TOWARDS A BETTER UNDERSTANDING OF ORE RESERVES

by

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CRA ADDS LIFE TO ITS MINES

Shareholders in Australia's largest mining group, CRA Limited, no doubt would have been intrigued and pleasantly surprised to see from the 1981 annual report that the remaining life of their lead/zinc/silver mines — Zinc Corporation and New Broken Hill Consolidated — increased substantially from a year earlier.

Specifically, in 1980 Zinc Corporation reserves were stated at 6.1 million tonnes of ore (about 6 years life at current production rates), but had more than doubled to 13 million tonnes by the end of 1981.

New Broken Hill did even better. From 7 million tonnes of ore that had been fully outlined and available for mining in 1980, proven and probable reserves in 1981 had increased four-fold to 28 million tonnes.

Lest anyone imagines that a major exploration effort had met with exceptional success, a closer examination of the statement on reserves revealed that ore reserves had been reclassified. Under the previous policy, pre 1981, CRA for its Broken Hill Mines reported only reserves that had been "fully outlined and available for extraction", whereas the new policy embraces "proved and probable" reserves.

Proved ore reserves are those in which the ore had been blocked out in three dimensions by excavation or drilling, but include in addition minor extensions beyond actual openings and drill holes, where the geological factors that limit the orebody are definitely known and where the chances of failure of the ore to reach these limits is so remote as not to be a factor in the practical planning of mine operations. Probable ore reserves cover extensions near at hand to proved ore where the conditions are such that ore will probably be found, but where the extent and limiting conditions cannot be so precisely defined as for proved ore.

Probable ore reserves may also include ore that has been cut by drill holes too widely spaced to ensure continuity. It may be helpful to think of these categories as "best known", "not so well known", and for possible ore (another category) "poorly known". But it is well to remember the three terms are geologically relative and organisationally subjective; one mine's "proved" may well be no better than another mine's "probable".

Annual report readers will also see the reserves at the other operating and proposed mines including coal in the CRA group are displayed in greater detail than previously. (In 1981 CRA was not unique in this regard since MIM Holdings has also seen fit to provide much greater reserves information for its metal and coal operations.)

CRA did not embrace the enlightened policy of more meaningful and useful reserves disclosure without deep consideration. It was during the course of their deliberations as to how reserves should be *stated* that the CRA group management became critically aware that there was a need for wider examination, discussion and review of the concepts and procedures involved in ore reserve *estimation*.

The company recently released a report written by three senior consultants in the group, Haddon F. King, Denis W. McMahon, and George J. Bujtor, and published by the Australasian Institute of Mining and Metallurgy entitled "A Guide to the Understanding of Ore Reserve Estimation". The report was three years in preparation and involved three separate visits by some of the authors, consultants and other collaborators to each of the six of the group's mining activities.

ORE RESERVE ESTIMATION SHORTCOMINGS

The guide, as the authors prefer to call it (not a manual) is unconventional in that it highlights the shortcomings in ore reserve estimation, and the inherent imprecisions therein. In addition, it stresses that mathematical

calculations are only one, and not necessarily the most important part of an ore reserve estimate. The report acknowledges that ore reserve estimation has been and has remained to the present time one of the most prickly topics in the mining profession and one on which various professional institutions have unsuccessfully sought consensus for many years.

Nevertheless ... "By contrast with its performances in most technical fields the mining industry generally has not made itself expert in ore reserve estimation ... It manages well in easy situations but often poorly in difficult situations which, with the trend towards lower grades, are becoming more common."

The authors support this contention with evidence, but unfortunately with the exception of the Mary Kathleen Uranium mine, do not specify particular mines. They do point out that in Australia in the last generation, some 50 new mining ventures (coal excluded) reached the production stage. Of this number, 15 mines or 30 per cent were based on large good grade deposits relative easily assessed. Of the remainder, 10 mines, or 20 per cent suffered ore reserve disappointments more or less serious and some mortal.

These included production to realisation ratios in grade of about 100:75 in a large gold mine, 100:70 in a major uranium mine, 100:55 in a sizeable copper mine and 100:80 in a small nickel mine. All of this happened to some of the most experienced companies in the industry. The most notable, or more accurately, the most notorious example of over-estimation of reserves was Queensland Mines' Narbarlek deposit, which was stated in 1970 to contain 49,900 tonnes of uranium oxide in ore averaging 595 pounds U_3O_8 per tonne. In September 1971 the ore reserves were revised dramatically downwards to 9,528 tonnes of contained U_3O_8 at a grade of 52 pounds per tonne, or a production to realisation ratio of grade of 100:8! The realisable U_3O_8 content of reserves has been revised variously since, as more information became available from actual production operations. On the other hand, it is so rare for an ore reserve to understate grade that the authors can identify only two such instances — Bougainville Copper and an unnamed recent gold mining operation in Western Australia.

HOW CAN ORE RESERVE ESTIMATES BE SO WRONG?

One reason advanced for poor reserve estimates was that the mining industry has continued, perhaps until quite recently, to see the problems as being mainly computational and cite an earlier report on the problem in which the "solution" was simply "to hire mathematically oriented staff and to hire computer time". The authors strongly reject this simplistic viewpoint, and from an exhaustive examination of the other problem areas conclude the hazards are found more in the realms of assumption and judgment in the geological and mathematical fields than in the mere computations ... "Some of the (reserve) estimators appear to become fascinated by figures and to lose sight of their meaning."

However, before any calculations at all can be made a 'data-base' must be assembled, usually from sampling, manual sampling of sub-surface exposures and drilling of various kinds. The conclusions here are that some new ventures have experienced difficulties due to inadequate sampling and to having stopped exploration too soon. In other words, the original data base was too sparse.

The problems in establishing such a data-base can be better appreciated when it is realised the essential conclusions will be based on analyses and interpretations of a set of samples in the aggregate to perhaps one ten-millionth of the orebody being studied. Rather like drawing definitive conclusions about the whole Australian population based on the analysis of only one person!

IN-SITU AND RECOVERABLE

With few exceptions, ore reserve statements traditionally have left the user in the dark since they usually failed to specify how much of the metal contained in the orebody was realisable. An "in-situ" estimate depends chiefly on sampling, assaying and geological interpretation, while the "recoverable" estimate additionally involves factors such as the choice of a mining method, judgements on predictions of recovery (of ore in mining, and of minerals in metallurgical extraction), dilution in mining, of the presence of contaminants and the effect of non-technical factors such as environmental contraints on production.

It should be noted that the Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy/Australian Mining Industry Council in its revised report on the statement of ore reserves in March 1981 recommended that such statements should specify whether they were in-situ or recoverable, with a preference for the latter. Australian Associated

Stock Exchange listing requirements covering this point take-effect from July 1, 1982.

The CRA consultants take this aspect further and state ... "The use of the term reserves assumes and should imply that the valuable constituent is economically recoverable and that in relation to the first few years of operation that recoverability is assured. Acceptance of this further widens the reach of ore reserve estimation. Instead of being, as it so often is, a matter of dimensions and grade, it becomes an assessment of the whole production process from in-situ definition to separation of a saleable production."

THE ESTIMATE

Lest it be thought the authors are expert only at posing questions and criticising existing practices and standards, they quite correctly suggest an ore reserve estimate should consist of a *team effort* in which:

1. the basic data will be known to all concerned,
2. the in situ tonnage and grade will have been assessed by more than one computation method,
3. the initial cut-off grade will have been established,
4. adjustments will have been made to the in situ tonnage and grade to allow for percentage mineability, dilution, metallurgical factors and the effect of the learning curve,
5. it will have been recognized that in different deposits and economic circumstances any one of geology/drilling, or sampling, or mining, or metallurgy or the nature of the sales contract may be individually the most important qualifying factor,
6. the possible influence of relative changes in metal prices on cut-off grade, mining and metallurgical targets will at least have been thought of,
7. the estimate will be as free as possible of the unavoidable bias in favour of a viable answer,
8. environmental factors will have been considered,
9. it will have been appreciated that, though in reality "ore reserves" change with each change of metal prices, the need for operational planning and continuity transfer the variability to the financial result so that in practice it is the profits rather than the ore reserves which undergo short-term variations.

WHO SHOULD MAKE THE ESTIMATE?

Georges Clemenceau, the French statesman, claimed that war was too important a matter to be left to the generals.

The CRA consultants imply ore reserves estimation is too important a matter to be left solely to geologists and they explicitly state a multi-discipline approach is desirable. Because of the many assumptions and judgments involved, the ore reserve estimate commands the efforts of the best team of say four or five that could be assembled — geologist, mining engineer, metallurgist, geostatistician and possibly a financial advisor or marketing man.

So as to preserve objectivity and to counter-balance the views of those too close to the problem, the CRA consultants recommend the inclusion in the estimating team, while the ideas are still fluid, of one or more people who are not directly involved in the future of the project and who are of sufficient standing to be able to contribute.

WHERE DO WE GO FROM HERE?

The authors of the guide, their employers CRA Limited, and the Australasian Institute of Mining and Metallurgy, are to be commended for writing and publishing what is a most significant contribution, one that could almost be described as pioneering, to the understanding of ore reserve estimation. A fresh look was certainly overdue. However, it should be seen in perspective as only being a first step in what will be undoubtedly a long traverse along the learning curve.

As this vital subject comes under closer scrutiny within the mining, banking, and investment industries, as more answers to the prickly questions are forthcoming over time, as mining company management confidence grows in their ability to estimate reserves more accurately, and as public understanding of this complex subject similarly increases, we hopefully will see useful and meaningful ore reserves statements in annual reports become the norm, rather than the exception. Already some major companies are leading the way and have adopted the two principal new recommendations of March 1981 of the Joint Ore Reserves Committee and are emphasing that ore reserves are estimates, not precise calculations, and are specifying whether reserves are in-situ or recoverable.

Nevertheless, much ground needs to be made up before annual ore reserve statements can be regarded

as satisfactory (refer the article by this author in JASSA September 1981, "Ore Reserve Reporting Practices of Major Australian Mining Companies").

As pointed out by King, McMahon and Bujtor, the practice of companies on ore reserve statements in annual reports is spread over a wide range:

1. no statement,
2. declaration of a reserve equivalent to a few years production,
3. full statement of known reserves (in situ but not defined as such),
4. statement of in situ reserves even where an estimate of recoverable reserves is available,
5. statement of recoverable tonnage and grade,
6. statement of recoverable product.

The range is thus from saying nothing about the current ore position to making a long range forecast of total production.

It is to be hoped the new found interest by the mining industry in estimation and statement of reserves does not lose momentum. With sufficient stimulus and encouragement from within the industry and from elsewhere, for example, from the banking and investment community, is it too much to visualise the Australian mining industry by the mid-1980s as being the recognised world leader in this vital matter?

In the past, members of the Securities Institute of Australia have played an important role in encouraging mineral companies to disclose more meaningful information about ore reserves, and related issues.

There is obviously much scope for such co-operation to continue in the future, to the benefit of both the mining and the securities industries.

Copies of "A Guide to the Understanding of Ore Reserve Estimation" are available from the Sydney and Melbourne offices of the Australasian Institute of Mining and Metallurgy at a cost of $10 each, and are available for perusal at the offices of the Securities Institute of Australia.