cause of the nature of the speciality in which the student is majoring—forestry, geology, geography—and because he has been given an introduction to photogrammetry, to the properties of the photo and to a little of photo interpretation. I belong to the school of thought that believes a geologist can be translated into a military photo interpreter in a much simpler way than is possible for an intelligent GI who does not have a background in the earth sciences.

MR. DAVID VANCE (United States Army in the Department of Training Publication at Fort Belvoir): We have been looking for a P.I. key for the Army. I should like the opinion of Professor Cheney and of Doctor Belcher on the scope on what such a manual should be and whether one could be constructed that would be sufficiently complete and yet sufficiently portable for field units. That's our main problem.

MR. BELCHER: My reaction is that this matter is so complex that now is not the proper time for adequate discussion.

MR. COLEMAN (Navy Photo Interpretation Center): For a long time we have been seeking satisfactory definitions as related to photo interpretation. Also photo reading. We now add photo-analysis. I suggest that since those at Cornell and Professor Cheney have very definite thoughts on this subject and these definitions, a written proposal could be prepared by them and then considered by the Society, and possibly incorporated in future editions of the MANUAL.

*Economic Aspects of Aerial Exploration**

NORMAN VINCENT, *President, International Mining and Development Co., Canada*

ABSTRACT: *Aerial exploration accommodates itself to economical, efficient exploration of large concessions. For example; the million-acre concession held by Minex in Cape Breton.*

Savings are made in: staking and registering, retention of favorable ground, elimination of duplication of service, and time and dollars from speedy elimination of unpromising ground.

The odds for successful development bear a ratio to the largeness of the area explored.

Large concessions, large financing, enable Minex to employ the best brains and techniques, which are often beyond the budgets of small companies.

The efficiency of large-scale methods is recognized by oil companies. Minex has proved the efficiency and economy of its methods and is committed to large-scale techniques and the acquisition of large concessions.

THE mining industry is now attacking vaster projects than were ever attempted before, and the application of the old adage that "Time Is Money" has turned the attention of our industry to a basic problem: "How fast can we efficiently explore ground?" For many companies the answer to the question of money, space and time is aerial exploration. I will describe how two mining companies of which I am president have demonstrated the economic aspects of aerial exploration.

The mineral exploration corporation for three years has been carrying on a large-scale program of exploration on its one million acre concession covering the entire northern half of Cape Breton Island in the province of Nova Scotia. This concession is probably one of the largest blocks

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of potential mineralized ground ever to be intensively prospected by a Canadian mining company which set out to assess all development possibilities, overlooking no mineral.

The average size of claim groups held by individual prospectors or exploration companies in Canada is from 500 to 1,000 acres. The concession that Minex holds is roughly 1,000 times greater than the normal group.

The first economy we effected was through eliminating the time and cost of acquiring ground during the exploration stage. To stake one million acres of ground would take months and cost at least $625,000; with the inclusion of transportation and all other cost factors, the staking of claims costs at least $25 per claim or $1,250 to $2,500 per group. This figure is used only for cost comparison since other factors would make the complete staking of a million-acre block almost impossible. But with the methods of aerial exploration—magnetic and scintillometer surveys, and photo-analysis—Minex could pin-point its activity to the most promising localities of the vast concession. The company saved valuable time, and avoided an expenditure of $625,000 while locating its best prospects for development.

To hold ground acquired by staking, the costs in Quebec are $1 per acre per year; in most other provinces 25 days of development work are required for each 40 acres, with a cost of $6 per acre. Therefore the annual minimum expense to retain a million acres for exploration would be a round and prohibitive one million dollars—if no development work had to be done. If development work were required by the authorities, the cost of holding the ground would be an astronomical *six million dollars*. However, Minex did not have to pay anything or spend anything after it performed its first obligation (for tenure of the concession) to perform an aerial magnetic and scintillometer survey; this survey was made at a cost of $70,000. If initial aerial and ground work on such a block indicated that the chances for economic ore deposits were negligible, the project could have been dropped after the expenditure of approximately $150,000—this represents a saving of $475,000, with the amount actually spent being less than one quarter of the cost of staking alone.

At this point of the discussion, Minex has saved a lot of money. Perhaps you are wondering "What has it accomplished by using aerial exploration?" The answer to this question leads to showing further economy. Minex to date has made two important discoveries of zinc and copper, and is concentrating on 25 other "potentially mineralized areas," located by air photo-analysis and other aerial methods. The company has outlined 3 million tons of low-grade zinc ore. In accomplishing this localizing of its activity at a minimum cost, Minex obtained a good idea of the geology and general structural conditions over the entire concession, and the original million acres have been cut down to 100,000 acres favorable to the occurrence of mineral deposits. With this more limited objective, the company could move to actual intensive exploration.

When one considers antiquated methods of exploring an area equivalent to a million acres which would be employed by hundreds of small companies or individuals, the relative cost efficiency of aerial exploration by one company is even more strongly demonstrated. The duplication of services is immensely wasteful for a number of small areas. The average small-claim group under exploration or development will require the services of a mining engineer, geologist or experienced prospector, plus a handful of prospectors, diamond drillers, bushmen or linecutters, and other personnel. These personnel must be paid, transported, housed and fed. The amount of time and money consumed by hundreds of individual operations adds up to a staggering total of dollars.

To explore a smallish group utilizing some of the modern techniques—such as geo-physical and diamond drilling—the cost would range from $10,000 to $100,000. Taking the lower figure, an expenditure of ten million dollars would be required to explore a thousand small groups totaling a million acres in area. Minex, with its initial aerial exploration, in three years of systematic, uniform, efficient work, covered its million acres at a cost of only $500,000—a fraction of the amount which would have been required by a number of smaller operations covering the same area.

Minex's exploration cost only 25 cents per acre; the absolute minimum cost for smaller operations would be $10 per acre. The cost per acre of Minex's ground with

good mineral possibilities is increased by a ten-to-one factor, or, in dollars and cents $2.50 per acre, since the original million acreage has been cut to the 100,000 acres of favorable ground which eventually yielded favorable results.

Minex's experience shows that there are five important factors which can be assessed closely to show real economies

(1) in the staking and registering of mining claims,
(2) in the retention of such ground,
(3) in the elimination of duplication of services and personnel,
(4) in the elimination of unfavorable ground,
(5) the employment of the most able and efficient of the technical personnel.

But these are not the only savings which can be effected. Other factors cannot be expressed so concretely in dollars and cents, but they have a tremendous bearing on mining development.

How about the odds? In this case, with a million acres in one block showing the proper geology, sheer bigness gives a better chance of discovering something of commercial value. It is more than a chance; it is a likelihood. Aerial exploration enabled Minex to bite off this huge chunk of Cape Breton; this would have proved indigestible to any mining development company without the use of aerial techniques. We got four to one more chances per dollar spent; and the results have not been, by any means, negligible, although much remains to be done.

Another variable which favors aerial exploration is time. Vast mineral concessions are not given to mining companies for eternity by the authorities governing development of natural resources. Although this factor is difficult to show as an economic feature, time is really money to mining companies with large concessions.

The savings obtained by mass exploration techniques, based on aerial exploration and photo analysis, is not realized by many mining men or laymen. The sheer efficiency is an important saving factor. All modern geophysical methods can be employed and directed to maximum effectiveness when large areas are involved. The money which is spent can be effectively directed towards actually finding ore. This added efficiency multiplies the mathematical chances, in favor of a company using aerial methods, by an indeterminate but large factor, raising the odds possibly as high as 40 to 1.

So far we have been concerned primarily with the superiority of aerial exploration over conventional but out-dated methods. We have not mentioned that there are conditions under which aerial exploration is the only practical method. This often occurs where companies are operating in underdeveloped countries.

As the President of International Mining and Development Corp. I met this difficulty in the affairs of a subsidiary, the Dutch Guiana Minerals Corporation, which is now operating on a 40,000 acre mercury concession in the Hinterland of Surinam. Our property had never been mapped; access to it was by long river trips; and this access was barred at times by bad water conditions. Although the reports of various engineers were encouraging and some sampling had taken place, most of the old workings were overgrown, and even the course of some streams had been altered since the last map-making. By enlisting the photo-analysis experts of Donald J. Belcher and Associates of Ithaca, New York, we soon had maps showing the general geology, the location of the old workings and trails, the locations of alluviates favorable to gold content. We were then able to establish a heliport. When this property requires further extra personnel and heavy equipment. We will bring it in by air—to save time and money. Further aerial surveys will probably be made, and we may employ services to locate a dam-site to provide water and power for our operation. To perform these tasks by ground parties, over difficult terrain in the jungle would prove slow, costly and inefficient.

Another attractive aspect of aerial exploration over a large concession is the efficiency which results from the ability of a large company, with large finances to hire the best brains, use the most applicable and advanced techniques, and to pursue our own course in development.

From our experiences with aerial exploration in Cape Breton and Dutch Guiana, through the operations of Minex and International, I have come to the conclusion that the future of metal supplies for an expanding world economy lies in the acquisition of large concessions and the

employment of all aerial exploration methods.

We are committed to the principles of aerial exploration because of its economic effects on our problems of money, space and time in the discovery and development of minerals. Briefly: It pays.

In closing I should like to point out that while my remarks apply only to the search for metals, the oil industry has not been backward in using advanced techniques of exploration.

DISCUSSION OF MR. VINCENT'S PAPER

MR. BELCHER: The points you have brought out, especially the consumer standpoint of photo interpretation, are of value and interest to all here.

MR. ELLIOT (Photogeologist of Wyoming): How many photo analysts or photo interpretors did you use in your recent project and what percentage of your exploration program depends upon or uses the interpreter as a worker?

MR. VINCENT: We employed an outside firm of experts. Because we had not used photo analysis ourselves, we contracted the work to experts.

MR. HARGRAVES (Beach Erosion Board): What was the relative value or importance of aerial photography as against aerial geophysical methods in your survey?

MR. VINCENT: Each party that goes in the field is given an aerial photograph which covers the area it has to explore. Marked on it are features such as faults and structures and topographical features. For instance, take Cape Breton which is a very difficult area to explore because extremely hilly with sharp ascents and descents. On the photographs we first of all mark the areas that our geophysical flying and our photo analysis indicate to be the most favorable. The field party goes to those first. The instructions are to follow stream beds, if any, testing the water along the route, and also to go to any existing outcrops and bring back samples.

MR. HARGRAVES: In making the reduction from a million to a hundred thousand acres, what was the importance of the aerial geophysics in the preliminary reduction? Could not straight photography alone have been used?

MR. VINCENT: Yes, but only after going on the ground and checking the information we obtained from the air.

*Correlations between Man's Activity and His Environment which May Be Analyzed by Photo Interpretation**

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ABSTRACT: *There are many correlations which can be made between man's activity and his physical environment. These relationships are also influenced by economic, political and social factors. Man's activities may be interpreted on air photos and related to major terrain classes within geographic regions. These correlations help in deducing activities which may be only partially visible at small scales. They may even help in the interpretation of very small-scale photos taken from missiles or earth satellites. In the race for technical superiority we are in danger of being left behind in this neglected field.*

THERE are many correlations which may be made between man's activities and his environment. Man regards himself as a free agent, but even in the air age he is restricted in his actions by the conformation of the earth around him. For example,

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