

## General Discussion

### *Atholl Sutherland Brown:*

One of the reasons for organizing this session is that predictive metallogeny appears to have reached a sort of plateau. Many people are going through the process of making geological predictive studies, but the main emphasis in method development seems to be on the side of the refinement of conceptual models for ore genesis. We need also advances in methods of using these models more effectively in combination with other information. I think that the reservations George Mannard expressed are in fact good reasons for attempts like DeVerle Harris' to systematize the use of information in predictive studies. There are a number of common threads and some contrasts in what our speakers have said. We invite you to explore them further in discussion.

### *Unidentified Discussant:*

There are two main steps in the process of interpretative metallogeny. The first is the collection of good hard data in the field and laboratory. The second is the interpretation of the data. We should not institutionalize the interpretation process because that may lead to a group I would call "keepers of the holy data". After collecting good data we should keep the next part of the process open and let the data be disseminated as quickly and as widely as possible.

### *Chris Findlay, Geological Survey of Canada, Ottawa:*

I have a comment coupled with a question. Besides distinguishing clearly the terms "qualitative" and "quantitative" it is important to make clear whether one is speaking about these terms in an input or an output sense. We almost always assume that "quantitative appraisal" refers to the output end of the process, but we must consider also the quantitative aspect of the input end. The GSC's studies in the north that Don Sangster spoke about had qualitative input and qualitative output. I think we'd like to see more sophisticated methods developed to make quantitative inputs but still retain qualitative outputs, the objective being to produce a relative ranking of areas for use in decision-making of various kinds. My question to George Mannard and the other panel members is, what do they think about using the kind of input mechanism DeVerle Harris spoke about to produce the qualitative kind of assessment that you say industry is more in favour of.

### *George Mannard:*

I can see taking a very quantitative approach to input when dealing with an area like the San Juan Basin or in any area that is geologically simple, with stratigraphy

that is like a layer-cake, and is wellknown, which has only a few lateral facies changes and in which the mineral deposit type in question is a relatively simple one. In such a situation, I can see both quantitative input and quantitative output. But where the situation is not simple, where structural, metamorphic and other complexities are involved, I cannot see using the quantitative approach. Perhaps my problem is partly in understanding what you mean by "quantifying the input". The only quantification I can see is in an area with a mining history and where measurements are possible.

### *Chris Findlay:*

Well, there are a host of parameters that can be measured. One of the things that we found of interest when we visited Professor Rundquist's institute last fall is that what the Soviet geologists call "quantitative forecasting" is in many respects similar to what we have been doing in this country. In other words, the end-product of the process is still qualitative—a relative ranking of areas—although the process uses input of data in quantitative form. A difference is that the Soviet process may be directed at a local exploration target as well as being done on regional scales. What they have been doing at local scales is digitizing geological, geochemical and geophysical data and any other quantifiable parameters and then constructing a series of residual maps that depict only the parameters they judge, on the basis of experience in the area, to be relevant to ore localization. These various residual maps were then "stacked one on top of the other" and forecasts of target areas for detailed exploration were derived from the stacked data sets.

### *George Mannard:*

I do not differ with your opinion about those kinds of quantifiable input. Two things I find most encouraging about the work being done in the USSR and here by the GSC: first, the conceptual models are becoming more numerous and better defined. Second, a clear distinction is being made between shallow tectonic structures and the deep underlying ones; in examples that Professor Rundquist gave the deeper structures are given proper emphasis. I think mining companies, until very recently, have tended to neglect those deeper structures, thereby missing the boat.

### *Marcel Vallée, Soquem:*

The kind of analysis of geologists' thinking processes that Dr. Harris described should aid geologists to communicate among themselves and with others. In such a system, as with a computer program, much of the benefit comes in the act of setting it

up, because of the structuring of the thinking process this involves. But I am concerned that once a sophisticated system is running the geologist may be eliminated.

### *George Mannard:*

I wonder if you were thinking of Edwin Gaucher's paper on geological noise in which he made an excellent attempt to quantify the variations in the description of the same drill core by different geologists. But Edwin then went on to derive a purely statistical approach to exploration for volcanogenic massive sulphides in the Abitibi belt, and as far as I know nobody has found anything by the statistically-controlled grid method.

### *Sutherland Brown:*

I think Harris was saying that the geologist has to be involved in the whole evaluation process; geological decisions are required throughout; it does not become mechanical.

### *Don Mustard, BP Minerals, Vancouver:*

On the matter of predictive metallogeny by government, should the government be putting our money where its mouth is, and very soon?

### *George Mannard:*

If I interpret your question correctly, I guess I'm the one to answer it, because I've already said that I don't really feel that mining companies should be doing these studies. They should be done by government organizations and other research organizations that have consistent funding and the obligation to publish. I think it is a legitimate application of the taxpayer's money; I don't have any problem with that at all. My problems come with improper use of the findings and the difficulty this causes for us in trying to carry out mineral exploration. For example, the U.S. Geological Survey released an excellent study in which they were trying to predict how many more Viburnum-type areas there might be in southwestern Missouri. A local newspaper came out with a banner story that three major deposits were going to be found in Wayne County. It immediately became hopeless to negotiate with land-owners and impossible to explore there.

### *Dave Barr, Dupont of Canada Exploration, Vancouver:*

We do not yet have any follow-up results on the GSC's predictive studies. In selecting areas for study the economics and logistics are important, because if the studies are made in areas where these are too formidable, the conclusions of the studies will never get a fair test.

On the other hand, I can mention two examples of relatively quantitative predic-

tive studies that worked. One was by Homestake, who decided the number of dollars they would spend to find a certain amount of gold over a given period. I think they found some three million ounces within expenditure of half the allotted budget. The other example is older, the Hudson Bay Mining and Smelting work in Manitoba, in which they calculated that one drill hole per 1000 anomalies drilled produced a viable mine.

*Don Sangster:*

The GSC has made and published resources assessments of hinterland areas, northern Ellesmere Island for example, as background for discussions and decisions on land use. We believe that some of these studies could be of use to some of the mineral industry, though I don't want to overstate this point. The publications serve to draw public attention to proposals to designate large areas for special uses. It behooves all of us as conscientious citizens to be aware of the arguments pro and con on these designations.

*Rolly Ridler, Goldfields Exploration, Toronto:*

The definition of ore—"anything that can be mined for profit"—needs to be considered carefully in predictive studies. In this context I'd like to extend and emphasize something Julian Boldy hinted at with his "surprise factor". First, there are going to be new ore types that we haven't thought of yet. Second, changes in technology that we cannot envisage today will have a dramatic effect on what constitutes ore. These two things can have major effects on probability estimates and may totally invalidate them. Third, and extremely important, we cannot predict what substances society will want in the future. What this adds up to is that no part of the earth's crust has a zero or even a low probability of containing ore. I think it is a fallacy and a shame to designate any part of the crust as exempt from possible future exploration.

*Geoff Leech:*

We can surely agree on the danger of rating any area as low in mineral potential when we don't know everything that will constitute ore in the future. But calls for appraisals as background for decisions on land uses are here-and-now events and there are others besides geologists who respond. Geological appraisals of the relative ranking of areas prevent the uninformed setting aside of ground that appears to have significant mineral potential even by today's understanding. We are keenly aware of the need for reappraisals in the light of new concepts and information and new ways of handling them. This message should be part of every mineral resource appraisal.

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