



# Minera Florida



**John Chadwick saw the significant transformation of this Chilean gold mine brought about by aggressive exploration and expansion programs**

**M**inera Florida began operations in 1986 at a processing rate of 10,000 t/month producing a gold, silver and zinc concentrate for off-site treatment. By 2003 process improvement had increased the treatment rate to 35,000 t/month for on site doré production and production of a zinc concentrate for off-site treatment. Meridian Gold purchased Minera Florida from a private Chilean company in July 2006. Subsequently, about a year later, Meridian was absorbed into Yamana Gold.

One might think that there would be resistance from a mine that was once run by a local company to the enterprising push from Canada and Brazil. Not a bit of it, the mine is enthusiastically embracing the plans and pushing hard for expanded production and greater efficiency. Minera Florida is currently working on mine and plant expansion projects increasing monthly treatment to 70,000 t and annual gold production to over 120,000 oz gold equivalent. This project was expected to be completed by year-end 2008. Production in 2009 and thereafter should be 125,000 to 135,000 oz/y of gold.

The mine is located on about 120 km<sup>2</sup> of lands 73 km south-southwest of Santiago, in the historic Alhué mining district. It is situated in an area with moderate to rugged topographic relief characterised by narrow valleys and high hills.

Proven and Probable reserves (at December 31, 2007) amount to 4.1 Mt at 4.51 g/t Au, 37 g/t Ag and 1.09% Zn. Measured and Indicated resources (excluding reserves) are a further 2.7

Mt at 4.8 g/t Au, 37 g/t Ag and 1.16% Zn. Inferred resources are 2.4 Mt at 5.18 g/t Au, 46.5 g/t Ag and 1.16% Zn. This year the mine is expected to produce 70,000 to 75,000 oz gold equivalent (62-65,000 oz gold, 440-470,000 oz silver and 3,400-3,600 t zinc). The plant recovers 84% of the gold, 72% of the silver and 70% of the zinc, at a forecast cash cost for 2008 of \$330-350/oz gold equivalent.

This year should see a dramatic increase in production to 110,000 oz and then to about 120,000 oz gold equivalent in 2010. Gold grade is rising, forecast at 5.2 g/t in 2009 and then 5.4 g/t au in 2010. At the same time silver head grade is falling, to 20.6 g/t in 2009 and 16.2 g/t Ag in 2010. Zinc grades are on the increase, from 1.03% in 2009 to 1.45% Zn in 2010.

Conceptual engineering has begun for an increase in gold production to 150,000 oz gold equivalent in 2012. This will require an increase in ore production to 90,000 t/month. At December 2008, mill throughput was 70,000 t/month. About \$30 million will be spent on this in 2009. The mine will still be providing 120,000 oz/y by 2012 and the other 30,000 oz gold equivalent will come from tailings retreatment.

The gold deposits in Minera Florida's concession are classified as stockwork and vein gold deposits. The Alhué deposit is situated within the Coastal Cordillera in the Metropolitan Region of Central Chile. Gold and polymetallic mineralisation is hosted by quartz veins and stockwork within gently east dipping andesitic tuffs and other volcanoclastic

rocks of the Upper Cretaceous Lo Valle Formation.

The Alhué property consists of 149 Mineral Licences covering a total area of some 16,000 ha, of which the mine facilities occupy just 200 ha. The property comprises Mining Licences around the Alhué mine as well as Exploration Licences around the mine which have been granted by the Servicio Nacional de la Geología y Minería (Sernageomin). Thus, there is extensive land to explore. Only a few of the deposit's veins have seen much exploration in the past. Diamond drilling indicates that the trend of gold mineralisation at the Alhué deposit continues along strike to the northwest. These include the Flor y Megia and Farellón Tribuna veins. At least two areas of gold mineralisation are interpreted to be present southeast of the Alhué deposit. Systematic exploration is testing these areas.

Access to the underground workings is via a number of adits up the side of the hill, ramps, crosscuts and drifts. There are adit entrances at 620 m, 740 m, 840 m (the main production level) 990 m and 1,100 m above sea level. The underground mining method is sublevel open stoping (20 m between sublevels), using trackless mining equipment exclusively. Typical mining blocks in narrow veins are 100 m high, 70 m long and 4 m wide. Such a block will contain 80,000 t of mineable reserves and will require 1,100 m of development drifting. Single sublevel drill drifts are driven in narrow veins.

In wider veins the blocks will typically be 140 m high, 125 m long and 25 m wide,



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containing 900,000 t of ore. These blocks require 3,800 m of development drifting. Hanging wall and footwall sublevel drill drifts are driven in wider veins. Both types of block employ production fan drilling with 1.8 m burden and spacing in the narrow veins and 2 m burden and spacing in the wider blocks. The yield is 4 t/m of drilling in narrow veins and 6.5 t in the wide blocks.

Stoping begins with ore blasted in vertical slices using the slot as the free face. The minimum planned stope width for most veins



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is 2.5 m, and for the Milenium Vein, it is 3.5 m. As the mine deepens, new stopes are developed below previously mined blocks. Sill pillars are required to allow access to lower stope blocks. Depending on the ore thickness, remnant pillars may be left for support.

Recent mining statistics reflect the new approach at this mine. Two years ago, underground development averaged 350 m/month and today it is around 850 m/month (750 m horizontal and 100 m vertical). During Meridian's ownership (before Yamana) exploration drilling was increased from 10,000 m/y to 50,000 m/y. The deployment went up to five diamond drills on site. Major Drilling is the main contractor. The results have been successful. In the past gold reserves were normally 100-150,000 oz, but today that figure is up to 600,000 oz. By the end of 2008 the gold reserve is expected to be up to 1 Moz, with 10 Moz of silver.

Development until recently relied on two single-boom Atlas Copco Boomer H-281s. One new H-281 and an H-282 have been delivered to cope with the increasing development drilling requirements. There is a mixed fleet of Atlas Copco 2.7-4.6 m<sup>3</sup> Scooptrams for mucking ore and waste – one new ST1030, two ST6.5s, five ST710s and one ST2D.

P&V drill tools are used for all development work. The diameter of development round blastholes was recently increased from 45 to 51 mm and much of the drilling was turned over from the COP 1238 to COP 1638 drifters. These changes improved the advance per round by 10% and allowed better precision drilling at the greater diameter. The number of development metres drilled was reduced by 20% but the capacity was maintained through the larger diameter holes.

Stopes are developed by driving sublevels, in ore, at 20 m vertical intervals from access drifts and crosscuts driven from the footwall. Crosscuts are driven on approximately 30 m centres to the ore. Undercuts are driven at the



bottom of the stope blocks at the drawpoint levels. A slot is developed at end of each stope connecting each sublevel.

The production drills are all Atlas Copco Simbas, with the exception of one Boomer H-104 in the narrow vein stopes. The other unit in those stopes is a Simba H-157. The older rigs in the wide veins are two H-1254s. More recently two S1Ds have been delivered, the latest in June 2008. These drill 57 mm diameter holes in the narrow veins, and 70 mm in the wider orebodies.

An internal ramp system provides access to the Milenium, Maqui, and Agua Fria vein systems. The average width of the veins is 4 m. Milenium, which currently amounts to around 20% of total production goes up to 30 m in places. The Scooptrams haul ore from the stope drawpoints to storage areas where it is loaded onto 30 t trucks by Volvo 120L wheel loaders and hauled down the mountain to the mineral processing plant, 8.2 km away by a contractor. Waste is transported by 20 t trucks.

A new level is being developed at 470 m above sea level which will be fed by a 240 m deep, 3 m diameter raise bored orepass. The Scooptrams will dump ore through grizzlies equipped with hydraulic breakers for secondary breaking that will fall down the orepass to a chute feeding the trucks on the



*Drilling a production ring blast pattern with a Simba H-254*

new level. The aim is to ensure that the maximum haul distance becomes no more than 1 km.

At the concentrator, ore is crushed in three stages in closed circuit with vibrating screens. The trucks deliver ore to a dump hopper where a grizzly removes the plus-610 mm oversize which is subsequently broken by hydraulic breaker. The undersize is crushed to minus-102 mm by a 112 kW primary jaw crusher and then placed either in one of three 80 t storage bins or alternatively on a stockpile. The ore is further crushed by a 150 kW, 4.25' Symons secondary cone crusher and a 186 kW H-4000 tertiary crusher. The final product is 95% passing 10 mm and is delivered to one of two 600 t storage silos ahead of the grinding circuit.

The crushed ore is fed to the No. 3 ball mill where it is ground to 65% passing 75µ in a 985 kW 12' x 14' Dominion ball mill in closed circuit with a cyclone cluster. The cyclone overflow reports to the flotation plant. In November 2007, 56 flotation cells in two circuits were replaced with one circuit of eight new Outotec cells improving gold, silver and

*H-282: Atlas Copco has delivered one new H-281 and an H-282 (like this one) to cope with the increasing development drilling*



concentrate contains some 56% Zn and the circuit recovery is 70-77%. **IM**

zinc recoveries. The flotation plant resulted in a 4% gain in recovery. It comprises five Outotec TankCell 20s as rougher cells. Two TankCell 5 cells are for cleaning and there is one more as a scavenger cell. The next expansion will double the current cell layout.

The flotation plant product reports to a thickener where the flotation bulk concentrate is thickened to 50% solids and then to one of six 50 m<sup>3</sup> leach tanks for leaching with NaCN solution in a series of six 50 m<sup>3</sup> leach tanks providing 72 hours of residence time. Leached slurry reports to a thickener with the overflow comprising the leached gold and silver and the underflow containing the sulphidic solids. The leaching circuit produces a pregnant solution containing some 30 g/litres Au and a thickened pulp containing the zinc sulphides. The leaching circuit recovers some 97% of the gold and 80% of the silver.

The pregnant solution is first clarified and then heated to 70-80°C via a heat exchanger and two electrical heaters. The warm solution is pumped to four EW cells where a gold and silver sludge is deposited on the cathodes. The sludge is periodically washed off, filtered, and dried prior to being smelted into doré bars. The doré bars contain gold, silver and about 1-2% impurities (Cu, Pb, Zn). The EW circuit recovers about 98% of the gold and 99% of the silver.

The barren solution containing 0.3 g/litres Au, 0.5 g/litres Ag, and 2-3 g/litres free cyanide is first used to heat the incoming pregnant solution via the heat exchanger and is then sent to an Inco SO<sub>2</sub>/air cyanide destruction circuit. The water from the Inco circuit is reclaimed as process water and cyanide is precipitated as cyanate and iron-cyanide salts that are disposed of in an impoundment area.

The thickener underflow containing the leached solids is filtered and stockpiled. The filtered solids are then rehandled by wheel loader and fed to the zinc flotation circuit at a rate of 1,400 t/month (50 t/d). The solids are first re-slurried and conditioned with reagents. The zinc flotation circuit consists of ten 1.4 m<sup>3</sup> mechanical flotation cells as roughers and scavengers followed by a 2 m diameter by 10 m high column cell as cleaner. The final zinc



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