

# CENTER for SCIENCE in PUBLIC PARTICIPATION

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*"Technical Support for Grassroots Public Interest Groups"*



## MEMORANDUM

Date: March 20, 2007

From: David M. Chambers

To: Scott Brennan, Renewable Resources Coalition  
Aileen Lee, Moore Foundation

Re: **Resource Estimate of the Pebble Deposit**

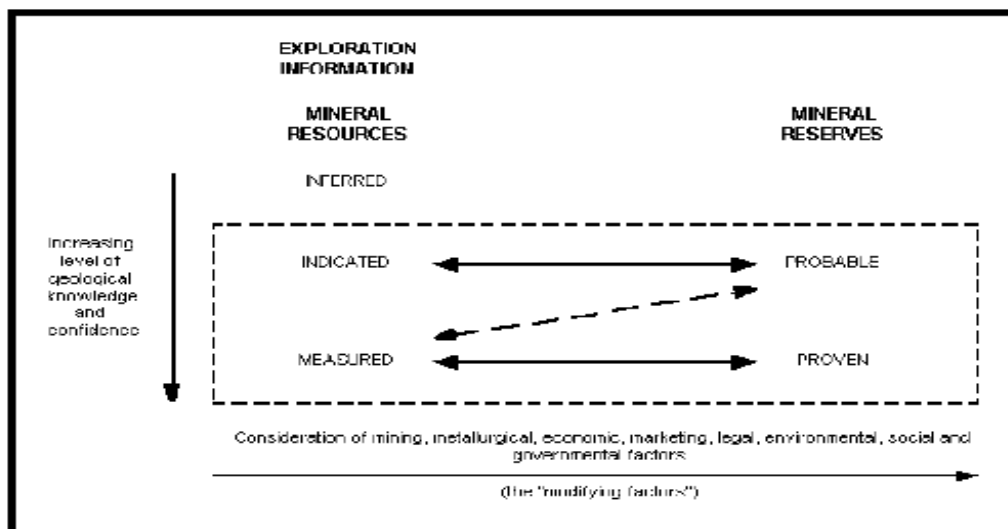
The Resource Estimate of the Pebble deposit is a estimation of the gross value of the deposit based on amount of metal present above an assigned cutoff value (below this cutoff value it is not economical to mine and process ore).

The Resource Estimate of the Pebble deposit is huge - approximately \$157 billion using today's metal spot prices. However, the Resource Estimate does not take into account the capital investment and processing costs that will necessary to open and operate a mine. It also does not include the cost of smelting/final processing. And, while the Resource Estimate of the deposit is calculated using the price of the end-product metals, the actual product that comes from the mine is a mineral concentrate that will require further processing before it can be sold for the value quoted to calculate the Resource Estimate.

It is vitally important in discussing the Resource Estimate of the Pebble deposit, or any mineral deposit, to recognize that this estimate does not insure that that a mine will be economically viable.

Despite the inferences in the literature from Northern Dynasty, Pebble is a low grade deposit. The lowest grade copper ores being mined today is approximately 0.3% copper - the grade Northern Dynasty has used as its lowest copper cutoff grade for mining in the open pit Pebble West deposit. Underground mining is more expensive that open pit mining, so the cutoff grade for the underground Pebble East deposit (0.6%) is also somewhat speculative. In addition, all of the ore at the Pebble East is currently classified as an 'Inferred Mineral Resource.' An 'inferred' resource is the lowest ranking classification that can be assigned to exploration data for resource evaluation purposes. See Figure 1 below.

**Figure 1**  
**Relationship between Mineral Resources and Mineral Reserves**



From: On Mineral Resources and Mineral Reserves, adopted by CIM Council, 14Nov04

All of data for Pebble East (underground) is classified as ‘inferred.’ Most of the data for Pebble West (open pit) has been classified as indicated or measured.

Using the resource classification in Figure 1, Pebble West (open pit) could be classified as a probable/probable mineral reserve, and a mine could be anticipated. Because the data from Pebble East (underground) is all ‘inferred,’ defining it in terms of a mineable deposit must wait on the evaluation of further drilling information. That drilling, or at least part of it, will take place in 2007. It is quite probable that additional drilling beyond the data that will be provided in 2007 will be required.

Table 1 on the following page gives a more detailed estimate of the Resource Estimate for the Pebble deposit. The table is admittedly ‘busy,’ but it does supply a more detailed look how the valuable minerals are split between the Pebble East and Pebble West deposits, and also gives some sense of the sensitivity of the deposit to mineral prices.

This estimate is based on information provided by Northern Dynasty Mines from its website. Cutoff grades<sup>1</sup> evaluated in the Table 1 are 0.3% and 0.6% for the open pit Pebble West deposit, and 0.6% and 1.0% for the underground Pebble East deposit.

Two ranges of metals prices were also utilized in the Table 1 - those used by Northern Dynasty Mines for their resource estimate, and the spot metal prices from the London Metals Exchange for March 19, 2007. The London Metal Exchange prices are higher.

It is apparent that the potential value of the Pebble deposit is huge. However, from an investment and mining standpoint there are still many serious questions to be answered.

The primary attraction of the Pebble deposit is:

- It is a very large deposit of metal.

The detractors are:

- It is a low grade orebody;
- The capital investment required to reach production would be very large (probably on the order of several billion dollars);
- All of the infrastructure for the project will have to be built from scratch (increasing the initial investment cost, unless government will provide part or all of this need); and,
- The area is environmentally sensitive, which means environmental costs could be underestimated, and there is local opposition to the mine.

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<sup>1</sup> The cutoff grade is the grade of mineral below which it is uneconomical to mine and process the ore - it then becomes waste which must either be moved to access more ore, or left in place.

**TABLE 1 - PEBBLE RESOURCE ESTIMATE**

<b>PEBBLE RESOURCE ESTIMATE</b>		
*Mining data from: NDM News Release, 20-Feb-07	@ NDM*	@ 19-Mar-07
	<b>Assumed</b>	<b>Spot Market</b>
<b>TOTAL PEBBLE RESOURCE ESTIMATE</b>	<b>Metal Price</b>	<b>Metal Price</b>
Cutoff Grade: Open Pit = 0.3% -- Underground = 0.6% (\$billion)	\$123	\$157
Cutoff Grade: Open Pit = 0.6% -- Underground = 1.00% (\$ billion)	\$351	\$460
<b>Assumed Metals Prices:</b>		
Copper (per pound)	\$1.00	\$3.00
Molybdenum (per pound)	\$6.00	\$24.00
Gold (per troy ounce)	\$400.00	\$650.00
<b>PEBBLE WEST (open pit mine)</b>		
Measured + Indicated + Inferred Mineral Resource*		
Copper Cutoff Equivalent Value*	0.30%	0.60%
deposit metric tons*	4.16E+09	1.20E+09
copper (lbs)*	2.47E+10	1.05E+11
molybdenum (lbs)*	1.35E+09	5.21E+08
gold (troy oz)*	4.21E+07	1.74E+07
<b>Resource Estimate in (\$ billion) based on:</b>	=====	=====
20Feb07 NDM Assumed Metal Prices (\$ billion)	\$49.7	\$115.1
19Mar07 Metal Prices (\$ billion)	\$134.0	\$338.8
<b>PEBBLE EAST (underground mine)</b>		
Inferred Mineral Resource*		
Copper Cutoff Equivalent Value*	0.60%	1.00%
deposit metric tons*	3.40E+09	1.40E+09
copper (lbs)*	4.26E+10	2.64E+10
moly (lbs)*	2.70E+09	1.20E+09
gold (troy oz)*	3.69E+07	2.09E+07
<b>Resource Estimate (\$ billion) based on:</b>	=====	=====
20Feb07 NDM Assumed Metal Prices (\$ billion)	\$73.6	\$42.0
19Mar07 Metal Prices (\$ billion)	\$216.6	\$121.6
<b>Note 1:</b> Copper equivalent (value of copper, gold and molybdenum expressed as copper) has not been adjusted for metallurgical recoveries.		
<b>Note 2:</b> Definitions:		
<b>Mineral Resource:</b> Mineralization and natural material of intrinsic economic interest which has been identified and estimated through exploration and sampling.		
<b>Measured Mineral Resource:</b> That part of a Mineral Resource for which quantity, grade or quality, densities, shape, and physical characteristics are so well established that they can be estimated with confidence sufficient to allow the appropriate application of technical and economic parameters, to support production planning and evaluation of the economic viability of the deposit.		
<b>Indicated Mineral Resource:</b> That part of a Mineral Resource for which quantity, grade or quality, densities, shape and physical characteristics can be estimated with a level of confidence sufficient to allow the appropriate application of technical and economic parameters, to support mine planning and evaluation of the economic viability of the deposit.		
<b>Inferred Mineral Resource:</b> That part of a Mineral Resource for which quantity and grade or quality can be estimated on the basis of geological evidence and limited sampling and reasonably assumed, but not verified, geological and grade continuity.		