Placer Dome Case Study: Misima Mine
Catherine Coumans – April 2002

MINE: Misima Mine – Misima Mines Limited
Location: Milne Bay Province, Misima Island, Papua New Guinea.
Ownership: Misima is owned and operated by Misima Mines Limited, which is jointly owned by Placer Dome Asia Pacific (80%) and Orogen Minerals Ltd (20%) which is owned 51% by the PNG government and 49% public shareholding. The Placer Dome group owns 100% of Placer Dome Asia Pacific (prior to April 11, 1997 this was 75.4%).
Product and Reserves: Gold, with silver as a by-product. Proven and probable reserves as of December 31, 2000, 525,000 ounces of Gold, and 5,481,964 ounces of silver.
Production Rate and Cost: During 2000, 60,900,002 tonnes of ore were mined and milled to produce 217,762 ounces of gold (no silver recorded) at a total production cost of $289 per ounce.
Type: Open pit mining, the milled product undergoes cyanide vat leaching and dissolved metal is recovered through carbon-in-pulp process.
Operating Dates: July 1989 – Mining was completed end of May 2001, stockpile milling continues until 2004.
Employment: 645 PNG citizens, 72 non-PNG citizens.

HISTORY:

In 1977, Placer (PNG) Pty. Ltd. signed a joint venture to explore for gold on the island. In 1985 Placer (PNG) increased its interest to 100%. In 1988 the government of PNG acquired a 20% interest in the mine. In 1989 production started.

ISSUES:

1) Overburden was dumped onto a near shore coral reef from 1989-1994.

Approximately 53 million tonnes of soft waste rock and soil was dumped into the ocean over a 5 year period, smothering a coastal coral shelf over 1 km-long and having an extended impact on coastal reefs extending along 9 km of coast. This dumping killed the corals in the immediate impact zone and wiped out the subsistence fish resource in that area. In a broader impact zone the dumping led to significant reductions in coral fauna diversity, reduced numbers and diversity of fish, significant reductions in subsistence fish yields, high suspended sediment concentrations, turbidity, and turbid plumes extending out into the ocean, particularly during the southeast trade wind season.[1] This dumping was done in complete contradiction to international standards of best practice during the time the dumping was done and should have been avoided.

2) Submarine Tailings Disposal.

[1] NSR Consultants, October 1999. Review of the Coral Reef and Nearshore Environment, Misima Mine, Papua New Guinea. p. 13.

Placer Dome chose to use Submarine Tailings Disposal at this site for disposal of the mine's tailings. The tailings are treated to recover some of the reagents and reduce dissolved metal concentrations. The tailings are then piped to a coastal mixing tank where they are diluted 15:1 with seawater. The tailings are then discharged by submarine pipe at a depth of approximately 112 metres into a 1,500-metre ocean basin.

This disposal method is highly controversial and is effectively banned under Canadian and US regulations.

In theory, proponents believe that if "de-aerated" tailings mixed with sea water are deposited by pipe below the "mixed surface layers," and below the "euphotic zone," and below a "thermocline" onto a sea bed with a "sufficient" slope so that the tailings flow through gravity into the deep waters of the ocean, where there is little oxygen, then tailings will stay together in a "density current" like toothpaste; they will not be able to come back up above the thermocline, they will not significantly leach out metals, they will not damage corals and they will not negatively affect marine organisms, fish in general or particularly species that make up part of the human food chain.[2]

Independent studies have shown that plume shearing and pipe breaks occur at all STD systems causing increased turbidity and wider than predicted dispersal of tailings, including into more shallow and biologically productive zones where they may impact corals and marine life and increase the likelihood that metals in the tailings become bioavailable. Other ways in which tailings are deposited in areas where they should not be is through upwelling, lack of sufficient slope gradient of the seabed, internal waves, bottom currents on a sloping seabed, tidal flows, as well as more unusual events such as earthquakes at sea or tsunamis. All STD systems smother benthic organisms in the planned deposition zone. As these areas of the deep sea are not yet well understood, it is as yet unknown what the ultimate effect will be of benthic smothering.

Both total and dissolved metals in the tailings may become bioavailable through ingestion of whole tailings particles or through absorption of dissolved metals through gills tissue. Residual flotation chemicals and reagents enhance the solubility of metals in tailings. Significant volumes of metals from tailings deposited at great depths may make their way up to higher seawater levels and into the human food chain through "vertical migration," from the depths to higher layers, of plankton and fish that have absorbed tailings or leached metals, and by fish from the higher layers travelling down to the lower levels to feed.[3]

The Misima mine is often held up as a model of how an "ideal" deep-water STD system should work.

Problems at Misima:

Plume Shearing:

Plume shearing at the Misima mine happens at 112-metre depth, where the tailings leave the pipe (this is typical for STD systems) and also at depths between 150 and 1,000 metres at discontinuities in the water column.[4] Deepwater snapper, an edible species of fish, swim between 100-300 metres depth, so

[2] See, for example, the claims made by NSR Consultants, January 2000. Deep Sea Tailing Placement. p. 2.
[3] Sheaves, M. 2001. *In* Mineral Policy Institute, A Review of the Risks Presented by the Ramu Nickel Project to the Ecology of Astrolabe Bay. p. 73.
[4] NSR Consultants, April 1997. Review of Submarine Tailings Disposal: Misima Mine, Papua New Guinea. p.9.

metals in the tailings that shear off, may be absorbed by the snapper and passed up the food chain to people.[5] The degree of turbidity in the plumes is measured by the amount of Total Suspended Solids (TSS) in the plumes. TSS in plumes from the Misima Mine can be as high as 51 milligrams per litre (mg/l). Consultants for Misima minimize this number by saying that the TSS is "only" 51 mg/l,[6] but this is far higher than allowable under Canadian law, where mine effluent may not contain more than a monthly average of 25 mg/l.

Metal Contamination:

Misima's tailings contain residual cyanide from the gold extraction process. Before being released into the sea the tailings are first diluted on shore with seawater 15:1 in a "mixing tank" to reduce the concentration of cyanide and other contaminants.[7] Even after this dilution, the tailings contain such high levels of cyanide that they do not meet Papua New Guinea's "water quality criteria for seawater."[8] Therefore, Placer Dome was granted a very large area in the sea around the outfall of the pipe, called a "mixing zone," within which the seawater is polluted with cyanide and other chemicals at levels not otherwise allowed by Papua New Guinea.[9] This "mixing zone" in the sea extends 42 metres above the end of the pipe (which is at a 112 metre depth), and 488 metres below the pipe. The mixing zone is about 2.5 km wide at the top, tapering down to about a kilometre wide at the bottom. In addition to available cyanide, at the boundaries of the mixing zone, copper levels exceeded USEPA criteria, and lead levels exceeded Australian and USEPA criteria for total metal analysis.[10]

Pipe Breaks at Sea:

The submarine section of the tailings pipe at Misima broke in 1997, at 55 metres depth (in the euphotic zone). It took Placer Dome 6 months before the pipe was fixed in 1997. In December 2001, the pipe split down one side for a 10 metre length from 13 metres to 23 metres depth, in the mixed surface layers of the sea. Placer did not fix this pipe break until March 6th, 2002. In the meantime the system was reversed and the seawater intake pipe was used to pump out the tailings at 60 metres depth,[11] again, within the euphotic zone. During each of these pipe breaks at sea, cyanide and metal enriched tailings particles were pumped into shallow zones where STD advocates say tailings should not be dumped. Furthermore, by releasing tailings and cyanide at the shallow depths of 55 metres and 60 metres, Placer Dome was not in compliance with the conditions of its permit as these shallow areas fall outside of the "mixing zone" Placer was granted.

One of the principles of sustainability is to use and reuse the earth's resources frugally. STD degrades and destroys two resources, the marine environment and earth's metals. We know that STD smothers life on the ocean floor and that it puts potentially lethal and sub-lethal metals into the marine environment, but it also places potentially useful metals in the tailings out of our reach. On land, ways are being found to mine tailings for the many useful metals they still contain.

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[5] *Ibid*. p. 10.
[6] *Ibid*. p. 13.
[7] *Ibid*. p. 8.
[8] Ibid. p. 18.
[9] Ibid. p. 21.
[10] Ibid. p. 21.
[11] Foley, Noel, February 18, 2002. Personal Communication.