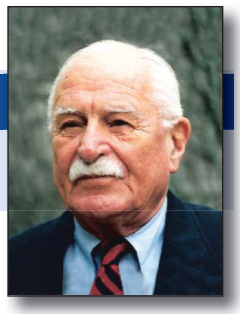
Views columns are the opinions of the authors and do not necessarily reflect the opinions of the SEG

VIEWS

The Ore Finders

An oral history video of Sig Muessig discussing the topic of this article—exploration canons—is available at www.segweb.org/OralHistoryVideos



Siegfried Muessig

(SEG 1957 SF)

An Introduction to Sig Meussig's Exploration Canons

Discovering an orebody is a difficult and challenging task—few seekers of ore succeed. Even fewer succeed in being involved with several world-class discoveries, including one as significant as the giant Escondida copper orebody in Chile. When a person of this caliber takes the time to write down his thoughts on how orebodies can be discovered it is worth taking close note of what is written—even if these thoughts were first publicized 21 years ago.

Dr. Siegfreid (Sig) Muessig is a rare individual, one who in the late 1960s built a company, Getty Exploration, into a much-respected and highly successful discovery team with a formidable reputation as a finder of ore. Sig's thoughts on how to find ore were first made public in 1993, at a talk that he gave to the Denver Regional Exploration Geologists Society. They were subsequently disseminated to a wider exploration audience in the April 1998 issue of the *SEG Newsletter*, where they were presented as 18 Exploration Canons in a Special Feature paper, "The ore finders."

As Sig noted in his 1998 paper, his thoughts were not all original. Many he accumulated over the years from wise individuals who, no doubt, learned the truths contained in these pearls of wisdom the hard way, by trial and error. These thoughts, or canons, represent a collective body of practical knowledge that is as relevant to seekers of ore today as it was to my generation and to previous generations. I have no hesitation in recommending them as wise counsel for all aspiring ore finders, and for this reason, SEG is reprinting Sig's 1998 note as a Views column, with minor edits for current style.

Dan Wood

What makes for success in exploration? Is it money? Is it superior technology? Is it the presence of superior scientists? Is it superior and persistent organizations? All these attributes are desirable and their presence will enhance the chances of success; but we've all seen examples of well-funded, capable organizations that find nothing though they do some of the right things, such as exploring in the trends and using the latest models and technology.

What then are the critical ingredients without which no exploration group is going to make discoveries, except through blind luck or brute force? Much has been written about exploration philosophy, and many colleagues such as Paul Bailly and Stan Holmes have made important contributions to the literature on the subject. For the most part, however, they and others have concentrated on the character of the organization and on the scientific, technological, financial, and political aspects of successful exploration. Indeed, of the "five main ingredients of exploration success" given by Brian Mackenzie, the 1992 Denver Region Exploration Geologists Society (DREGS) Distinguished Lecturer, four are organizational and the other states the one we all put first: superior scientific and technical skills.

To have any chance of success, an exploration effort has to be geologically and economically well conceived, directed, and executed. It has to be well funded, well staffed, organized effectively, and has to assess the political risk in the areas in which it operates, The unit has to have relaxed and open communications, and distinctive and strong leadership. These attributes deal solely with what we might call the front end of the exploration process and involve the scientific, technological, and management aspects of the organization—and there is general agreement as to the importance of these factors. They also involve effectiveness and efficiency, which are laudable characteristics, but do not furnish a real basis for successful exploration.

Very few authors have dealt with the role of the **individual** and his or her desirable characteristics. Those that have talk about "hunger," "motivation," "vigor," "inquisitiveness," "persistence," etc. There is no doubt that these are great qualities, but they are not enough; we have all seen hungry, motivated, and vigorous failures. In what follows, I will concentrate on the behavior, attitudes, and most importantly, the understanding of individuals, as they alone make the decisions leading to discovery. Organizations only set a permissive and favorable climate within which individuals act. Exploration is like research; it is an intellectual activity and it is the **decisions and actions of individuals**, not their organizations, that lead to the discovery hole.

I want to emphasize what we might call the tail end of the exploration process, the operational phase, where the actions and decisions of individuals come into play. It is these actions and decisions that are the added critical ingredients of success. How then can we guide the individuals, be they exploration managers or field geologists? Or, put another way, what philosophy and principles can guide the successful explorer—the ore finder? I propose a set of principles—**the exploration canons**—that should be part of the intellectual equipment of ore finders, actual or wannabe.

The exploration process is moved along the track toward discovery, or failure, by the cumulative actions and decisions made in parallel or in sequence by individuals. Thus, one or more individuals determine the direction of the track. A basic premise is that most decisions are not made by consensus. One needs sound advice, but not a cast of thousands to make operational decisions. Group

to page 18 • • •

...from page 17 VIEWS — The Ore Finders *(continued)*

decisions tend to average out good ideas until they reach mediocrity! If there is to be much of a chance of success, these individuals and their colleagues should be guided by the philosophy expressed and inherent in the proposed principles—the exploration canons.

My thoughts are obviously not all original. As is the case with most of us, I have been exposed over the years to wise individuals, all of whom influenced my thoughts and professional attitudes. Therefore, with thanks to my unnamed mentors, I hope that my thoughts might stimulate discussion and perhaps reduce the time and money needed to find that next orebody.

I want to preface my thoughts with an observation of Charles Park, ". . . getting in close is the art of geology." One obviously needs to know the geology of the area being studied, and of the deposits that occur or may occur there. Be realistic about the geologic permissiveness of the area and develop a realistic model, one that distinguishes observations and facts from inferences and hopes. This aspect of the exploration process—the good science part—is not all that difficult. Many unsuccessful organizations are scientifically sound. **Good science does not necessarily generate or trigger good exploration.** It is what is done with the data that is important. Attention to the proposed canons will improve the odds for discovery.

THE EXPLORATION CANONS

■ **Exploration is not a science.** The aims of exploration are fundamentally at odds with those of science. Science seeks understanding, whereas exploration seeks discovery, by whatever means, with or without understanding. Paraphrasing John Ridge (CIM 1983), the way it gets there is really of no concern in the search for ore. The empirical model is more useful than the generic one. If I had to pick a basic flaw in the philosophical approach of many organizations to exploration, it would be here. Many geologists tend to ignore or disbelieve data and observations simply because they cannot explain them—no scientific cause can be established. As a result, many either walk away or they over-geologize and then walk away. Consider a classic case: the Wegener hypothesis of continental drift was derided primarily because no understandable cause could be developed, so plate tectonics lay "undiscovered" for many years. It follows that one should:

■ **Go with the facts, forget the theory**. If there is a question of genesis vs. empirically derived facts or observations, go with the facts, forget the theory, ignore the model. For example, in a drilling program, when the physical model has been tested, considerations of the genetic model, whether understood or not, should have no bearing on the decision to drop or continue.

Let me illustrate my experience at Escondida. The alteration pattern at Escondida fit the classic halo of the porphyry copper model and five holes drilled through alluvial cover in the most "prospective" area were all blank. A secondary target did not fit the model, but was drilled because of the favorable appearance of the leached capping and the presence of a coincident geochemical anomaly. The first hole hit the orebody.

■ **Try for the definitive test.** An absolute essential of the "exploration kit" should be the concept of the "definitive test." One should constantly strive to test the target with the drill as soon as possible. If the test is negative, walk away, unless new ideas or data from the drilling justify further work. Too many geologists become victims of excessive scientific arguments and do more work, even though the target could have been adequately tested relatively quickly with the drill. Sometimes it costs more to reduce risk than to take it by drilling.

■ **The odds are best in the shadow of the head frame.** This obvious, important principle reflects the fact that ore-forming processes tend to occur as multiple events and produce multiple deposits in favorable geologic settings. This is not to say there cannot be isolated deposits such as Bingham, or the cryolite at Ivigtut, or the Kramer borax deposit. However, since deposits do tend to occur in clusters, the odds are improved by exploring in or close to mineral districts, the identified mineral trends, or the extensions of trends. Some groups tend to shy away from expensive district or trend land plays, preferring to go where ground is cheaper. But remember, where land is cheap, it's cheap!

■ **Save the agonizing for mineralized trends.** Generally speaking, in areas without mines or prospects ("virgin" areas), unless early drilling of targets gets results, it is better to walk away. However, even negative results can lead to meaningful reassessment of the prospect, especially of geophysical or geochemical anomalies. From this might emerge a quite different interpretation or a new set of drill targets. This may be especially true in deeply weathered terrain or in the search for the deep blind orebodies.

■ **Look for ore, not mineralization.** Mineralization furnishes clues, and in the early stages of exploration, mineralization (alteration) may lead to ore, but at the target stage, you should be looking for ore. An important corollary is:

■ **To find an orebody, you have to drill ore holes.** This may seem to be stating the obvious, but each of us knows of deposits that have been overdrilled in the vain hope of improving the grade. Mineral deposits, by definition, need to have continuity and grade to become orebodies. It follows, that if an "ore hole" cannot be offset by others, there probably is no orebody there. Continued drilling usually results in finding more mineralization or alteration, neither of which can be put through the mill.

■ **There needs to be room for the ore.** This is such an obvious principle that is often ignored when drilling out a deposit. Is there actually room for the tonnage needed to make an ore body, or are there structural, stratigraphic, or other constraints on the necessary space? The more known about the detailed geology of the prospective area, the less attention should be paid to the model and the more given to this principle.

■ **Improve it or drop it.** Unless a property is improved, generally, at each stage of exploration, you should walk away, especially in virgin territory.

■ **Do not chase spurious anomalies.** Unless the model or other knowledge of the local geology account for an unexpected anomaly, either geophysical or geochemical, disregard it and continue with the program at hand.

■ **Do not be preoccupied with explaining anomalies.** If the drill hole or other evidence has tested the

anomaly and there is no evidence of an orebody, walk away, even though the anomaly is not explained. If, however, in the geologic environment being explored there is strong correlation between certain kinds of anomalies and ore, or conditions that are guides to ore, then perhaps more effort should go into trying to explain the anomalies. The key here is that the anomaly itself is tested. If it is blank, it's best to walk away.

■ **Do not be preoccupied with pathfinders.** Generally speaking, the metal sought is its own best pathfinder. Some groups are enamored of expensive multi-element surveys, but John Prochnau claims that he has never seen a gold discovery in which indirect evidence—geochemistry or geophysics—played the principal role. Some use arsenic as a pathfinder for gold, claiming that its halo is larger than that of gold and therefore sampling can have a lower density. I am not convinced.

■ **Do not be preoccupied with stereotyped concepts**. Avoid overemphasis of such qualities as "ground preparation," "leakage," and yes, structural control, unless they can be clearly correlated with the occurrence of ore in the geologic setting or district being explored. These factors should not override the significance of ore intercepts or other favorable drill-hole or sample results. For years the conventional wisdom in the Republic district, Washington, was that pyroclastic rocks were poor ore hosts; when the drill hit pyroclastic rocks, the hole was stopped. As a consequence, the three ore intercepts of the Golden Promise vein system, drilled in pyroclastic rocks in 1963, were ignored for over 20 years, until further work showed that veins in pyroclastics do "make ore."

■ **Do not be technology driven.** Some organizations fall in love with a given geophysical method, with geophysics itself, or with other indirect methods, such as satellite imagery, and overuse them, when more direct, simpler methods, such as mapping, sampling, and drilling will give faster, cheaper, and more definitive results.

■ **Acquire first, study later.** It is amazing how this basic principle is so often ignored. When a discovery is made and the land play is on, some groups insist on taking samples or doing other work before making a commitment. As a consequence, they arc commonly left with fringe acreage or a competitor gets the deal.

■ **Disregard competitor's previous actions.** Do not base exploration strategy on your supposition of the reasons behind a competitor's previous action in the area you're exploring. If the available data compel you to a course of action, take up the ground and plan a series of drill holes; do not be swayed by imagined scenarios of why a previous holder dropped the ground.

■ **Go for the jugular.** If you have faith in your geology and judgment of the potential of an area, do not take halfway cheap measures; take the bold strokes that make for discovery, rather than nibbling away at the data.

■ **It's the drill hole, stupid!** The geologist cannot substitute his wisdom and cleverness for the drill hole. The problem here is that the scientist believes in the power of the scientific method: more work, more data ought to do the job. And, therefore more work is done because it "offends" many geologists (scientists) to just drill a hole without understanding the geology. On the other hand, there are those who believe that many prospects can be tested by indirect geophysical means. One geologist on a project with which I was associated once said (and believed!), "... but we ought to be able to model the anomalies and test them without drilling." Not so!

The authors of "In Search of Excellence" found that the difference between successful and unsuccessful exploration companies is a dramatic difference in the amount of diamond drilling they do. Although diamond or other drilling looks expensive, it is really the only way to find out what is down there.

IQ gets you there, but NQ finds it!