MARINE GEOCHEMICAL EXPLORATION

JOHN S. TOOMS[1])

Marine mineral deposits of economic potential or possible future economic potential can be divided into broad categories presenting different exploration problems. Excluding petroleum products, these are (a) industrial minerals such as calcium carbonate and sand and gravel, (b) detrital heavy minerals and bedrock deposits, (c) authigenic minerals on the continental shelf and slope (e.g. phosphorite and glauconite), (d) precipitates associated with ore bearing solutions erupting onto the sea floor and (e) manganese/iron nodules on the deep ocean floor. Economically exploitable sand and gravel deposits are known to exist and are being worked in many locations on the continental shelves and do not normally present a prospecting problem of any appreciable magnitude at this time. Furthermore, this represents the one category of deposit which it is most doubtful whether geochemical methods can make a significant contribution to prospecting procedures.

There is little doubt that, as on land, geochemistry will be a major tool both in exploring for most other types of mineral deposits and in assessing their potential when found. It should be emphasized, however, that particularly in the marine environment, geochemical prospecting methods to be fully productive must be integrated with geophysical and geological techniques.

Detrital heavy mineral deposits, present in the marine sediments as a result of previous weathering of bedrock ores, as well as the bedrock source can be located by detection of the dispersion aureole which is normally of much greater extent than the economically exploitable deposit. However, in determining the existence of such aureoles consideration must be given to the mode of transportation of heavy minerals relative to the associated lighter (generally quartz) fraction. Results are normally expressed, therefore, in terms of hydraulic equivalents. However, in assessing the results, allowance must be made for other complicating factors such as the threshold particle movement velocity.

True marine heavy mineral placers (i.e. formed by the concentration of minerals derived from rivers) and drowned beach deposits can be located in some instances by similar or by the use of associated minerals or elements. For example, the radioactivity of rutile, monazite, zircon deposits could be used in prospecting for these deposits.

Submarine outcrops of phosphorites and accumulations of detrital phosphorite are, at least in those areas studied, associated with broad zones of anomalously phosphatic rich sediments. Because of the association of uranium with these old phosphorites an approximate estimate of grade can be made by measuring the radioactivity and preliminary trials of underwater scintillometers have been sufficiently encouraging to justify the construction of a continuous telemetering towed scintillometer which will be used during 1971.

The existence of metalliferous (Fe, Mn, Zn, Cu) sediments, such as those discovered by chance in the central part of the Red Sea off Jeddah, can be detected by broad scale regional sampling of the sediments. In the sediment of the Red Sea outside the median valley there is an increase in the trace metal concentration towards deeper water. This is probably

[1]) Royal School of Mines, London.

the result of dispersion through the sea water of the elements present in the hot brines from which the metalliferous sediments were precipitated. On present data it would appear probable that the existence of an individual deposit in the median valley might be forecast from a grid of sediment samples with a lineal spacing of 10 to 20 miles. Currently forming deposits might be located by, in the first instance, wider spaced water sampling. Results being obtained in the Red Sea may well be of application to the search for "blind" deposits on land as well as to the detection of similar occurrences within the sediments of other seas.

Knowledge of the possible economic potential of manganese/iron nodules has largely arisen due to geochemical studies. Furthermore, evidence of the factors controlling the variations in composition is gradually being built up as a result of continuing geochemical research. The role of geochemistry in exploration for workable nodule deposits will most probably be (a) the selection of areas and (b) assessment of the potential of deposits disclosed by camera or closed circuit T.V. surveys.

Little has been published on the application of geochemistry to prospecting for oil and gas beneath the oceans but there are indications that as on land, geochemistry could, under certain circumstances, be a useful tool in integrated exploration.

Marine geochemical exploration is at a very early stage of development although it is already apparent that it has a worthwhile role to play in the search for economic mineral deposits beneath the seas. Future developments will almost certainly include a greater use of serial sampling and in situ analyse as well as remote sensing equipment. Preliminary geochemical exploration at sea for some types of deposits may in future be largely confined to estimating the contents of volatiles in the air and determining element content variations in seawater with marine sediment sampling largely limited to the final exploration stages. For other types of minerals it is probable that surface sediment sampling and coring will always remain an essential aspect of all stages of exploration.

Discussions

G.H. Friedrich was interested in the possible contribution to be made by the exploration geochemist to the discovery of manganese nodules.

J.S. Tooms thought that in this instance the tasks to be performed by the geochemist were quite limited. He was of the opinion that the German approach involving exploration of the seabottom with the aid of television cameras, was the correct one. He agreed with G.H. Friedrich that the composition of the nodules differs at various points on the globe and that these variations were worth studying.

K.J. Weber mentioned that along the coast of Morocco γ-ray measurements were obtained with the aid of a towed gamma-ray detector. The instrument was connected to a spectrometer in order to search out u-bearing phosphorites.He requested the author's opinion concerning the possibly disturbing effect which the presence of potassium in glauconites might engender. The author described his first towing experiments which had not proved successful as the electric cables had been snagged by underwater obstrucions, while the scintillometer was lost when it crashed into rock. However, a promising new instrument had recently been developed and it was armed with "fail-safe" devices, which had no electric connections and which were towed by a main wire to the ship. Some material was taken to the laboratory and tested in order to detect the influence of glauconite. It appeared that the disturbing effect of K was negligeable.

R. Band requested additional information with regard to the mode of occurrence of metals in brine deposits and in the brine itself.

J.S. Tooms replied that at a depth of a few meters the brine deposits contained metalliferous oxides and smaller quantities of sulphides. In the brine itself the metals were present in the form of chlorine-complexes, which are stable in a hydrosulfuric environment.

CLOSING OF THE AFTERNOON SESSION

Before closing the afternoon session the chairman expressed his sincere appreciation for the excellent timing and discipline shown throughout. He considered the symposium a great success, one which would be even further enhanced should some of the attending students become keen exploration geochemists. He then invited H.J. Roorda, chairman of the Mining Section of the K.I.V.I., to address the audience.

H.J. Roorda indicated his pleasure in having the

opportunity to express, on behalf of the sponsors of the symposium, his appreciation for the work done by the organising committee which had resulted in such a succesful day. He also thanked Mr. C.J. Groothoff of the Delft University of Technology whose kind permission had allowed those present to make use of the facilities of the main audience hall.

CLOSING ADDRESS

S. Dijkstra, chairman of the organising committee, thanked H.J. Roorda for his kind remarks. He suggested, however, that the success of the symposium had depended essentially on the contribution of the audience. He expressed his belief, inspired by the reactions of the large number of attendants (some from neighbouring countries), that the object of the symposium, namely that of promoting interest in applied geochemistry in this country and particularly at the universities, had been achieved. His special gratitude was directed to the guests from abroad, to the industries for their financial support, and to all those who had played active roles in the undertaking. Comparing human behaviour with the behaviour of metals whose mobility can be increased of decreased under certain environmental conditions, he invited all participants to enter the alcoholic environment of the "Balonnenzaal" for an informal drink.