LETTERS TO THE EDITOR

Geostatistics a complex issue

As an exploration and mining geologist, I am very uneasy with the image projected by the editorial "Challenging geostatistics" and the feature "Recent history reveals trends in mine failures," which target a very complex field of activity. [Both articles appeared in the Sept. 28 issue — *Ed.*].

These texts indirectly raised the basic issue of quality assurance in reserve/resource estimation, and their importance to the feasibility of mining projects. But the excessive emphasis on geostatistics as the culprit may not lead to significant improvements, as these texts skip over much more significant causes of the problems described.

The editorial oversimplifies the critical review and soul-searching that went on in the industry at the end of the flow-through period. In fact, the word "geostatistics" was hardly mentioned at the PDAC special session in March 1991 that reviewed the problems encountered. This session took place the day following the headline in *The Globe and Mail* concerning the total $1.4 billion in writeoffs of mining projects that occurred at the end of 1990. It is true that during this period some people used geostatistics very inappropriately to churn out poorly supported reserve estimates, taking advantage of the added trust given to computer-generated figures. But poorly supported estimates were also made using conventional methods. In fact, it appears that inadequate estimation practices have been happening for many years.

Various reviews from 1988 to 1991 (by Nick Tintor, Kerry Knoll, Graham Clow, David Harquail and Graham Farquharson) contend that the poor results of mining projects during the flow-through period could be attributed to:

- ❑ shortcomings in experience of deposit appraisal and mine development among several exploration organizations, particularly in relation to gold deposits;
- ❑ shortcomings in the geology, engineering and financial studies supporting these decisions;
- ❑ short schedules for spending the money; and
- ❑ undue pressure on the consultant for the justification of a production decision that has already been made.

Anyone could infer from the above comments that the use and occasional misuse of geostatistics in resource/reserve estimation is just one element of a complex situation. And this was shown by the content of a 2-day session on quality control at this year's CIM meeting in Montreal. Only four of the 22 papers presented dealt, to some extent, with geostatistics.

The conclusions of your editorial and article on mine failures amount to an indictment of the weaknesses of geostatistics and a glorification of applied statistics and analysis of variance as promoted by Jan Merks. The case made by your writer against geostatistics is just as applicable to any other estimation method. All methods for estimating grade and tonnage between drill holes and other sampling points work from the same premises, projecting the available sampling points to outline the dimensions and grade of a mineral body.

I am concerned about the misunderstandings and shortcomings these two texts contain regarding resource/reserve estimation requirements. The case studies presented are sketchy and, in my opinion, inconclusive, as they provide little information regarding the amount of drilling and sampling actually carried out. For instance, the information on the Grouse Creek gold mine differs in detail from that provided in the December 1995 issue of *Mining Engineering*. Reference is made to geological modelling, based on the 20-metre drilling grid, that failed to predict grade continuity accurately. In fact, continuity in the Seligman pit was better than expected in the first 12 benches, which were small, but worse than forecast on three larger, higher-grade benches.

This example points to a serious

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shortcoming of present delineation methods that was described by myself and Alistair Sinclair in several recent papers. It consists of the lack of recognition, both for standard evaluation methods and for geostatistical methods, that the usual drilling grid only measures continuity in detail in the direction along the drill-hole axis. In the plane perpendicular to the main drill-hole direction, continuity is mostly interpreted between the drill holes, and the actual level of information directly depends on the dimension of the grid cell. In problem cases, geostatistics cannot be expected to make up for the lack of data, but it can point out these spatial relationships more explicitly than conventional estimation methods and/or conventional statistics. It certainly has not done worse. This does not diminish the problem described that must be faced jointly by geologists, engineers, geostaticians and managers.

Our conventional drilling patterns are efficient to a point, but we must be aware of their limitations. Too often, the importance of confirming and measuring continuity in the plane perpendicular to the drilling as the work progresses is overlooked. The verification of continuity is what is being achieved by going to a smaller grid dimension, drifting or sampling underground, or sampling on the surface along a vein structure. In 1978, A.G. Journel and C. Huijbregts pointed out this problem and suggested using locally, for verification, a much more narrow experimental grid or a cross pattern (say 10x10 on a deposit drilled on a 100-metre grid). That this suggestion rarely is followed is, in my opinion, probably the major shortcoming of both conventional methods and mining geostatistics and the cause for the occasional uneven performances that draw so much attention. Less evident are the hidden losses in mining operations.

Whatever the method, any estimation based on drill holes that are spaced too widely is vulnerable. A widely-spaced hole grid, relative to deposit perimters, can only provide an indicated resource or, at times, an inferred resource, particularly when dealing with a sparse substance like gold. This is not appropiate for a production decision. Mine project planning leading to a production decision should never depend on such a flimsy base; a feasibility study and decision carried out under those conditions strictly are "at the owner's, lender's and investor's risk."

Bre-X provides an example: even if the sampling had been correct, the large distances between the isolated clusters of drillholes involved kilometre-range projections that were not allowable. This is why ounces grew so fast, and each of the 200 drill holes would have been supporting 350,000 oz. gold on average.

The basic estimation problem lies with the frequent lack of belief in the need for enough data, of appropriate quality. Undue parsimony and savings often are made at the expense of data acquisition for the geology, sampling and other detail work required for a production feasibility study. As a result, the mine development and production phases face undue risk regarding reserve quality and quantity, the ability to develop the mine within budget and schedule, and the ability to meet production targets on time.

In conclusion, a quality assurance/quality control approach appears required. It must be implemented from Day One and include exploration, delineation, deposit appraisal, project feasibility and resource/reserve inventory. Statistics, after the fact, are not sufficient, either for manufacturing or mineral development. The "best practices" approach is probably not sufficient either, as one man's or one company's best practices may not be appropriate or sufficient for the neighbor's problems, unless one is guided by an objective-oriented approach to apply them to other conditions.

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