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SUGGESTIONS ON THE ROLE TO BE PLAYED BY THE BMR IN SEDIMENTARY PHOSPHORITE EXPLORATION AND RESEARCH IN AUSTRALIA

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* Dr. Sheldon is a geologist with the United States Geological Survey and his services were kindly made available by that organization to the Bureau of Mineral Resources in Australia.

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INTRODUCTION

I pointed out in my report on the appraisal of the Australian continent for phosphate rock that several areas were prospective for sedimentary phosphorite, and in particular the lower Paleozoic of eastern Australia. More than a dozen companies are actively exploring Australia for phosphate, and a few are examining the lower Paleozoic of eastern Australia. Thus, the immediate job of exploration is being actively carried out by a group of men that includes some of the finest phosphate exploration geologists in the world. There are several things that the BMR can do on a short term basis to help this effort. However, it is on the long term basis that the role of the Bureau is vital, because a viable phosphate mining industry requires continued geologic research of the kind that only a federal geologic organization can do. A federal geologic organization is in a favored position for such research because it is not in competition with industry, so that industry usually will share information with such a central agency when they will not share it with each other. Also mining industry in general cannot afford to engage in the basic research that is the normal job of a federal geologic organization. This is particularly true of the smaller mining companies, which, though small, through their numbers and flexibility contribute a great deal to the health of the industry.

The role of the Bureau in a future phosphate mining industry of Australia is easy to define in general terms, but difficult to project at this stage in specific terms. It would perhaps be helpful to discuss the role of the U.S. Geological Survey in the phosphate mining industry in the U.S. before going into the Australia situation in the hope that the things learned there will be applicable here.

The reserves and production of phosphate in the U.S. are very large and the mining industry is quite active. One factor in its success is the long standing and continuing research carried out by the U.S.G.S. Early in the history of the industry known phosphate deposits were studied in detail by G.R. Mansfield and a good many other geologists. Such study was not then, and is not now, restricted to economic geology, but more importantly includes regional mapping in areas of known phosphate deposits and stratigraphic and petrologic research of the rocks in the various areas. At least one district, the North Carolina deposits, were found by the U.S.G.S., and quite a few mines have been indicated by Survey work. The role of the U.S.G.S., however, is not directed at exploration, but research in exploration and the study of basic geology of mining districts. It complements but does not duplicate the geologic work of private industry. The Survey's work includes such studies as the sedimentology

and regional stratigraphy of the various phosphate districts, 7½ minute quadrangle geologic mapping of the important parts of those districts, mineralogy of apatite, and geochemistry of uranium and other trace elements in apatite, to mention only a few of the fields involved. On the average about ten professional men are working on phosphorite research and mapping, though of course this number changes from year to year.

Much more research is projected but much of the future research will be based on the problems that come up as the industry expands and as research uncovers the new problems. Thus, there is a constant interplay between industry and government science and a constant feedback from research projects.

It would seem that the general approach by the BMR in Australia could follow these guidelines. An active though not necessarily large research program on phosphogenic provinces at this stage would help the companies with little experience in the geology of phosphorite and would at the same time supply data useful to the more experienced companies. It is probable that some of the companies now active in Australia will leave for one reason or another. It is important that data and drill samples gathered by them are collected by the BMR so that the results of these early efforts are not lost.

The immediate program of the BMR must be guided by several factors. Insofar as the program tries to keep abreast of the mining company efforts, it is governed by their lead. Thus, a part of the BMR program must concentrate at this time on the Cretaceous and other systems of western Australia that are being prospected. The BMR also needs to lead in studies of the lower Paleozoic of eastern Australia, so a part of the BMR program must concentrate on this aspect. Research on the mineralogy of phosphate minerals is badly needed because of the peculiarities and duration of weathering in Australia. Finally some collecting of information scattered throughout the literature and unpublished reports on Australia should be made and collated on maps and in bibliographies. Each of these subjects are discussed in broad terms below.

LOWER PALEOZOIC OF EASTERN AUSTRALIA

As more and more indications of phosphate in the lower Paleozoic of eastern Australia turn up it becomes obvious that a thorough study of this phosphogenic province should be made. It will be particularly fruitful to do this at the stage when private companies are actively exploring the area.

Compilation -

The first step is to start putting data down on maps. The first set of maps should be objective, and from these, interpretative maps can be constructed. In light of rapidly accumulating data, these maps will be little more than work sheets, but perhaps as patterns begin to emerge they can be issued as BMR Records.

All occurrences of phosphate in lower Paleozoic rocks should be plotted on a map and referenced in a list including bibliographies. Perhaps the age of the occurrences could be shown by symbol. If possible a measured section showing the associated rocks could be drafted for each

locality. Similar maps should be made showing the distribution of minerals and rocks associated with phosphorite. These include shale rich in organic matter, chert (especially spicular chert), and secondary phosphate minerals such as turquoise and variscite.

The lower Paleozoic rocks should be broken down into systems and series if possible and various objective maps constructed such as isopach, lithofacies, feet-percent maps of various lithic components (see Sheldon, 1964 for an explanation of feet-percent maps), and minor component (such as glauconite) maps. The validity of such maps depends on the correlations between sections. In some places these are well established by paleontologic information, but in other places much guesswork will have to be done and correlations will have to be made using physical stratigraphic techniques.

Interpretative maps can be constructed as soon as enough objective data is accumulated. Paleogeographic and paleotectonic maps will be necessary for phosphate evaluation, as explained in the companion report. Paleoclimatic maps might be helpful. Faunal distribution maps also might help show areas of cold water fauna expected in areas of upwelling and areas of warm water fauna that are possible in shelf areas adjacent to areas of upwelling.

Once phosphatic horizons have been identified and traced, outcrop maps of these horizons should be prepared with structure contour maps showing the configuration of these beds in the subsurface. It is important on such maps as these, as well as all the other maps, to show the localities on which the map is based, so that when new data is added the map can be adjusted. Also the reader can see by the distribution of the data how reliable the map is or which areas are better controlled.

Such a map series will not only show the state of current knowledge, but also will point out the areas that need more work and areas that are more prospective for phosphate rock. At this stage, field work can be better planned, and critical well cuttings can be re-examined with new ideas in mind.

Field and laboratory studies - This study is essentially stratigraphic and must be based on carefully measured stratigraphic sections. Sections are hard to measure in most of Australia due to lack of outcrop, but even so, much can be learned from partial detailed sections. They are also necessary to accurately place stratigraphically specimens collected for paleontologic, petrographic, or mineralogic study. The stratigraphic field study should follow standard modern techniques and there is little need to go into details of the approach. However, it might be worth pointing out several problems that occur to me that need study. There are two kinds of chert in the lower Paleozoic of eastern Australia, that of volcanic origin and that of biologic origin. The former is not associated with phosphorite whereas the latter commonly is. In hand specimen it is very difficult to tell the two apart, but a study of associated rocks usually is sufficient to distinguish them. It also might be possible to tell the two apart from their petrography once a suite of rocks of the two different origins is obtained. If such techniques are worked out, it would greatly aid the search for phosphate. Another special problem that should be kept in mind as the program progresses is the weathering of apatite. Both fresh and weathered samples should be collected, if possible from the same bed, with a record of topographic

position, faults, etc., and petrographic, mineralogic and chemical analyses made. A part of such a study should be made in cooperation with N. Trueman of AMDEL as discussed below.

One source of data that should be particularly watched is the drilling by companies. There is no substitute for such fresh samples, and the BMR should try and get splits of all possible samples. It is unlikely that the companies will carry out the detailed work on samples that is necessary for a complete evaluation of the geology of the phosphorite, so copies of their results probably will not be sufficient. If money is available, a series of stratigraphic holes should be drilled and the cores carefully described and analysed from all points of view, paleontologic, stratigraphic, mineralogic, and petrographic. Such sections would stand as sign posts for directing company exploration and BMR research.

It is difficult to project the detailed path of this program because there are too many unknowns. Thus the program should be flexible and managed by an experienced physical stratigrapher and sedimentologist. He should be aided by a junior geologist. If and when the need arises, additional staff can be added.

MESOZOIC OF WESTERN AUSTRALIA

A program similar to that on the lower Paleozoic of eastern Australia should be started on the Mesozoic of Western Australia, particularly the Cretaceous. The approach should be the same by and large, and there is not much to add here. It would appear to me that if next year's exploration by the companies is so discouraging that they pull out, there may well be little need for the BMR to continue working this area on a high priority but an effort is needed to collect and co-ordinate company findings while they are in the field. At least the results could be summed up and recorded for any future round of exploration in the area. I would think that one experienced geologist aided by a junior geologist could handle this program at this stage.

MINERALOGICAL RESEARCH

Mr. Norman Trueman of AMDEL is a first rate mineralogist with experience in phosphate mineralogy and has the equipment to carry out complicated research into phosphate mineralogy. In addition he has the desire to do so, and AMDEL has the desire to start a coherent research program on phosphates rather than perform strictly as a service organization in this matter. This puts Australia in a very excellent position, as men such as Trueman are very rare indeed. He should be encouraged in his Christmas Island studies and could well be used on agreed research programs for phosphate founded by BMR. I know that he is quite interested in research in the aluminium and iron phosphate minerals and their genesis. Thus, he would be invaluable in the studies on apatite weathering, a subject I have pointed out in the companion report as being important to the phosphate geology of Australia. I think that it would be a mistake for Trueman to be used for service work only, as he has many creative ideas to add.

BOOK-KEEPING SERVICES

It would be most helpful for the members of the phosphate group of the BMR as well as companies starting in the field to begin collating information on phosphate occurrences in Australia. All occurrences should

be plotted on a map, perhaps an overlay of the Tectonic Map of Australia. A card file of references on phosphate occurrences and geology of the area in which phosphate occurs has been started and should be diligently continued. In addition a general phosphate bibliography will undoubtedly be made by members of the phosphate group and it would be quite helpful if some sort of form of this be available to the public. A punch card system would probably serve the best.

CONCLUDING REMARKS

I have emphasized two provinces in Australia for concentrated work. These provinces are admittedly large, but they certainly are not all inclusive. As covered in the companion report, other areas offer some potential for phosphate. In view of the limited staff of the phosphate group, it was felt wiser to limit the projects to the most prospective rocks (in light of present information and concepts) and those rocks actively being prospected at the moment. However, if the situation should change by significant discoveries in some of these other areas, or by variations in company participation, there is no question that the role of the group should be reviewed.

In summary, the group required for the tasks recommended would comprise two sub groups each consisting of a party leader and one other geologist to handle the immediate eastern and western Australian projects and subsequently, other projects which undoubtedly will arise. These sub groups will need the overall supervision of one experienced senior geologist and at least two sub-professionals and a draftsman to assist in laboratory, field, and office studies. The group will need support from groups already in the BMR including mainly paleontology, petrology, chemistry, and geophysics.

REFERENCE

SHELDON, R.P., 1964 - Exploration for phosphorite in Turkey - a case history. Econ. Geol. 59, 1159-75.