

## *Editorial*

### TRAINING GEOPHYSICISTS FOR THE FUTURE

In several countries the training of geophysicists in the universities is at this time a point of detailed discussions. This may imply that there is still a greater or lesser degree of flexibility in the way in which this training is organized. If this is true, there are a few points which might be worth serious consideration.

The amount of scientific literature in the earth sciences has increased enormously over the past few decades. Now well over a million printed pages of geoscientific literature are being published annually. No one can read all of this or even a fair proportion of it. This makes a selection necessary, which is more effective in the short run, but also easily leads towards a narrowing of vision. Because one is concerned for such a large part of the day with his own field of specialization, one is very easily inclined to overestimate its importance. This attitude can be found also with several geophysicists. While writing for an audience of geophysicists now, this may be a good place to bring this to the fore.

From time to time passionate geophysicists declare that the future of the earth sciences lies with them and not with the geologists. Geology, they state, is becoming an antiquated science. With the aid of geophysics, modern scientists can look right across the earth layers. Why then is it necessary to go out into the field with a tent, a hammer, a map, and a notebook? It is now a waste of time since geophysics works faster and more accurately. Just as there are dead languages, there will also be dead branches of science in the future when the relevant principles are known and nothing new is left to be discovered.

First of all, it may be questioned whether these prophets, in all consciousness, believe what they themselves say. Secondly, one of the great rediscoveries of our times is the concept of the unity of science. It is increasingly realized that no one specialized branch of research can exist by itself and that information from many sides needs to be brought together to produce a modern picture of our earth. Thirdly, an attitude as sketched above reflects one's own limited vision and a lack of scientific good-fellowship.

Rather than geology, it is the overrating of one's own field of scientific specialization, be it geophysics or any other branch, that is becoming out-of-date.

As a first conclusion, therefore, one of the aspects to be considered in the training of geophysicists is the cultivation of a general, rather than a very specialized interest in earth science. A general understanding of other specialties in the fields of the geo-sciences and an appreciation of their particular merits will bear its fruits in a more outbalanced development of geophysics and an easier achievement of the highly desirable team work between earth scientists of various backgrounds and specializations.

The importance of team work can be illustrated by two facts. First, it appeared that the percentage of manuscripts with multiple authorship which are turned down for publication in a group of international journals is distinctly lower than the percentage for manuscripts with single authorship. Secondly, when a random group of readers was asked to express their appreciation for the various papers actually published in these journals by means of a numerical system, it appeared that the average appreciation for the papers under multiple authorship was higher. Both facts are indicative for a further stimulation of team work.

Another point is that with the continuing trend for team work in the foreseeable future, groups of several scientists will be at work to solve scientific problems. Not only researchers will then be needed but also good team leaders and scientific documentalists. In the past, the merits of a scientist have been rather one-sidedly qualified as the degree in which he was a success as a scientific investigator. Other kinds of human activity which need to be carried out by trained earth scientists were often considered to be of a lower rank. This will certainly have to change as well in the years ahead. Other capabilities than research capacities will be greatly needed as well and consequently will also have to be developed and stimulated while training young scientists.

The team leaders of the future will need to have manager's abilities. They must be able to see the various aspects of the problem to be studied, to assemble the group of scientists needed to solve these, and to guide and stimulate them; further they need to be trained to prepare well-written reports which are readable also by non-scientific managers, to clearly formulate conclusions and suggestions for further action and to understand the position of the work of their team within a general framework of activities of a company or a scientific institution.

As far as scientific documentation is concerned it is downright astonishing how little attention both scientific institutions and industries have thus far paid to the efficiency of their libraries and the accessibility of their stored knowledge. The subject of documentation is neglected almost completely in both teaching and the composition of a scientific staff. The time when each student and researcher could easily find his way in the available amounts of recorded scientific knowledge has, however, definitely passed. In the present stage of dynamic production of scientific literature, it is absolutely impossible for any scientist to keep abreast of these developments solely under his own power. Assistance is needed to make selections

and to establish pathways for direct or future use of available information. Any institute or company which fails to supply its staff with well-trained documentalists is bound to fall off in both the quantity and quality of the work it is doing.

May the above remarks be of use to those nominated to study the training of geophysicists. Students need to be trained not only for today but also for the future. When the students of today retire from their profession, the calendar will have passed the year 2,000. The question will more and more be what teachers gave them; not for the nineteen-sixties, but for the seventies, eighties and nineties. Much of what is being taught today or tomorrow will by then have been proven to be either superfluous or insufficient. Teachers can be forgiven for not having prepared students for developments which could not be foreseen. However, they will be seriously criticized, and correctly so, if they do not recognize the first signs of future needs and trends, or, even worse, if they do not wish to accept and evaluate new directions when they first appear.

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