

# RIO TINTO

## **Memorandum**

---

To: **John Burgess**  
Copy: John Stephenson, Ian Ledlie, Gerard Rheinberger  
From: Alan Millar  
Date: 3 December 01 File: Doc. No.

### **Wonarah Resource Estimate Up-date**

#### **Summary**

A revised Resource Estimate for the Wonarah Phosphate Deposit has been carried out following the drilling programme completed in May – June 2001.

An Inferred Resource of 72 Mt @ 23% P<sub>2</sub>O<sub>5</sub> (cog 15% P<sub>2</sub>O<sub>5</sub>) has been defined for the same area as that previously reported.

The decrease in the tonnage from that previously reported (115Mt @ 22% P<sub>2</sub>O<sub>5</sub> (cog 15% P<sub>2</sub>O<sub>5</sub>)) is a result of the recent drilling failing to confirm the geological/grade continuity assumed in the previous geological model. The drilling, along with a more rigorous definition of the geological units in the existing holes has modified the geological model with a reduced continuity, leaving gaps in what was previously considered continuous Mudstone Phosphorite.

#### **Wonarah Resource Estimate 2001**

This memo up-dates the resource report for the Wonarah Phosphate Deposit completed in April 2001 and reported on in August 2001 in Rio Tinto Exploration Report No.24543. The initial resource estimate used only the data from drilling completed in 2000.

Additional drilling was completed by RTE between May and June 2001. Full details of this drilling programme are included in the annual report.

Several of the holes from the 2001 drilling resulted from recommendations made in the previous resource report, namely the need for better definition of both geometry and grade around the edges of the defined resource, and selected close spaced drilling to clarify grade and geological continuity within the resource.

Drilling within and near the previously defined deposit has indicated a more complex phosphate distribution than previously identified. A more rigorous definition of the

---

Rio Tinto Exploration Pty. Limited ABN 76 000 057 125  
37 Belmont Avenue, Belmont WA 6104 Australia  
Telephone +61 8 9270 9222 Facsimile +61 8 9270 9223  
Postal Address: PO Box 175, Belmont WA 6984 Australia

geological zones was completed following the 2001 drilling and this has reduced the extent and continuity of the main Mudstone Phosphorite Unit.

### **Data Used**

The block model covered the same area as previously reported and all drilling data used in the initial resource estimate was used in the up-date.

The 2001 drilling programme consisted of 71 RC holes of which 37 were within the bounds of the previously completed resource block model.

All drill holes from the Phase II (2001) drilling were used in the revised geological model. Of the 71 holes from Phase II, 37 were located within the area of the new block model and used for grade estimation. (Holes WON066-074, 092-097 & 115-136)

### **Modelling**

The resource modelling was carried out using Vulcan software and followed a similar process to that used previously.

Preliminary surfaces were modelled on the boundaries of the main interpreted units:

- Hanging Wall Mudstone (HMU),
- Convolute Mudstone (CMU),
- Mudstone Phosphorite (MPH),
- Chert Breccia (CBX),
- Undifferentiated Phosphorite Unit (PUN),
- Transition Sediments (TUN) and
- Basement (BAS/DOL)

Following the Phase II drilling all the geological boundaries were refined by the Wonarah Project team by comparing the results of chip logging, major element data interpretation and down hole gamma logging.

The geological units are based on a combination of sample description and sample geochemistry. Field descriptions are used initially but these may be modified after receipt and interpretation of whole rock multi-element analyses. The final triangulated surfaces were modelled in Vulcan using a 2<sup>nd</sup> order trend surface applicable to flat to gently folded surfaces.

Using the geological boundaries and the defined ore zones, a geological block model was constructed with a parent block size of 250m(x) x 250m(y) x 5m(z) and a minimum sub-block size of 50mx50mx1m. For the block model, the undifferentiated phosphorite (PUN) and Chert Breccia (CBX) were modelled as a single unit (PHOS).

### **Assay QA/QC**

Since the initial resource estimate was completed all the geochemical data for the RTE drilling has been submitted to Jetmin Pty. Ltd for QA/QC analysis.

Two QA/QC reports prepared by Jetmin Pty have recently been received and reviewed. The reports cover both the year 2000 and 2001 drilling programmes. Issues of quality

control procedures relating to the 2000 drilling have previously been reported (i.e. insertion of standards at beginning of DPO rather than through-out) and these have generally been resolved.

The main area of concern remaining from the QA/QC work is a possible problem with field sampling procedures that is highlighted by the poor precision for field duplicate assays. This is possibly related to “nuggety” chert within the mudstone phosphorite suggesting that a larger field sample maybe required. If further drilling is planned trials of a suitable sample size should be completed.

### **Resource Estimation**

The statistics and variography of the 1m composited data were examined both globally and within each of the geological zones having mineralised samples. Basic statistics were examined within Vulcan. Variography was carried out using GSLIB software running within Vulcan. No strongly preferred directions of continuity were evident from the basic variography.

Final search ellipses used were based on the geological interpretation, drill spacing and variography. A minimum of one sample and a maximum of 20 samples within the search ellipse were set as minimum estimation requirements. The recent drilling and reinterpretation of the geological units no longer supported search parameters used in the initial model. For all zones a circular based search ellipse was used with a 1000m horizontal and a 15m vertical radius.

Because of uncertainties and lack of confidence with the variogram, the final grade estimation was again completed using an inverse distance squared estimator (ID2). An ordinary kriged estimation was completed in conjunction with the ID2 estimate for checking purposes.

Grades were estimated into parent blocks using only composites from within the zone being estimated. Sub-blocks receive the grade of the parent block within the same zone to which they belong. A block discretisation (declustering procedure) of 4x4x4 was used along with an octant search restricting the number of samples in a particular direction. This procedure splits the block to be estimated up, in this case into 64 component blocks, completes an estimation for each and then averages the values for the final block grade.

A dry bulk density value of 2.0 t/m<sup>3</sup> was used, as in the previous estimate and appears reasonable for this level of study, however this may be a little high as samples appear to be biased towards higher grade ore material.

The model was then interrogated and tonnages, volumes, metal content, minimum, maximum and average grades extracted at 5 % cut-off grade (cog) intervals, for each of the estimated zones. These are tabulated in Table 1 and plotted against the composite data - Figure 1)

Comparison of the graphs with data used for the estimation indicates that the estimate is generally honouring the composite data, at least for cut-off grades up to about 20% P<sub>2</sub>O<sub>5</sub>. At higher cut-off grades, this may not be the case and caution should be exercised in using estimates at these higher cut-off grades.

## **Resource Classification**

In classifying the resources for the modelled Wonarah Deposit the following factors have been considered: -

- Several drilling techniques have been used;
- Assay reliability in general appears reasonable with some issues relating to field sampling remaining;
- The current drill spacing is typically 500-1000m with areas of both higher and lower data density, variography suggests the need for closer spaced drilling;
- Significant variations are observed in both mineralised thicknesses and grade in holes drilled adjacent to each other;
- The geological/grade model is in its infancy and uncertainties in the relationship between geology and grade remain; and
- A single bulk density value, based upon limited sampling, has been used for all mineralised blocks regardless of the grade.

Considering the above factors, that part of the resource modelled within the MPH zone in the main area of the deposit with a reasonable confidence in the grade estimate has been classified. Even with in this zone certain blocks with insufficient samples available for grade estimation have been excluded.

***In accordance with the JORC code (1999), 72Mt @ 23% P<sub>2</sub>O<sub>5</sub> (15% P<sub>2</sub>O<sub>5</sub> COG) is classified as an Inferred Mineral Resource.***

A plan of the mineralised estimated blocks is presented in Figure 2. For comparison also shown on this plan is the outline of the previous classified estimate in white and the all estimated MPH blocks shown shaded.

The resource has been quoted at a cut-off grade of 15% P<sub>2</sub>O<sub>5</sub>, a likely cut-off grade in an operation. The grade-tonnage relationship appears reasonable up to this grade however, lesser confidence is held in using cut-off grades above this level.

Mineralised intersections do occur outside the presently defined MPH zone and grade was estimated into parent blocks in these areas. However, none of this material has been classified in the current resource estimate, as insufficient data was available to give any degree of confidence as to the extent and grade of these intersections.

It should be noted that as the resource has been classified as an Inferred Mineral Resource then according to the JORC code guidelines, "*Caution should be exercised if this category is considered in economic studies.*"

Alan Millar  
Senior Geologist

Full Model

MPH Zone only (including unclassified blocks)									
Modelled									
cog	Ore	Ore	Metal	Metal	Av.G	Samples	Av.G	Ore	Metal
%P <sub>2</sub> O <sub>5</sub>	tonnes x 10 <sup>3</sup>	%	tonnes x 10 <sup>3</sup>	%	%P <sub>2</sub> O <sub>5</sub>		%P <sub>2</sub> O <sub>5</sub>	tonnes x 10 <sup>3</sup>	tonnes x 10 <sup>3</sup>
	model	model		model	model		1m comp	1m comp	1m comp
0.0	74,870	100.0	16,770	100.0	22.4	145	23.4	74,870	17,490
5.0	74,870	100.0	16,770	100.0	22.4	143	23.6	73,837	17,455
10.0	74,680	99.7	16,760	99.9	22.4	140	24.0	72,288	17,356
15.0	72,615	97.0	16,490	98.3	22.7	128	25.1	66,092	16,569
20.0	52,610	70.3	12,920	77.0	24.6	97	27.4	50,085	13,743
25.0	18,570	24.8	5,200	31.0	28.0	65	29.9	33,562	10,042
30.0	2,200	2.9	680	4.1	30.7	31	32.6	16,007	5,221
Based on 1m composites within ore zones used for block model									
Vulcan Model :wrhnew01									

Full Model

Main phosphorite Zones (MPH,CBX,PUN,TUN)									
Modelled									
cog	Ore	Ore	Metal	Metal	Av.G	Samples	Av.G	Ore	Metal
%P <sub>2</sub> O <sub>5</sub>	tonnes x 10 <sup>3</sup>	%	tonnes x 10 <sup>3</sup>	%	%P <sub>2</sub> O <sub>5</sub>		%P <sub>2</sub> O <sub>5</sub>	tonnes x 10 <sup>3</sup>	tonnes x 10 <sup>3</sup>
	model	model		model	model		1m comp	1m comp	1m comp
0.0	1,810,300	100.0	143,170	100.0	7.9	1669	6.5	1,810,000	117,831
5.0	1,200,450	66.3	127,670	89.2	10.6	661	14.5	716,842	104,157
10.0	421,360	23.3	72,570	50.7	17.2	395	19.5	428,370	83,404
15.0	253,640	14.0	52,290	36.5	20.6	267	23.0	289,557	66,482
20.0	141,430	7.8	33,380	23.3	23.6	155	27.0	168,095	45,302
25.0	46,730	2.6	12,390	8.7	26.5	97	29.7	105,195	31,285
30.0	2,220	0.1	680	0.5	30.7	43	32.9	46,633	15,337
Based on 1m composites within ore zones used for block model									
Vulcan Model :wrhnew01									

Table 1 Wonarah Resource - Grade Tonnage data

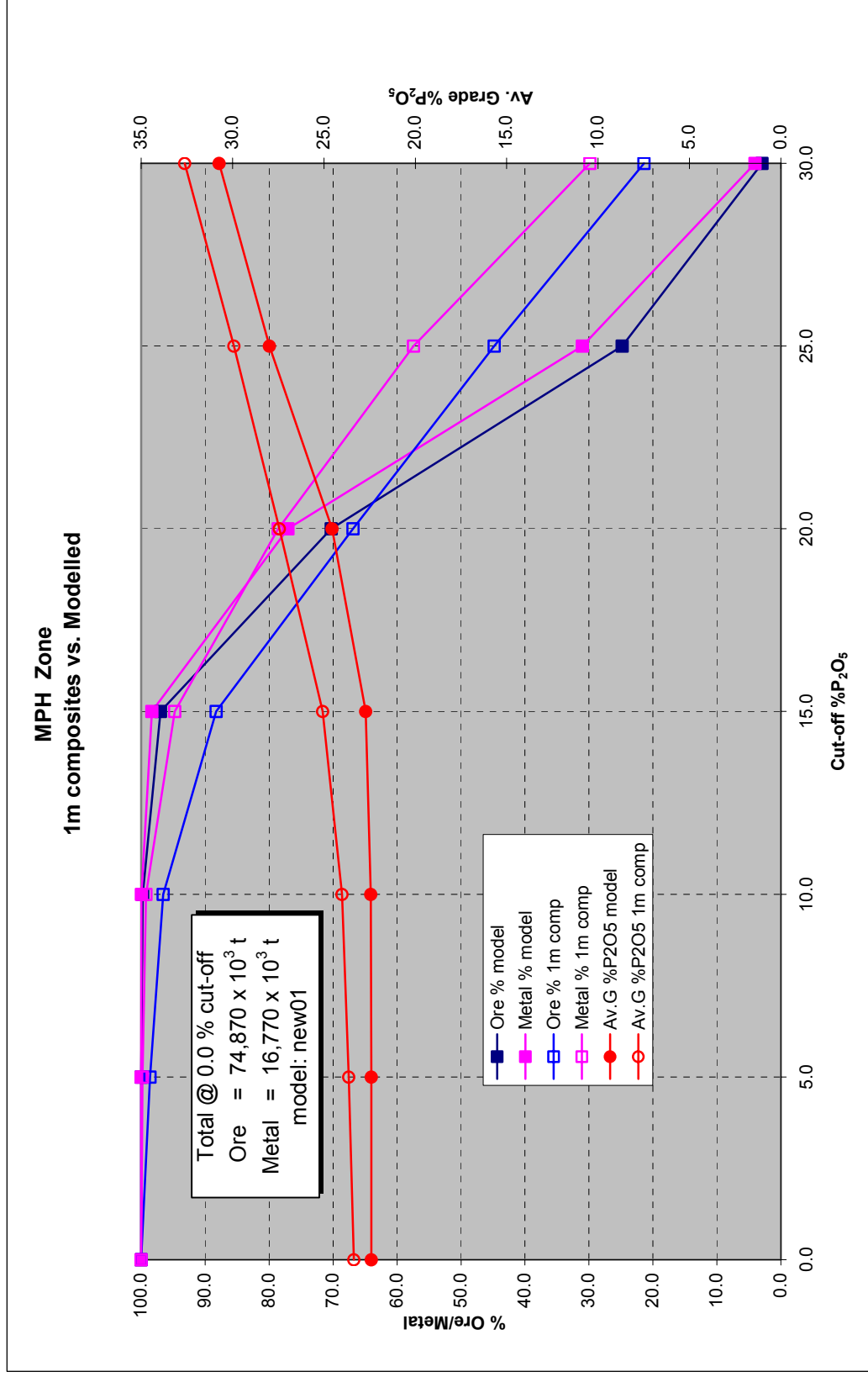
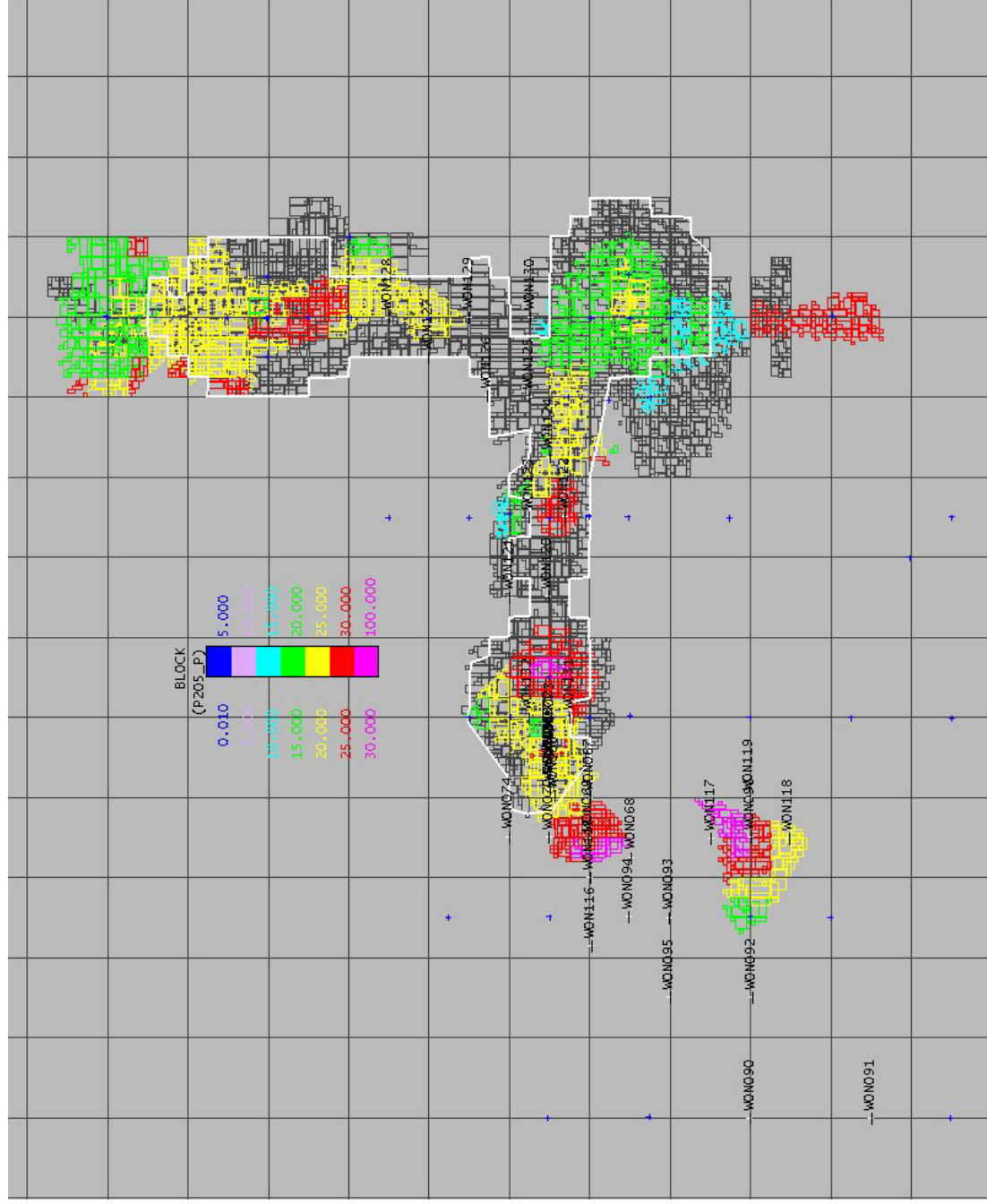


Figure 1 Wonarah Revised Resource: Grade Tonnage plot for Mudstone Phosphorite unit ( all blocks) with 1m composited data used for the block estimation.



**Figure 2** Wonarah Resource. Revised model coloured by estimated grade. Previous model shaded with area of Inferred Resource outlined in white. Drill holes from 2001 drilling programme labelled. (Grid 1 km)