fractionation can account for the dyke variants and the observed geochemical trends. Large dykes show a more or less continuum of compositions (e.g. Morning Star, A1) probably through episodic injection of magma contemporaneous with fault movement, whereas in localities where there are several dykes intruded, the geochemical trends are discontinuous and indicate temporally discrete intrusive events (e.g. Lauraville, Walhalla and Harbinger localities).

All of the dykes show evidence of deuteric alteration that is similar to propyllitic alteration. The intensity of deuteric alteration increases with fractionation in the dykes. Ultramafic rocks only show incipient alteration with the most intense alteration occurring in diorite. Chlorite, sericite, actinolite, prehnite, carbonates and leucoxene are the main products of the alteration.

A temporal distinction can be made between deuteric alteration and metasomatic alteration that envelops veins. Moderate to intense carbonate alteration, sericitisation and weak to strong pyritisation characterize post-magmatic metasomatic alteration envelopes. It would

appear that the fluids producing metasomatic alteration in vein margins are genetically related to those magmatic fluids responsible for deuteric alteration in the dykes because of their common characteristics. Alteration associated with post-magmatic hydrothermal fluids also produces abundant sulphides and minor gold.

Mineralisation

Gold mineralization in the Woods Point dyke swarm occurs mainly in dyke-hosted, shallow to moderate-dipping quartz reefs that are up to 2metres thick and are often referred to as ladder veins. These reefs infill reverse faults, commonly extending across the entire width of the dyke and offsetting it but, do not persist for any great distance into the sediments.

Gold may also occur in steeply dipping laminated veins along the dyke contacts. Generally one side of a dyke bulge is preferentially mineralized with elevated gold values compared to the other. In the case of the Morning Star Dyke, the gold grades tend to increase towards the NE footwall wall side where the dyke rock is more felsic. A favourable site for gold deposition is where dyke on the hanging wall of quartz reefs overlies sediments in the footwall.

Gold occurs in the free state along with quartz, pyrite, ankerite and minor amounts of arsenopyrite, boulangerite and tetrahedrite. The sulphide content of the veins is generally low (<5%) but pyrite along with ankerite and sericite is abundant in the altered wallrock enveloping the veins.

Five common reef types are recognised in the dykes:

(1) Massive, vuggy quartz reefs
(2) Laminated reefs
(3) Coarse stockwork reefs
(4) Breccia reefs
(5) Composite reefs

(1) Massive, vuggy reefs

Massive, vuggy quartz reefs contain quartz, with lesser ankerite and numerous vugs. Veins of this type normally contain sub-economic gold grade.

(2) Laminated reefs

Consist of laminae of quartz together with minor ankerite and sulphides, alternating with laminae of wallrock material. Veins of this type contain usually contain the highest gold grade and may contain visible gold.

(3) Coarse stockwork reefs Consist of an irregular network of quartz veinlets that form in the hanging wall or footwall of some reverse faults.

(4) Breccia reefs

An advanced stage of coarse, stockwork reefs, where angular clasts of altered wallrock are enclosed by vuggy quartz. These reefs normally carry low grade.

(5) Composite reefs

In addition to the four basic reef types, there are also compound reefs that contain components of those veins previously mentioned

Vein envelopes are strongly bleached and contain abundant sulphides and carbonate.

Exploration model

In exploring for gold in the Woods Point gold province, there are several parameters that are considered important, firstly the presence and compositions of dykes. Within the Walhalla Synclinorium, there is a strong spatial relationship between gold mineralization and the occurrence of dykes. Even in localities where gold mineralization is hosted by sedimentary rocks, dykes occur in close proximity (e.g. Star of the West mine, Kevington). Dyke rocks with primitive compositions (e.g. Maynard's Gully, Coopers Creek, Shamrock) contain elevated Mg, Ni, Cr and Cu but they invariably host only sub-economic gold mineralisation. The largest gold producing dykes are the ones with more evolved compositions, particularly compound dykes where geochemical variation diagrams indicate multiple intrusive phases and prominent fractionation trends.

Dyke bulges vary in width from about 10m to more than 100m. Small bulges can be identified in areas of poor outcrop as inflections in the dyke trend. Bulge areas are highly prospective because they are the loci of fault jogs, prolonged dilational movement and increased fluid flow. They also contain a larger volume of vein material because of their size.

Another feature that is characteristic of the gold mineralized dykes is the presence of broad pyrite haloes in the sedimentary rocks enveloping the mineralization. In drill core from diamond holes that intersect mineralized dykes, the first indication that the hole is nearing a dyke is the appearance of pyrite cubes in the sedimentary rocks. Carbonate veinlets commonly occur in the enclosing sedimentary rocks in proximity to the dyke contact.

Potential targets

Two dyke bulges in the Morning Star Gold Exploration lease areas that satisfy the criteria in the exploration model are the Wallaby and Reliance dykes west of Gaffney's Creek. Neither of these dykes has been previously drilled to assess their economic potential. It is anticipated that both of them will be drilled as part of the exploration program in the upcoming field season.

The Wallaby dyke forms a large lenticular dyke bulge approximately 70 metres wide that hosts economic gold mineralization. It was mined to a relatively shallow depth (120 metres) below the surface (Kenny 1925). Dyke rocks composing the dyke bulge are hornblende gabbros that have granophyric textures and moderate to strong deuteric alteration. Geochemical compositions of the dyke rocks are similar to the fractionated phases of the Morning Star and A1 dykes. Moderate angle quartz reefs traverse the dyke and are enriched towards the SW contact with sedimentary rocks.

The Reliance mine situated high on Moonlight Track west of Gaffney's Creek is also on a dyke bulge approximately 40m wide. There is a single adit driven in the dyke parallel to strike with a crosscut driven out to the NE contact. Historic mine development was minimal with no reported production. Geochemical analyses of the dyke rocks are yet to be completed, however, the rocks composing the Reliance dyke bulge are hornblende gabbros with a similar mineral composition and texture to the felsic dyke rocks at Morning Star and A1 mines. Abundant quartz veining is exposed in the adit with one quartz sample taken from a sub-horizontal reef in the mine returning an assay of 13ppm Au.