Review of evaluation models for the representative sampling of ore*

by N.O. Lotter

Contribution by W. Assibey-Bonsu†

I congratulate Mr N.O. Lotter on his paper.

There are two main aspects of the paper on which I would like to comment. One aspect is his review of P. Gy's sampling theory under the heading 'Sampling the mill feed' (p. 153). The other aspect relates to his reference to one of our papers[1] that was published in the *Journal* (p. 152). My comments on the former will be given elsewhere[2].

In reviewing our paper, Mr Lotter refers mainly to Sichel's *t*-estimator and omits one of the most important recommended evaluation models resulting from our research. This relates to the macro-kriging technique in the estimation of mean grades for new gold mines or large sections of existing mines. This technique is very useful when additional information is available from neighbouring existing mines or developed sections of existing mines.

In such cases, for example via the three-parameter lognormal distribution model, the grade can be seen as a function of the logs of the grades (ε) and their variances (σ^2). For a population, this function is defined as follows[1]:

$$\text{Mean grade} = \exp(\varepsilon + \sigma^2/2) - \beta,$$

where β is the additive constant. These parameters can be introduced as spatial variables, for example from adjacent mines. Alternatively, one can compute the mean estimates directly using macro-kriging on lognormal transformed or untransformed data.

Our paper shows, among other things, that the simple macro-kriging technique provides significant advantages over all the traditional borehole-valuation procedures including Sichel's *t*-estimator.

The following are of the main differences between the macro-kriging technique and the use of Sichel's *t*-estimator.

- The *t*-estimator approach considers the area to be estimated as a unique geological population, i.e. no information external to the area is considered relevant.
- The macro-kriging technique accepts the area to be estimated as a member of a larger geological 'family' or population in the area, and external information is therefore accessed in the valuation of the area.
- The *t*-estimator depends on the variance estimate derived from the limited number of borehole values available. Such a variance estimate is subject to wide limits of error, and is often outside the range of variance values known from experience for adjacent or geologically similar areas. It is in this respect that macro-kriging, involving a macro-kriged variance estimate, can provide substantial improvement.

References

1. KRIGE, D.G., and ASSIBEY-BONSU, W. New developments in borehole valuations for new gold mines and undeveloped sections of existing mines. *J.S. Afr. Inst. Min. Metall.*, vol. 92, no. 3. 1992. pp. 71–77.
2. ASSIBEY-BONSU, W. Further thoughts on the representative sampling of ore in the mining industry. Paper to be published in *J.S. Afr. Inst. Min. Metall.*

Authors' reply

Dr Assibey-Bonsu's contribution to the subject is appreciated. The use of macro-kriging[1] is a well-found method to handle the limitation identified in the Sichel *t*-estimator, in that the third parameter β is modelled from the data available in surrounding 'family' mines. In the case of the gold-bearing orebodies of the Free-State and Witwatersrand systems, this is workable neighbouring since shafts exist and have often been in operation for some time. This allows the investigator to better characterize the logvariance and third parameter, and accordingly improve his confidence in the modelled value for the unknown orebody.

Reference

1. KRIGE, D.G., and ASSIBEY-BONSU, W. New developments in borehole valuations for new gold mines and undeveloped sections of existing mines. *J.S. Afr. Inst. Min. Metall.*, vol. 92, no. 3. 1992. pp. 71–77. ◆

* *Published in* J.S. Afr. Inst. Min. Metall., *vol. 95, no. 4. 1995. pp. 149–155.*

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