FUTURE PROSPECTS FOR EXPLORATION GEOPHYSICS

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It seems most appropriate that the first Technical Journal of the Canadian Society of Exploration Geophysicists should be published on this the 15th Anniversary Year of the Society. The past fifteen years have been productive in many ways in spite of the general downward trend of the overall activity. It appears that this downward trend in operational activity has now levelled out and an upward reversal may be forthcoming as far as the future prospects are concerned. This is without regard to the extremely sharp seasonal fluctuations which are such a hazard to the economics of operations and to the training programs for future personnel requirements. It is feared that these seasonal depressions may remain for sometime to come. Nevertheless it seems timely to observe that the state of the industry and future outlook appears brighter today than in the past few years.

Of course the future prospects for Exploration Geophysics are dependent upon the continued demand for petroleum products and the entire oil industry seems to agree that over the next twenty-five years the demand for crude will grow at a very rapid pace. For example, in Canada, the present production level is at about 850,000 barrels per day. In twenty-five years, it is estimated, this daily rate will increase to over two and one half million barrels per day (about three times the present rate of consumption). This will amount to almost a billion barrels per year just to stay even and maintain our current comfortable margin of approximately twelve years supply.

It is estimated that in twenty-five years the total demand throughout the free world will reach one hundred million barrels per day. From these figures it is certainly obvious that we can safely forecast a great and continuing increase in the demand for petroleum products. Finding such reserves shall be a most extraordinary challenge to the exploration industry. The geophysical division of the industry, in particular, will be called upon to play an ever increasing role.

Lets consider how and where the required reserves will be found. A small portion of the reserves will be provided from presently productive areas through improved production techniques and practices. The majority of the reserves will be found by the improved exploration techniques in the deeper horizons of the presently so called explored areas. Some of the reserves will come from the unexplored continental shelf and remote areas such as the Arctic. Also, some will come from production of synthetic crudes such as the Tar Sands of Alberta and Oil Shales of Colorado.

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First lets dispel the thought that synthetic production will supplant conventional crude. While it will supply some portion of future requirements, it will only supplant the conventional production because of the economic, political and technological considerations. The Tar Sands processing techniques are approaching a stage whereby a profit position can be realized, however, it is far from being as attractive from an investment point of view as is the conventional industry. Also, at the present rate of progress in the development of sand handling equipment, it will take years and years to complete the facilities adequate to even come close to meeting present day production.

Geographically, we can expect a considerable increase in geophysical exploration in offshore areas throughout the world. It is surprising to note that in Canada alone there is as much offshore exploration acreage held by oil companies as there is onshore acreage, approximately 155 million acres in each case. This offshore acreage is situated off the east and west coasts of Canada and within the great Hudson Bay. It has been predicted that we will soon be drilling in water over 2,000 feet in depth. This will be accomplished by using remotely controlled robots in conjunction with closed circuit T.V. viewers to make sea floor connections and to carry out other mechanical operations of drilling and producing. Recently, we have already seen the volume of offshore exploration increase considerably. Over the period of one year the number of deep water seismic crews has doubled. Future prospects for the heretofore unexplored areas situated on land are just as unlimited.

Technically, we must look to deeper horizons for a great percentage of our future reserves. Definite strides have recently been made in deeper seismic mapping through the use of common depth point (horizontal stacking) methods. This technique has proved to be quite successful in the elimination of noise and in the suppression of multiple reflected events. The success of the method reopens all of the Gulf Coast and the Gulf of Mexico as future prospective regions for seismic exploration at depths greater than previously considered possible. Future prospects for mapping deeper features are certainly not limited to these areas and can be extended to all of the deeper basins of the world.

In the past some success in stratigraphic exploration has been experienced through careful study of very detailed isochron data and through amplitude ratio and phase analysis. This success will be greatly increased in the future. In fact it should be stated that while progress has been made in stratigraphic exploration utilizing the seismograph, there remains much to be accomplished in the future through the full use of both analog and digital methods.

Our most advanced and sophisticated systems for gathering and processing seismic data, which have found wide application and acceptance, have been developed over the past six or seven years. Falling into this category are modern magnetic field recorders (both with and without program gain control units), cen-

tral magnetic replay equipment, Vibroseis, * Dinoseis ** *and the digital* systems.

The primary objective in the development of this equipment has of course been data enchancement through reflection quality improvement, elimination of the effects of differential weathering, elevation and normal moveout removal, cancellation of random and organized noise, ghost and multiple reflection removal. These factors along with signal absorbtion problems within the earth have extensively contributed to the poor results encountered in some areas.

In routine operations, both the Vibroseis and the Dinoseis systems have been quite successful in the elimination of noise and ghost events. They can also be easily employed in the C.D.P. method due to their versatility of signal placement. The main advantage of these two systems is the tremendous effort (multiplicity of input signals and receiving positions) that can be economically expanded in the interest of quality. The Vibroseis system has an additional advantage in its ability to control the amplitude and the frequency of the input signal.

Digital field recording and analog field digital conversion techniques are currently in rapid advancement stages. Already the digital system has met with considerable success in the removal of reverberations (ringing) so prevalent in offshore geophysical operations; in the removal of ghost reflections and organized noise; and in various types of digital filtering. Eventually the horizontal stacking procedure may be accomplished more economically through digital means. Programs for the elimination of multiple reflections can be developed, however, it is currently believed that in most cases this can more effectively be done at the source with the use of the C.D.P. method. The necessity of obtaining the best possible field data prior to analog and/or digital processing cannot be over emphasized.

The resultant possibilities of having the seismic data in digitized form will be endless. Due to the high process speed, so many more researches and analyses can be performed. Numerous studies of relative amplitude of reflections can be accomplished which will provide leads to the presence of reefs and sand bodies. In fact, it is quite reasonable to predict that improved instrumentation and better utilization of present instrumentation will permit better lithological definition for more detailed studies and location of stratigraphical traps. It is also reasonable to assume that an inverse filter designed to correct for the filtering effects of the earth and of the seismic amplifier will soon be developed for practical use. This will allow the preparation of logs (similar to the continuous velocity logs) from the field data and thus will provide a more direct correlation tool, permitting the correlation of velocity breaks instead of the character of the ellusive wavelet.

It is quite possible that eventually all seismic source signals, probably of the controlled frequency and amplitude type, for all field recording systems will be

* Trade Mark for Continental Oil Company

** Trade Mark for Sinclair Research, Inc.

initiated at the surface. This is because certain frequencies can be emphasized at the source so as to increase the over-all dynamic range of the entire system and also because too little is known about what actually happens in the immediate vicinity of the dynamite explosion in the shot hole. Control of the input signal will be essential for the "ultimate" in digital processing and analysis. Research has made very little progress concerning the actual physical reaction in the vicinity of the explosion. We do know, however, that a delay occurs before the "spike" impulse from the explosion is transformed into a wavelet which travels at the velocity of the surrounding material. The magnitude of this delay depends upon the size of the explosion and the physical properties of the surrounding media. It seems logical, since adequate means of handling the problems of differential weathering have been developed, to eliminate this variable through the use of the input signal control at the surface. This consideration, of course, has been the primary reason for the drilling of shot holes.

With reference to future equipment design, it is believed that the geophysical industry has reached a degree of technical excellence which shall dictate that such design be based upon technical goals rather than upon planned obsolescence.

Contrary to what the layman might believe, automation in the geophysical industry has not resulted in a reduction of trained personnel requirements. Just the reverse is true. The more sophisticated the approach and the electronic tools become the more we can accomplish; therefore, the greater becomes the need for more and more qualified geophysicists.

It is in this connection, that we urge educational institutions to assist us in attracting and providing geophysicists for the future. Because of the many new tools being adapted for use in the exploration industry (for geologist as well as the geophysicist), particularly the high speed digital computer, both the future geophysicist and the geologist will require a solid background in mathematics and physics as well as in statistical analysis, communications theory and in electronics. Due to the rapidly expanding technology, the roll of the specialized expert becomes more and more eminent; however, it is of the utmost importance for the "explorationist", regardless of his field of specialization, to have a firm understanding of the specialties and basic objectives of his exploration associates. Due to the rapid technical advancements mentioned, it would not have been possible to forecast these requirements as recently as five years ago.

It is well understood that the life of the exploration geophysicist is most interesting, never boring or mundane, with new adventures constantly occuring in his path. We must make this fact known to more potential students in the field of earth sciences.

Ours is a great industry with a tremendous future. The geophysicist of tomorrow will rise to meet the challenge to provide the future petroleum production requirements, however, to meet this challenge the utmost in co-operation and effort will be required.