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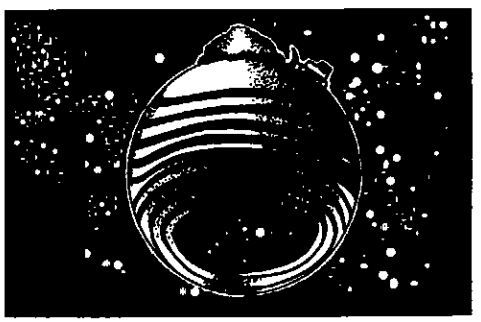

One World for Good or Ill: The Impact of Globalization on Mineral Exploration[1]

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SUMMARY

Just as the year 1500 indexed the arrival of One Europe so the year 2000 seems to be indexing the arrival of One World. We can now, if we so choose, explore for minerals over the whole world. We need to learn the lessons of the past, and looking back at four outstanding discoveries of Company Maker deposits it seems that a tenacious geologist with a good exploration idea and a convinced, sympathetic exploration manager to keep the funding flowing may be important ingredients. Experience suggests that there are three species of geoscientists in mineral exploration: the scientific aristocrats who ask How? and want to study the genesis of deposits; the tradesmen who ask Where? and expect to find the next one by association; and the criminal investigators who ask What? and are convinced a deposit will be revealed by the clues the deposit itself leaves. The bulk of the members of a successful mineral exploration team will be tradesmen: most exploration discoveries are made by association. For mineral exploration to provide the excitement, the challenge, and the fun it deserves, the emphasis must be on the risky game of prediction rather than on the safe, secure world of description.

RÉSUMÉ

Si l'an 1 500 a présidé à la naissance de l'Europe, il semble que l'an 2 000 aura marqué le début de la mondialisation. Dorénavant, on peut maintenant mener des stratégies d'exploration minérales d'envergure mondiale. En essayant de profiter des acquis de l'expérience, et en nous attardant à l'histoire de cas de 4 gisements d'envergure mondiale, on se rend compte que la meilleure recette pour découvrir de tels gisements serait une équipe formée d'un géologue tenace ayant une bonne idée d'exploration et dont les efforts seraient appuyés par celles d'un directeur d'exploration convaincu qui s'assurerait du financement adéquat des activités d'exploration. L'expérience montre qu'il existe trois types de géologue dans le domaine de l'exploration : *l'aristocrate* qui s'intéresse au « Comment des choses », *un maitre d'oeuvre* qui veut savoir « Où elles se trouvent », et le type *inspecteur de police* qui ne s'intéresse qu'aux « Choses elles-mêmes » et qui est convaincu qu'on ne découvrira le gisement qu'en relevant avec minutie les indices de sa présence. La majorité des membres des équipes d'exploration qui ont du succès sont du type *homme d'affaire*, ce qui démontre que la plupart des découvertes sont faites par association. D'ailleurs, quand on accepte le risque associé à l'approche prédictive plutôt que de se cantonner à la sécurité de l'approche descriptive, l'exploration minérale devient alors beaucoup plus captivante.

THE MILLENNIUM: A RENAISSANCE?

I don't suppose readers will be pleased to see yet another mention of the millennium, but I would like to suggest that, although the millennium seems to be a natural time for looking back and for trying to look forward, it is, in fact, only a milepost. There is nothing intrinsically special about a milepost with three zeros on it. The road on either side could be essentially the same. No law states it has to be steeper, flatter, straighter or more hilly.

[1]This paper was given as a keynote address at the 1999 GAC-MAC meeting in Sudbury, Ontario, 28 May 1999. Oliver Warin, now a consultant on geology and management, retired in 1998 from his position as Senior Vice-President, Exploration with BHP Minerals, the operator of the EKATI™ mine, Canada's first diamond mine in the Lac de Gras region, NWT. Born in the United Kingdom, he holds a Master of Arts degree (Natural Sciences) from Cambridge University. Early in his career Oliver spent 7 years in field mapping with the Australian Bureau of Mineral Resources, then took a position with Utah Development Company, working initially on the Mt. Goldsworthy iron ore deposit. Following work on projects all over Australia, he was appointed Chief Geologist, then Exploration Manager, pioneering Utah's involvement elsewhere in the world from an Australian base. Eventually he was asked to lead the worldwide mineral exploration activities of the parent company, Utah International, from San Francisco, California. He continued in that role when Utah was acquired by BHP. In 1994 Oliver Warin was awarded the Mawson Medal by the Australian Academy of Sciences. He delights in informing readers that he has spent most of his professional life in the sport of mineral exploration. This paper arises from his breadth of experience and insight in this most demanding sport, mineral exploration. R.W. Macqueen, editor.

But we happen to be passing this particular thousand milepost at a time of very rapid technological and cultural change, not caused by the milepost, but rather nicely indexed by it. The last time anything like this happened seems to have been in the year 1500, also a year that rather neatly indexes for us that time of accelerated change in Europe generally known as The Renaissance.

There are some interesting and perhaps instructive parallels between the year 1500 and the year 2000.

There was, around the year 1500, a revolution in information technology every bit as significant as the one through which we are now living. Johann Gutenberg began printing books around 1440, but by the turn of the century in 1500 there were printing presses in at least 60 German towns, and it is estimated that 40,000 editions comprising probably 20 million volumes had been printed. What a transformation from the time when every individual book had to be hand scribed on vellum and was commonly chained to its place in the monastery library! Remember also that this was a time when the largest cities of Europe (Paris, Naples and Venice) had populations of only approximately 150,000 each, and London was about half the size of Sudbury, with about 50,000 inhabitants.

This was the time also when intrepid European navigators headed out from Europe to discover new worlds, and in the process perhaps looked back toward Europe and saw it as a single entity for the first time, just as in our own time our astronauts are seeing the world for the first time as One World as they head out into space.

And this was the time when the institutions of church, state and royalty began to be questioned and discussed more openly. We, of course, live in a time when everything is "up for grabs." If you doubt that, I suggest you spend a day at home, as I do now in retirement, and listen to talk radio for a few hours.

If 1500 was the year when One Europe began slowly and painfully to take shape and emerge, will not future generations see the year 2000 as the birthday of One World? Many people living in the 1500s chose to ignore the arrival of Europe, or were too preoccupied to notice, or decided only to bewail the changes going on around them. And, of course, two world wars and the present state of affairs in the Balkans are stark reminders of the difficulty — even 500 years into the experiment — of creating not just One Europe but One United Europe!

We have the self-same options with the One World that is being thrust even more suddenly onto us in our generation:

- We can ignore it,
- We can busy ourselves with other things,
- We can join others in weeping over its emergence and its problems.

Alternatively we could, as earth scientists, welcome the efforts of the political and cultural minions to catch up with the geological practitioners, and say, quite loudly and firmly: "Yes...It is One World, and geologically speaking it always has been!" Doing so, I believe, puts us squarely in the camp with the realists, which is surely where we rightly belong. But what we, as individual geoscientists, individual mineral explorers, or as individual companies, decide to do about it is entirely another matter. We may decide to explore over the whole world (Figs. 1, 2) or we may decide to contain our interest to one country, one province, one mineral field, or even one deposit. These are simply choices available to us in the world newly recognized as a single unit, this One World, this globalized entity.

PHILOSOPHY OR MEAT AND POTATOES?

One of the good things about being asked to give a keynote address is that in the run up to it you are likely to make new friends. During the course of the correspondence for the address from which this paper is derived I made the acquaintance of a new friend, Dr. John Fedorowich. He had the audacity to suggest at one point that my title and abstract had "too much philosophy and not enough meat and potatoes"! I thought after awhile, "This man probably knows his audience," so let's leave the philosophy for awhile and enjoy some meat and potatoes!

I am now in my upper 60s and I suppose I can claim about 35 years involvement in foreign exploration, if by the term we mean exploration outside the country in which I was based. So forgive me if I concentrate on personal experience rather than charts and diagrams.

In the early days, the first part of the mineral exploration game was to "pick a country." The first two countries in which I was involved were Oman and Iran. I did not pick them, however. They were picked by circumstances and by requests of various kinds directed to my boss at the time, Richard Ellett, a distinguished American mineral explorer to whom I owe a very great deal. I may be able to note the geological results below, but suffice it to say at this point that within a year, if my memory serves me, the old Sultan of Oman had been deposed by his very much more progressive son and within a few years the Shah of Iran had been replaced with results we all know about. Following these events, I started picking my own countries!

One of my first choices was Madagascar, with, at that time, an enviable record of stability, one president since independence, and well known for its friendliness to the West in general and to France in particular. I picked it for its unmined, undelineated and possibly undiscovered Permian Coal Reserves. A target, I thought, that should provide a fitting follow-up to my boss Dick Ellett's previous huge success with the Bowen Basin coals of Australia. About a year after we began a series of very slow negotiations with the Madagascar people, the long-time President of Madagascar was assassinated, and the country began a 15- to 20-year experiment with socialism that effectively closed the country's mineral sector to foreign investment. They even had a little red book with the sayings of the new president!

On another occasion, in an effort to try to hurry up the process of negotiation, I got the president of the company (Utah International) to join in directly in support of an Indonesian project. We got him to Jakarta just in time for those great anti-foreign investment, anti-Japanese riots that had the main street of Jakarta, Jalan Tamarin, closed off with burnt out Japanese cars, and that resulted in the closing down of foreign investment in coal exploration for some 10 years. My timing was so faultless I thought of hiring myself out to the United Nations as a

consultant with an uncanny knack of choosing those places most likely to explode!

FIRST PRIZES

To continue with this meat and potatoes adventure, I would like to pass readers quickly along a smorgasbord of the exploration with which I have been connected in the last 40 years. We will take a bite here and there to see if we can safely draw any conclusions about what sensible people should do in terms of mineral exploration from the year 2000 on.

First we have to understand that mineral exploration is a game in which the first prizes far outweigh the others.

Figure 1 Visiting a stream sediment sampling program on Sumba Island, Indonesia, 1997. Foreground, Oliver Warin; backgound, Geoff Woad.

Figure 2 BHP party visiting the Noril'sk magmatic sulphide deposit in Siberia, 1996; Oliver Warin in foreground.

These first prizes get called by various names: World Class Deposits or World Beaters or a practical one that I quite like, Company Makers. Like many of the world's most ecstatic experiences they are difficult to describe or define, but generally speaking if the pleasure persists you know you have found one.

My company — in those days Utah International — was really built as an international mining company by two Company Makers:

- The coking coal deposits of the Bowen Basin in Australia;
- The Escondida porphyry copper deposit in Chile.

What can we say about these two?

- They were both clear-cut geologically based grass roots discoveries.
- They both showed the company as ready to be a lonely first in an exploration area.

Australia and Chile now both seem like thoroughly respectable places in which to explore and mine. But when Utah International first took up leases for coal in the Bowen basin in the early 1960s (Diessel, 1992; O'Brien, 1989), it was one of only a handful of non-Australian companies exploring in Australia, and the only one, as far as I know, exploring for coal. It was essentially a construction company out of Salt Lake City that had tried its hand with some success at mining in North America (less feast or famine than construction) and, having extended its construction activities to Australia, decided to try its hand, or perhaps "chance its arm" would be a more appropriate phrase, at exploration and mining in Australia. The success of the exploration phase was the result of excellent geological prediction by a very able and tenacious Australian geologist, Don King, and the support he got from my mentor, the American Dick Ellett who, as exploration manager, persuaded the company to continue funding this project "at the other end of the earth."

At the time Utah International began its joint-ventured copper exploration in the Atacama Desert of Chile, the Allende years and the memories of the appropriation of the Anaconda and Kennecott mines were still uncomfortably close. Again Utah was able to take up large areas for regional appraisal because so few others were active. The project had

excellent geology provided in the first instance by its initiator, Dr. David Lowell (Lowell, 1988), but eventually Escondida (Figs. 3, 4) was found, in my view, because of the work of a very tenacious Chilean geologist, Dr. Pancho Ortiz, who continued to drill to satisfy his geologically piqued curiosity when caution would have dictated stopping. "La Escondida" according to Thompson (1995) is one of the most important orebodies discovered in the last 20 (now ~25) years; in 1997, Escondida produced 933,000 tonnes of copper, to rank as the single largest copper producer in the world (Richards *et al.*, in press). Again my role, in the year immediately before the find was made in 1981 (Lowell, 1988) was probably to trust and encourage Pancho and ensure that the company continued to fund the project.

So we probably have two pluses (and very, very, very big pluses at that!), for foreign exploration and being brave enough to be the first to venture in. These mines are two Company Makers, but let us not forget that some less profitable mines — some second prizes at the exploration stage — can be very useful as trial runs and places to learn.

The Bowen basin mines benefited from Utah's previous coal mining experience in the western United States, and to a very large extent, the Island Copper Mine on Vancouver Island was where the company mined the people — mostly Canadians, of course — who did so much with the Chileans to make Escondida such a success.

I have already mentioned our ill-timed early attempts to negotiate coal leases in Indonesia. We survived and moved our exploration effort to Sarawak, Borneo, but we had already done sufficient preliminary reconnaissance so that when the embargo was finally lifted (perhaps 10 years later) we were not quite first in but we did know exactly where we wanted to go. Once again an excellent and very tenacious geologist, Dr. Ted Milligan, spearheaded our work. (Sadly, I have to add for those of you who knew him that Ted passed away in the spring of 1999 in Brisbane).

BHP Minerals which, as most of you know, bought Utah International from General Electric just before the development of the Escondida deposit, has perhaps two more potential World Class Deposits, two more First Prizes:

- The lead/zinc/silver deposit at Cannington in Queensland, Australia, and
- The Canadian Diamond joint venture at EKATI™, NWT.

Cannington is an entirely home-grown discovery made by Dr. Cory Williams' BHP team using refined aeromagnetic surveys and new interpretive techniques in shallowly covered areas.

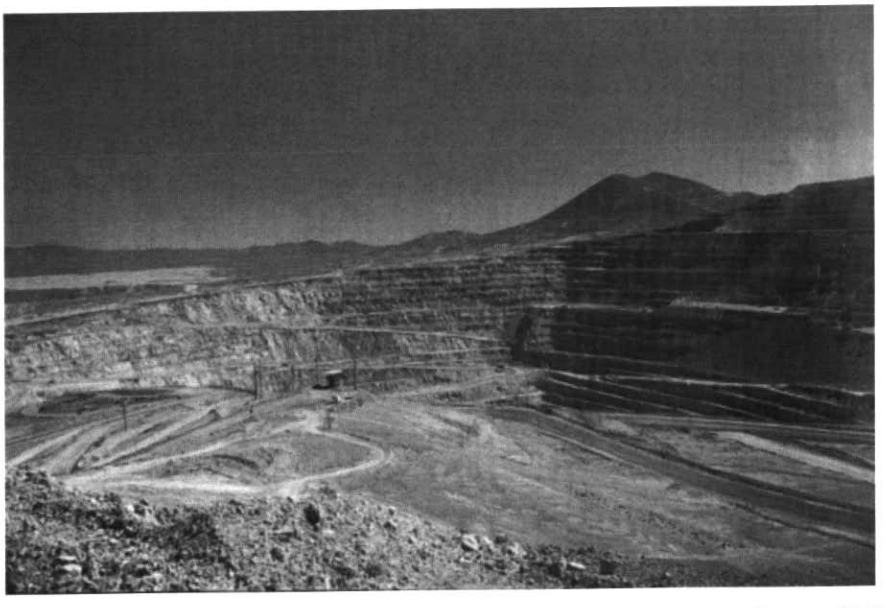

Figure 3 View of BHP Escondida open-pit porphyry copper mine, Atacama Desert, Chile. Escondida is controlled by BHP (57.5%); other partners are Rio Tinto (30%), Mitsubishi (10%), and IFC (2.5%). In 1997, proven and probable reserves stood at 2070 million tonnes of ore averaging 1.28 % copper, a figure that will be substantially increased by the delineation of the new Escondida Norte deposit located 6 km to the north adjacent to the Zaldivar mine (J.P. Richards *et al.*, in press). Zaldivar porphyry copper mine is seen in Figure 4, distance. (photo courtesy of Jeremy Richards).

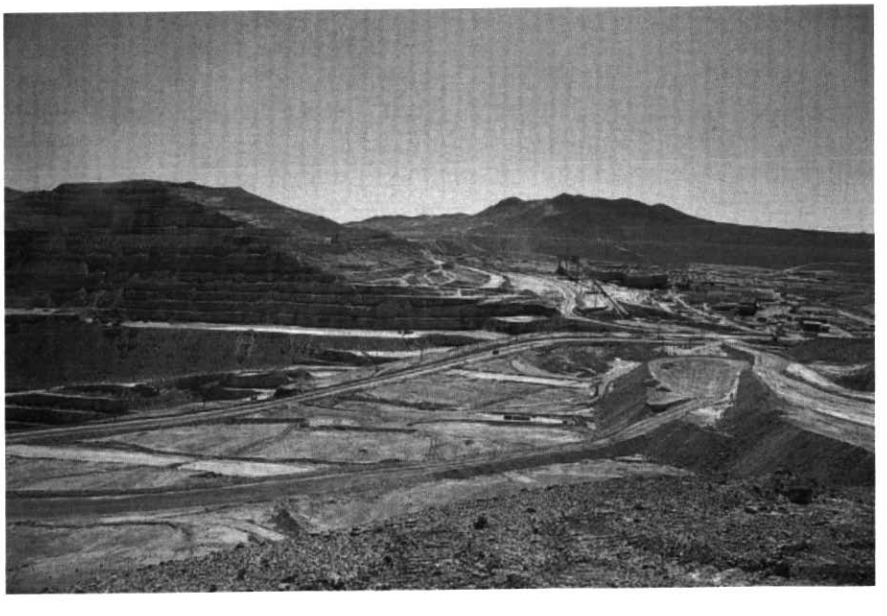

Figure 4 View of BHP Escondida open-pit porphyry copper mine, Atacama Desert, Chile: showing mill buildings in right middle distance, and the location of the Zaldivar prophyry copper mine (100% owned by Placer-Dome by year-end 1999) in the centre far distance (courtesy of Jeremy Richards).

The Canadian Diamonds story is, of course, one that needs no telling to Canadians. It belongs in the home-grown discovery category. It is certainly a story of great geological reasoning and great tenacity on the part particularly of Chuck Fipke and Hugo Dummett, my successor. I, meantime, was cast in the role of the one responsible for keeping the money flowing, even to the extent, in the project's initial year, of robbing other projects over the pained cries of their geologists.

COMMON ELEMENTS

What are the common elements in these successes, and what do they say about the pros and cons of worldwide exploration over the last 40 years, and the likely pros and cons of mineral exploration into the millennium? If I were a statistician I would beg that the sample is too small and, of course, all explorationists will know that beneath the surface of a successful discovery and a successful mine there is a whole complex of choices, knowledge, skill and people that I have not mentioned. But perhaps the one common theme in the exploration phase for all successes is the presence of a tenacious geologist, perhaps a tenacious geologist and a convinced exploration manager doing the non-spectacular work of keeping the money flowing. I think I might further risk the statement that BHP would not have reached the eminence it reached a few years ago, among the world's top three or four mining companies, without a willingness to explore around the world.

But you will notice how carefully this last statement was worded. Many readers will know in detail of the travails BHP Minerals has gone through in the last few years. I cannot wisely comment on the possible reasons for the steep decline in its fortunes. Perhaps I can, unwisely, state that it is interesting that no one seems to be blaming an over-adventurous exploration program for the things that have gone wrong. It may also be worth noting that among the acknowledged financial causes of BHP's travails are:

- The costly overrun on an investment in new technology, with the culprit property located in Western Australia, and
- The copper company whose acquisition is now described as unwise at the price (and by some commentators as maybe a mistake at any price), located in the United States.

So! The Grizzly Bear of Disaster not only stalks a mining company when it ventures away from home, but also can be waiting in the trees right next to the homestead! Dare one suggest that close to home may also be where careless assumptions about financial safety are most likely to be made? So you see that I plead not guilty and remain a totally unrepentant advocate of major exploration programs and a worldwide presence for major mining companies.

SOMETHING WRONG?

But...hold it for a moment! This paper is written for geoscientists, not engineers, not lawyers, and not accountants. Can we geoscientists not honestly admit that the one thing we could have done was to have found one or two, or even three or four more, World Beater deposits sooner? Huge tonnages and high grades are great at covering mistakes! Let's ask some tough questions: Why is mineral exploration so difficult, and why are we all so unsuccessful at it? Will it always be this difficult? Will we always be this unsuccessful? Does one not sometimes get the feeling that mineral exploration is becoming so complicated that maybe we are getting some parts of the story wrong? Are we not ready for a paradigm shift in our understanding of how metal deposits form and how to find them equivalent to the huge shift that plate tectonics created such a comparatively few years ago in general geology?

On a previous occasion, a conference on Applied Geoscience at Warwick University, UK in April 1996, I loudly deplored the move, in the published science of the geology of mineral deposits, toward the safety of description, away from the risky and more testing business of prediction (Richards, 1997). Yet is it not in prediction that the greatest excitements and satisfactions of our business lie? When I was a young geologist we allowed the older fellows the luxury of reliving and re-embroidering their youth as we sat together around campfires. Of course, there were some sly winks and nods passed as we youngsters silently halved the length of the crocodiles and the snakes that had nearly attacked, the fish that had gotten away, and the number and size of the orebodies that the speaker had nearly found. Still, the whole thrust of the conversation was toward prediction and discovery.

And those very first reports that I wrote on the basis of the geological literature available in Melbourne's libraries for our first venture into foreign exploration were not just about the geology; they bravely and brashly purported to describe the mineral potential, the possibilities for discovery, within Oman and Iran. Brave indeed! I have faded yellowing copies of those reports of mine, predicting the possibility of Cyprus-style copper deposits in the mountainous spine of Oman (based on nothing more erudite than similarities of igneous style and placement of the Troodos Complex in Cyprus and the Semail Complex in Oman), of phosphates in the Tertiary sequences in the interior, and of a major belt of porphyry coppers in Iran, even suggesting a specific target near the area that hosted Sar Cheshmeh deposit. All this took place in 1966, essentially before plate tectonics and much of our modern understanding! I am proud of these predictions!

Another part of the problem may be the generally triumphant tone we feel we have to adopt in the papers we present at meetings like the GAC-MAC annual meetings. I sometimes feel like writing a paper with a title like this: "A Program of Porphyry Copper Search in Country X : how to spend a lot of money, use a lot of energy and suffer massive intestinal disruption to find a series of sub-economic porphyries." Why don't I write this paper? Because I, like every true explorer, am optimist and realist enough to believe that there is still that elusive big one out there just waiting to be found. I know full well that in exploration terms we have just scratched the surface!

THE HOW, WHERE, AND WHAT GEOSCIENTISTS

During these 40-something years of involvement with geology and mineral exploration I have found the practitioners, the geologists and explorers, to be as interesting a study as the science itself. Psychologists nowadays have become very interested in those things that we learn

when we are very young: the fears, the pleasures, the things that work, the things that don't, and that get imprinted somewhere near our brain stem and constitute what some call our world view. I am not suggesting that we pick up all our geological prejudices with our mother's milk, though the vehemence with which some points of view are sometimes maintained suggests that it might be so. I am stating that there are ways of looking at the world which, translated into mineral exploration, lead to three broad types of geoscientists, distinguished from each other by basic beliefs and the questions to which they seek answers. They are the How? Where? and What? people. Let's take a quick look at them.

How?

The people who look at an orebody and ask How? are the genetic people. They argue that if you knew how it formed you could easily find the next one. We sometimes suspect they only add that second phrase to justify the money they are asking for, whether it is for a drilling program or a research grant, while what they truly believe is that to find the truth of how it got there is more than adequate justification. For these, dear readers, are the scientific aristocrats of our profession. I feel able to be a little bit hard on them because were it not for the fact that I am the son of a pretty well penniless widowed village school teacher with a necessity forced on me to earn a living I would certainly be one of their number! Like all the world's aristocrats, they have these days fallen on hard times as they struggle to keep up appearances. They have to invite us mere tradesmen round for tea on the good china: they even have to have us stay as paying guests!

Where?

The tradesmen are the people who ask Where? (Fig. 5). They work by association. They want to find places that look the same and feel the same as one of the big ones. They want to see the same lithologies, the same ages, the same structures. They aim for success rather than innovative brilliance; they do not despise the idea that they practice a trade. Their failings, of course, centre on too great an attachment to the familiar, too little willingness to experiment, and the possibility that they, the good, may on occasion turn out to be the enemy of the best.

What?

Then there are the What? people. They ask "what is it made of?" of because they are convinced that a metallic sulphide orebody will be sufficiently different from its surroundings to perturb a magnetic, electric or gravity field, that it will be opaque to some penetrative radiation, or that it will be unstable enough to leak telltale metals up to the surface and betray its presence. They are the difference people, the criminal investigators of our profession. They throw as wide a net as possible, bring in a large number of suspects, and question them systematically, one after the other. They are the ones who proudly tell their exploration manager they have 10 first-rate anomalies and nearly 100 that look too interesting to be dismissed. He, meantime, does a little mental calculation that tells him that this project, which he has had difficulty funding this year, could easily have a life of some 20 years before the last one is tested.

Of course, in reality none of us fits exactly into one of these three categories. We are all a subtle mixture of the three traits. But I venture to suggest that in any successful team you will need a majority of the people who primarily ask Where? They have the best record of discovery at present. But you will need an aristocrat and a criminal investigator or two and, most fundamental of all, you will need an honest understanding of the worth of all, and genuine trust and respect among all of the members of your team if you are to get anything worthwhile from their combination. And, since we are talking primarily about a team for work around the world, you will need people who have the quality that enjoys difference and respects it.

A TIME OF OPPORTUNITY

We have passed the bulk of the smorgasbord, and you will be pleased to know that we are in among the deserts and coffee. I stress again that in my view a company and an individual geoscientist in mineral exploration need to seek what suits them: what they are suited for. No single choice is, thank heaven, right for all. But I think that the major companies need, for success in the millennium, to

Figure 5 Exploring for copper in Nova Scotia, 1996. L-R: Oliver Warin, Ambogo Guindo, Richard Brescianni.

have major programs in different countries and a worldwide watch, the worldwide presence that the new global world so easily makes possible. But it is a wise company and a wise C.E.O who knows what suits them, what is right for them. We are all tired, I am sure, of being told by every C.E.O. that their company is now global because they have opened an office in Moscow.

For the individual geologist, great satisfaction awaits you if you find the opportunity to do that for which you were made. I was, and am, personally very lucky. I was built to explore worldwide! I loved every moment of it, even in some perverse way the intestinal disruptions of country X and elsewhere! For many of the geoscientists I was privileged to lead for so long, a major part of the enjoyment was to be one of a team that was global in its outreach and internally international. We sought to enjoy the differences and, I believe, we can be proud of the fact that we made ourselves in so many ways into the "one by whom others are measured."

There is a major downturn in mineral exploration around the world. In the spring of 1999 BHP Minerals terminated 100 geoscientists worldwide. The reason I had to spend so much time in my hotel room preparing the talk which this paper represents during the Sudbury GAC-MAC meeting is because of the number of e-mailed reference letters I have been tackling from my home.

That side of the coin presents a sombre face; the other side is more appealing. It is that there will soon be a lot of vacant exploration ground. There will soon be governments falling over each other to attract exploration and mineral investment to their domains. It is just the right time for major and medium-sized companies to begin to position themselves!

It would, of course, be completely improper of me to mention that my own voluntary embargo on consulting expires February 2000, so I certainly will not mention that! But there are now a number of good geoscientists, ex-BHP Minerals, out there without positions! Many have rich and varied geological and cultural experience and expertise round the world: I think immediately of one who is fluent in three languages and can make himself understood in half a dozen. Snap them up, industry leaders, and have them read and look at maps for a year until you have the money to send them off adventuring! Meanwhile, I wish you happy and successful exploring!

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