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John Carrington Theron
D.Sc. (O.F.S.)

INAUGURAL LECTURE DELIVERED ON ACCEPTING THE
CHAIR OF GEOLOGY AT THE UNIVERSITY OF THE NORTH
ON WEDNESDAY, 24 OCTOBER 1979

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Mr Chancellor,

This lecture forms part of the symposium entitled "Where Theory meets practice : The Faculty in service of the Community" held at the University of the North on 23 — 24 October 1979.

INTRODUCTION

The Government of South Africa recently appointed a commission to investigate the consolidation of the homelands and newly independent states. The boundaries of these areas have not been conclusively demarcated at the present time. For the purpose of this lecture, therefore, the area referred to as the Northern Transvaal will include the homelands and new states situated within the boundaries of the area formerly known as the Northern Transvaal. The southern limit is taken north of Pretoria. Again, the term South Africa will be used for all the countries within the Republic of South Africa.

The mineral potential of the Northern Transvaal as defined will be discussed as an area and not in respect of the various political regions.

It is generally thought that South Africa has vast mineral resources: it is a well-established fact that South Africa is the world's largest producer of gold and platinum, but it is perhaps less well-known that it is a major supplier of a number of strategic minerals and other mineral commodities. As a supplier of mineral commodities the Northern Transvaal has played a major role in the history and economy of South Africa. Not only was the first gold discovered at Eersteling near Pietersburg, but the world's largest reserves of platinum, chrome and vanadium occur in this region, as well as a host of other economic minerals. This is indicative of the importance of this area to the economy of South Africa.

Since the discovery of the first gold the Northern Transvaal has been subjected to the scrutiny of many workers, from individual prospector and small companies to large modern companies. The South African Government and the universities have also contributed to the accumulation of knowledge concerning the geology and mineral potential of this area. It is not my intention, therefore, to give a review of all the various mineral deposits found in the Northern Transvaal, but to examine the importance of the Northern Transvaal in terms of world consumption and trends. I also intend to examine the role this university can play in developing these mineral resources and in generating interest amongst the members of the community to exploit these resources and thus create capital and job opportunities.

SOUTH AFRICA AS A PRODUCER OF MINERALS

It is necessary to examine the truth of the statement that South Africa has vast mineral resources. It is obvious that South Africa, and for that matter Africa as a whole, is at present passing through difficult times. Tremendous pressures are being put on South Africa, and the reasons for these economic and political pressures are usually ascribed to the mineral wealth of South Africa or the importance of the sea route around the Cape.

To put the matter in perspective it is necessary to analyze the mineral potential of South Africa and to look at its place in the world, a few statistics will not be out of place to provide insight into the status of South Africa as a producer of mineral commodities. The percentage given for mineral production refers to the value of the commodities.

The surface of South Africa is less than one quarter per cent of the Earth's surface, and less than one per cent of the total land surface. The population is less than a half a per cent of the total world population. South Africa contributes only about a half a per cent of the world's gross domestic product. When looking at the mineral production it produces only about one quarter per cent of the sources of energy of the world in the form of coal and uranium, both less in demand than petroleum. With sources of energy included, in value, it produces about two and a half per cent of the world supply, but when energy is excluded it rises to eight per cent (van Rensburg and Pretorius, 1977).

Looking at the production figure of two and a half per cent for the total value of minerals produced, and considering the fact that large parts of the world are almost inaccessible or poorly explored, such as Antarctica, this figure can be reduced further. The conclusion to be drawn at this stage is that South Africa does not hold such an important position as generally believed: its mineral wealth is only slightly greater than the world average. But, before this conclusion leaves us with a sense of disappointment, let us examine South Africa's production more critically.

The total mineral production of the world may be subdivided into sources of energy, metals and non-metals. Sources of energy account for more than 70 per cent of the world's mineral commodities produced in 1973. South Africa ranks tenth in the world as a producer of mineral commodities, including sources of energy. Excluding energy it rises to fourth position. Only the U.S.A. with 25,84, The U.S.S.R. with 14,89 and of Canada with 11,32 per cent exceeds that of South Africa. It is interesting to note that the area of the U.S.A. and Canada is about 8 times that of South Africa and the U.S.S.R. 18 times. From these figures it would appear that South Africa has in respect of its area the highest concentration of metals and non-metals in the world. This is partly due to the large deposits of the precious metals, gold and the Platinum Group Metals. Several countries such as Saudi Arabia, Iran, Libya and Venezuela, which rank 3rd, 6th, 7th, 8th and 9th respectively as mineral producers, lose their importance when sources of energy are excluded. Most predictions indicate that their resources will be depleted or greatly reduced by the turn of the century. South Africa's importance as a mineral producer will, therefore, increase, but this also depends upon the rate at which her mineral resources are exploited. When the distribution of the mineral wealth of the world between the West, the Communist Countries and the Third World is examined, it is noted that in 1973 the West produces 42,2 per cent of all mineral commodities, the Communist Countries 26,9 per cent and the Third World 30,0 per cent. The West produced only about two thirds of its own consumption, whereas consumption and production were more or less balanced in the Communist Countries; the Third World consumed only about one third of its

production. (Van Rensburg and Pretorius, 1977). Petroleum remains an important mineral exported by the Third World.

South Africa is the ninth largest country in Africa and its area is about 4 per cent that of Africa, and it has a population of 6 per cent of the total population. In value, it produces 22 per cent of mineral commodities. The greatest mineral producer in Africa is Libya, with 23 per cent, but it exports petroleum as its only mineral commodity.

In Southern Africa, South Africa produces 68 per cent of the minerals of this region, Zambia 12 per cent, Angola 10 per cent, South West Africa 6 per cent and Rhodesia 3 per cent. In total Southern Africa produces about 12 per cent of the world's minerals, petroleum excluded. Looking at the position of the West it is difficult to comprehend their strategy in allowing the communist countries to encroach upon Southern Africa. The availability of supplies of petroleum is possibly their major consideration. The West has probably been stock-piling strategic minerals but the storing of petroleum is inconvenient and hazardous. It is likely, therefore, that the West has chosen to retain political ties with the petroleum producing countries of the Third World in preference to the mineral producing countries of Southern Africa.

THE NORTHERN TRANSVAAL

The north eastern part of the Republic, that is the Northern Cape Province, the Northern Orange Free State, Northern Natal and the Transvaal are responsible for almost the total production of minerals in South Africa. The Northern Transvaal is a very important sector of this area and of the 93 mineral commodities that are known to exist in the area named, 61 of these are found in the Northern Transvaal. It is interesting to note that freely one half of the land area of the Republic is poorly endowed with viable mineral deposits.

In accepting the fact that almost the total mineral production of South Africa is derived from less than half of the area of the Republic one must conclude that an abnormally large number of minerals occur in this region. A hypothesis to explain the high concentration of minerals in this area has been put forward, amongst others, by van Rensburg and Pretorius (1977), who saw the solution to this in the age of Southern Africa. They found that most of the minerals occur in rock of great age. It is not my intention to discuss the theories of the development of economic mineral deposits and I shall only remark on this briefly.

Since the creation of the earth some 4 700 million years ago the world has been in constant turmoil, so much so that most of the rocks that were formed were destroyed again at a later stage in the history of the earth. Southern Africa was the exception in the distant past; an embryo continent was emerging whereas most of the crust of the rest of the world was in a state of constant flux. Of the oldest rocks found on earth are in the Transvaal. The age of these rocks is put at more than 3 600 million years. Van Rensburg and Pretorius (1977) in studying the correlation between the mineral production and the age of the formations from which the minerals

are derived, found that the rock younger than 570 million years contributed about 12½ per cent to the mineral production. The minerals mainly diamonds and coal. This period, the Phanerozoic Eon, is the period of evident life on earth. Older rocks are referred to as Precambrian or Archaean. Formations with ages ranging between 570 and about 1500 million years contributed 3,18 per cent, but between 1500 and 3000 million years 82,48 per cent, and the rocks older than 3000 million years only 1,85 per cent.

From these figures it would appear that the period 1500 to 3000 million years ago produced the greatest mineral wealth. This is probably correct, but if it were not for two major episodes, the minerals would have been more evenly distributed in time. During this period the Witwatersrand Basin developed and gold and uranium was washed into the basin from primary deposits occurring in older rocks lying to the west and north of this area (Anhaeusser 1976, Truswell 1977). The other event was the intrusion of the Bushveld Igneous Complex and its related effects. This is a very large body of associated rocks lying approximately Potgietersrus and Warmbaths with a northerly extension west of Pietersburg and an east-west axis of some 460 kilometers (Haughton, 1969). The importance of this unit is indicated by the fact that about 55 per cent of the world's production of Platinum, 45 per cent of the Vanadium and 30 per cent of the Chrome came from this body during 1973. (Dames and Moore International, 1978).

The high percentage of minerals mined from these rocks can be ascribed to the fact that the outcrop areas of this unit are so large. In turn, because of their mineral content, these outcrops have been investigated and studied better than most other areas.

However, it is probable, that, the older rocks are, the higher the likelihood that they could be mineralized due to events that occurred in their past. Depth of burial, heat, pressure and permeating fluids are factors that could have contributed to the formation of economic deposits. On the other hand, these same elements might have resulted in the removal of materials.

Various other hypotheses have been advanced to account for the localization of economic mineral deposits. Another theory states that the composition of the atmosphere has changed during geologic time. This would have influenced the chemical activity of the atmosphere, resulting in the hypothesis that certain types of mineral deposits developed at specific periods in the history of the earth (Kalliokoski, 1973). For example, most of the world's sedimentary iron deposits, the so-called Iron Formations, were formed during the Precambrian Eon. Crustal instability has also influenced mineral concentration. Certain minerals favour zones of instability called mobile belts, others the more stable areas, the platforms. But here again, there are always the exceptions.

From the discussion thus far it is evident that the deposits of economic minerals are distributed quite irregularly, both in time and location. For example, most of the world's platinum is to be found in South Africa and the U.S.S.R. This irregular distribution resulted in the concept of a

metallogenic province. A metallogenic province is defined as considerable areas at the surface and underground where favourable conditions existed for the deposition of specific mineral deposits (Bilibin, 1968).

From the discussion so far it appears that the processes of mineralization are complex and only partly understood. With this in mind the mineral potential of the Northern Transvaal may now be examined further.

Though an analysis of the concentration of minerals throughout the world has not been made it is likely that the Transvaal is one of the richest areas in the world. Van Rensburg and Pretorius (1977) estimated that from the beginning of modern mining up to the end of 1975 the Republic produced mineral commodities averaging at more than R57 000 per square kilometer. Excluding sources of energy this is by far the highest average for any country in the world.

Though large reserves of many mineral commodities have been proved, the actual mineral resources of the Northern Transvaal is still an unknown quantity. However, the day of the prospector and chance discovery of mineral deposits is drawing to a close the concerted efforts of well-trained geologists will be required to further the uncovering of mineral deposits. New surface deposits will become the exception and lower grades of ore will be mined and exploration at depth will have to be carried out. As B B Brock, a South African geologist once stated: "Geology is the only science which keeps exploration from being a lottery." This discipline should, therefore, become increasingly important in the future.

The Bushveld Igneous complex is unique and it probably represents the greatest single economic unit in the world. Mining companies are aware of its great importance and it has been the subject of much research. Most of its deposits are under the control of mining companies and this aspect is beyond the scope of this lecture.

It is generally believed that the Bushveld Igneous Complex and the Great Dyke of Rhodesia, though older, are related. Vail (1977) regards the twenty five complexes from Trompsburg in the Orange Free State to the East African Rift system, a lineation some 3 800 km long as being related. This stretches as far North as Ethiopia. McConnel (1978) relates this lineament to the greatest of the early dislocation systems that effected the crust of the earth. The area of the Northern Transvaal between the Limpopo and the Bushveld Igneous Complex is partly covered by rocks younger in age than that of the Bushveld Igneous Complex and the Great Dyke. Should a connection between the various complexes exist as postulated by Vail, then further mineralized areas might be covered by rocks of the Waterberg Group or a zone of mineralization might exist. The thickness of these overlying Waterberg rocks is about 1 500 m so that should such economic deposits exist, exploitation would still be possible.

Coal has been found in various localities in the Transvaal during recent years. These deposits occur in the younger strata laid down in depressions or basins on the platform and in mobile areas. It is possible that smaller deposits of coal remain undiscovered. Other minerals such as uranium might have concentrated as placer deposits in these basins as well.

The rocks older than the Bushveld Igneous Complex yield a variety of economic minerals. Many occurrences of gold are known and of the world's largest sources of antimony are present in the oldest known rocks of Southern Africa in the Letaba District (Coetzee, 1976).

MINERAL EXPLORATION

The work involved in looking for an ore is known as mineral exploration, more specifically, exploration is the effort to acquire the maximum number of new economic mineral deposits or ore bodies with the minimum cost and minimum amount of time.

Cost remains the dominant factor in any attempt to develop the mineral potential of the homelands. The Chief Minister of Lebowa, Dr Phatudi (1979) stated that a labour intensive rather than a capital intensive development strategy should be followed in the mining industry of Lebowa. Bearing this in mind, and considering the role the University of the North can fulfill in serving the community, prospective areas where low cost mining methods may be employed, will be investigated.

It would appear that in an attempt to develop the mineral potential of the homelands the local governments have two alternatives; firstly by holding a share in certain mining ventures, in which case income would be generated by participation and taxation, and secondly allowing big outside corporations to develop the mineral potential independently, in which case the income for the local government would be by taxation only. The drawback of such a system, though it will provide an income for a government and will create many job opportunities, is that the black entrepreneur will have a minor role to play in the development of the mining sector.

One of the main objectives of the Department of Geology as a member of the Faculty of Mathematics and Natural Sciences, apart from training geologists, is to attempt to develop the mineral potential of the Homelands and to make them aware of the importance of the mining industry.

This approach may prove to be beset with many difficulties. As stated, it may be assumed that the Northern Transvaal has been scrutinized carefully from the olden days of prospecting to the modern day surveys. The possibility of finding large new surface deposits seems to be remote. Furthermore, it is probable that the mining rights of likely or target areas in many areas will be held by mining companies or otherwise these rights can only be obtained at relatively high cost. The resources of the Department of Geology of this university are very limited and exploration can be undertaken only on a small scale. Except for geological considerations, the target areas will be selected after taking the future policies of the homeland governments into consideration.

In an attempt to develop the mineral potential of the Northern Transvaal the groundwork for exploration may be approached in several ways. Firstly, recent developments on the economic scene may result in the recognition of hitherto undetected opportunities. Previous discarded discoveries may

now be viable prospects: for example with the current rise in the price of gold old gold mining areas might be profitably worked. A study of known mineral occurrences might be a good point of departure. Secondly, in the examination of areas where known mineral deposits are found new prospects might be located. Lastly, deposits might be located in areas where little success had previously been achieved. It is reasonable to believe that deeply concealed ore bodies are still to be found as we fill out our geological knowledge of the Northern Transvaal.

If the local population is to be involved in an entrepreneurial capacity in mining, low cost ventures are the obvious choice. This restriction limits the exploration to surface deposits. Numerous possibilities exist but only a selected few will be discussed.

BUILDING MATERIALS

Building materials, such as stone and sand, play a very important role in the economy of most countries. Taken as a group the value of building materials probably ranks first of all mineral commodities produced on earth. In South Africa the total value of sales of building material for the period 1852 to 1975 was exceeded only by gold, coal, diamonds, copper, platinum, uranium, asbestos, manganese and iron.

It requires little imagination to see the possibilities of producing sand, crushed stone and bricks near a growth centre. As capital outlay required for producing these materials is quite small. For example, low grade bricks may be produced with simple equipment.

It should be remembered, however, that the location of these materials is of great importance as transport is a very significant cost factor.

Tin

Tin was produced by 35 countries during 1976 (United Nations 1977). The world's consumption of tin during 1977 was 15 000 tonnes greater than the world production. (Reed and Curry, 1978). This deficiency was probably made up by dispersal from world stockpiles.

South Africa's production of 2709 tonnes during 1976 represents about 1 1/2 per cent of world production, (United Nations, 1977), and remained more or less the same for 1977. (Department of Mines, 1977).

Tin mineralization is mostly associated with granitic rocks, but economic deposits of tin are formed only under specific geological conditions. These controlling factors are not fully understood: the influence of temperature, pressure, chemical composition and availability of fluids are important. This results in the development of relatively few economic deposits. Dames and Moore International (1978) considers the break-even point in tin mining to be a minimum cassiterite content of 0.4 per cent. Cassiterite is the only important mineral of tin. ISCOR is mining tin ore at Uis in South West Africa with a tin content of only 0.09 per cent. This is probably the lowest grade worked at present in the world.

Cassiterite is also found as placer or alluvial deposits. The exploitation of

alluvial deposits by panning might prove to be a profitable venture. In Bolivia, one of the world's greatest producers of tin, where there are more than 2 500 tin mines there are one-man operations producing only a few kilograms of cassiterite concentrates per year (Reed and Curry 1978). Tin concentrates (Cassiterite) were sold for almost R7 700 per ton and the metal for about R10 000 per ton during 1977. (United Nations, 1977). At present the price of the metal is about R13 500 per ton and that of the concentrates should be correspondingly higher than the price of 1977. Deposits of cassiterite might be present in the alluvial material of the rivers draining areas of the Northern Transvaal, where there are outcrops of granitic rocks. Furthermore, with the high price of tin, occurrences of low grade ore might be examined. A description of the known mineralized areas are given by Crocker et al (1976) but it is probable that other occurrences may be discovered in the future.

Gold

In the early days of gold mining in South Africa the recovery of 1 ounce (32 grams) of gold per week was considered to be the limit of profitable extraction by the individual miner and with the current price of gold small occurrences might be exploited profitably. It is also likely that more undiscovered deposits may be present in the Northern Transvaal.

Platinum

The recovery of platinum from the Bushveld Igneous Complex is beyond the scope of this lecture. It is recognized that alluvial platinum deposits might be present in the sediments of the streams draining the platinum-bearing areas. (Cousins, 1976, Dames and Moore International, 1978). A sedimentological study of the drainage systems might indicate target areas for platinum placer deposits.

Pegmatites

Pegmatites are exceptionally coarse grained rock presumably formed by permeating warm to hot fluids carrying elements not normally found in hydrothermal fluids. Pegmatites are usually elongated bodies and commonly occur in the granitic terrains. Pegmatites occur in the Pietersburg district and other areas in the Northern Transvaal. Some pegmatites carry ores of rare elements such as Lithium, Beryllium, Tantalum, and Tin. Pegmatites are normally mined by small concerns as ore minerals occur erratically and are often hand sorted.

Aluminium

Aluminium is the third most common element in the crust of the earth. Economic extraction of the metal Aluminium is restricted to the type of ore called Bauxite. There are no known economic deposits of Bauxite in South Africa, and the country has to rely on importing the ore for its supply of aluminium.

Bauxites are formed at surface in areas with a hot humid climate. The rock types on which these deposits form are of less importance than the climatic conditions, and it has been found that bauxites form under topical conditions within the latitudes 30 degrees north and south as the approximate limits. A possibility exists therefore that the bauxite might have developed in the Northern Transvaal, but development has probably

been impeded by the harsh climatic conditions of South Africa. The mist beld of the Transvaal, is, however, a target area.

There are other types of mineral deposits that offer possibilities such as the mining of limestone and dolomite for agricultural use, asbestos, uranium, flourspar, and many others.

CONCLUSION

It is impossible to give a full account of the mineral potential of the Northern Transvaal. I trust that I have succeeded in conveying the idea that the Northern Transvaal has possibilities for both the small operator and the large company. It is probable that most surface deposits have been located, but with the application of refined methods undiscovered surface deposits might still be found. However, the greatest potential is probably in deep seated ore bodies and in the mining of lower grades of ore.

With this, Mr Chancellor, I have the honour to accept the chair of Geology at the University of the North.

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