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THE MICROSTRATIGRAPHY OF THE CRETACEOUS SYSTEM OF ZULULAND

Dissertation presented in fulfilment of the requirements for the degree of Master of Science in the University of the Witwatersrand

by

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August 1968

I, the undersigned, herewith declare that this thesis is entirely my own work and has not been presented for any degree at another University.

M. L. de Gasparis

M. L. DE GASPARIS.

June, 1968.

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ABSTRACT

The topmost portion of the Cretaceous System of Northern Zululand, as represented in Anglo-Transvaal Borehole A, has been examined in view of establishing its position in the stratigraphic sequence.

Foraminiferal studies have been carried out on the fossil assemblages which were found to be very rich in planktonic and benthonic Foraminifera. Diagnostic species were identified amongst the benthonic and planktonic forms, and the sediments were accordingly subdivided into Uppermost Maestrichtian, Maestrichtian and Upper Campanian. Simpson's index No. 2 (Simpson 1960), a measurement of faunal resemblance, was applied to the fossil assemblages, and it was proved that two major changes occurred in the faunas, coinciding with the appearance in the succession first of Maestrichtian faunas, and then of Uppermost Maestrichtian faunas. Another minor break in the uniformity of the faunas, occurring within the Maestrichtian, was interpreted as representing the change from Lower to Upper Maestrichtian.

INTRODUCTION

1. Purpose.

The Cretaceous System of Zululand (northern Natal) has been studied in outcrop (see under Previous Work) and has been subdivided palaeontologically into zones, mainly with the aid of ammonites. Very little work has been carried out on Foraminifera (Smitter, 1957).

When Anglo-Transvaal Consolidated Investment started prospecting for oil in Northern Zululand, no work had been performed on the Cretaceous subsurface stratigraphy in that area. A detailed knowledge of the stratigraphy is essential in any oil investigation and therefore Anglo-Transvaal sponsored a stratigraphic research programme in which were engaged Dr. G. F. Hart, Mr. R. N. Pienaar and the writer.

The purpose of the present work is therefore to contribute to the knowledge of the Cretaceous subsurface stratigraphy in northern Zululand. Foraminifera have been used because of their high reliability in forming stratigraphic subdivisions and world-wide correlations, and because, due to their abundance in the Cretaceous seas and their small size, a good representation of the fossil record can be obtained from core samples.

2. Location.

Borehole A is one of four boreholes drilled by Anglo-Transvaal in northern Zululand. It is situated in the

proximity of Lake Sibayi (see attached Site map).

3. Review of Previous Geological Work.

The Cretaceous outcrops of Zululand have been studied quite thoroughly. They have been described from the lithological aspect, and their macrofaunas, consisting of Cephalopoda, Gasteropoda, Pelecypoda, Echinoida, etc., have been described and dated by various authors.

A short account will be given here of the more relevant previous research.

Anderson (1902-1907) wrote three reports for the Geological Survey of Natal and Zululand, in which he recorded the position of Cretaceous rocks in outcrop and in boreholes. The most southerly known occurrence of Cretaceous rocks in Zululand was in Anderson's time, and still is, a limestone which was found at the bottom of two bores north of the Umhlatuzi Lagoon. An outcrop is reported by Anderson at Umkwelane Hill, on the south bank of the Umfolosi river, close to Lake Isiteza. The outcrop, as described by Anderson, consists of an impure limestone of a bluish-grey colour, overlain by an earthy-coloured calcareous sandstone. The limestone is very rich in macrofauna, and the sandstone, which was stated to be unfossiliferous in the first report, was later reported to contain Foraminifera.

Farther north more outcrops occur at the crossings of the wagon track on the three tributaries of the Manuan Creek and another one west of the junction of the Manuan Creek and the Umsinene River.

More outcrops are stated by Anderson to occur along the north-western shore of False Bay. The outcrop at the northern tributary of Manuan Creek is stated to contain a conglomerate with rhyolite pebbles and numerous fossils. The other outcrops in this area consist of calcareous sandstones, limestones, chalk, chalk marls and sandy shales.

Anderson made collections from some of his localities and sent them for study to Etheridge and Crick. Their results are published in Anderson's reports.

In the first part of his report Etheridge (1904) described and dated the Umkwelane Hill molluscan fauna. His dating for this deposit is Turonian-Senonian. He found this fauna to bear a greater resemblance with the Indian than with the Australian one.

In the second part of his report Etheridge (1907) examined the fossils from the outcrop at the most southerly tributary of the Manuan Creek, which he called "the Umsinene river deposit". His conclusion was that these beds and those from the Umkwelane Hill "are simply horizons of one and the same geological series" (p. 89).

Crick (1907a) studied the Cephalopoda from the middle Manuan Creek deposit, which he called "the South Manuan Creek Deposit", and from the locality west of the junction of the Manuan Creek and the Umsinene River, which he called "the north end of False Bay deposit". The Manuan Creek deposit was dated as Cenomanian, possibly older. However, these fossils did not supply much information on account of their poor state of preservation. The Cephalopoda from the "False Bay deposit" are very well preserved and they were dated as Cenomanian, and correlated with similar

assemblages in Madagascar and India. The Zululand forms were found to have a less marked similarity with the contemporaneous European forms.

In a later publication, Crick (1907b) stated again that he thought the "False Bay deposit" to be of Cenomanian, possibly Upper Albian, age and that he doubted the presence of sediments younger than Cenomanian.

Spath (1924) studied the Cephalopoda from the Umkwelane Hill area, the Manuan Creek district and some isolated ones from the west shore of False Bay. He dated the Umkwelane Hill deposit as Campanian, possibly Maestrichtian. He made some very interesting ecological observations, comparing the Umkwelane Hill fauna with faunas from Pondoland (S.A.), India, Egypt and Europe. He found a difference between the Pondoland and the contemporaneous Zululand fauna. The Pondoland fauna includes warm water Indo-Pacific forms as the Lytoceratidae and Kossmaticeras, while in the Umkwelane Hill fauna Atlantic colder forms like Mortoniceras and Placenticeras are present. However, he reached the conclusion that the two faunas, when observed as a whole, belong to the same Indo-Pacific province. In Pondoland a bathyal facies is represented, while at Umkwelane Hill a neritic environment existed at the time of deposition. The Atlantic forms found in Egypt, Madagascar, India and Baluchistan are regarded as proof of a communication between these seas and of migrations, which took place from the Mediterranean along the north-eastern side of Africa to India on one side and to Zululand on the other side. The Manuan Creek deposit was found to contain beds ranging in age from Albian to Maestrichtian, the Turonian not having been deposited. The Manuan Creek fauna shows stronger similarities

with the Pondoland fauna than with the geographically nearer Umkwelane Hill fauna. The "Ammonoidea from isolated localities", along the north-western edge of False Bay, were dated as Campanian.

Du Toit (1926) gives a very short abstract of the work performed in Zululand.

In a joint paper by Rennie and Haughton (1936), Haughton described the Cretaceous geology of northern Zululand at the foot of the Lebombo Mountains and as far north as the Lombangwenya Spruit, in the magisterial districts of Ubombo and Ingwavuma.

Most of the outcrops are, as very often in Zululand, in river valleys. The rich ammonitic faunas were examined by Haughton and his results are given in the same publication. Rennie examined the pelecypod fauna.

At the Myesa Spruit the Cretaceous beds overlie flat rhyolites, the contact being covered by sand. The Cretaceous rocks consist of sandy beds, pebble beds and grits, and soft sandstones containing bands of calcareous grits. Four localities were found but they yielded few and badly preserved fossils.

In the southern branch of the Mfongosi Spruit Cretaceous beds were found two miles in a straight line upstream from the drift of the main road. This outcrop and another one, near the point where the two branches of the Spruit meet, were found to contain no marine fossils. Downstream from these, and all the way down to the Pongola River, 800 feet of fossiliferous beds outcrop, in which 19 fossil localities were found, consisting of sandstones, sandy shales, sandy clays, argillaceous sandstones, limestones, shales, etc. The fossil content of these beds was

high, and yielded a rich fauna of pelecypods, cephalopods and rare brachiopods. The presence of the upper part of the Lower Aptian or the lower part of the Upper Aptian (martini zone) was ascertained at two localities. The subnodosocostatum zone (uppermost Aptian) is not clearly recorded in any locality. The lowermost Albian (nodosocostatum zone) is present and the Middle Albian (mammillatus zone) is also represented, but the upper part of the Lower Albian was not found. No stratigraphic break is evident in the Mfongosi Spruit succession and it was therefore assumed that the complete succession from Upper Aptian to Middle Albian is represented here.

On the Pongola river, between approximately one and two miles measured on a straight line from the junction with the Mfongosi Spruit, six fossil localities were discovered, containing cephalopods, gasteropods, pelecypods and echinoderms. The outcropping rocks are limestones, clays, sandy clays and clayey sandstones, and pebble beds. The Pongola outcrops were dated by Haughton as Middle and Upper Albian.

North of Lombangwenya Spruit, the slope between the plateau where the Lombangwenya shop is situated and the spruit itself is formed of Cretaceous sandy limestones, sandy clays and marls. Three traverses were made across this slope, and rich faunas of pelecypods, brachiopods, cephalopods and gasteropods were recovered. The study of the ammonitic fauna proved this deposit to be of the same age as the beds at Mfongosi Spruit, and some indication to the presence of upper Lower Albian was found.

At Mysinyene Pan few outcrops yielded ammonites and pelecypods.

An area between the Pongola and the Mkuze rivers was named

Mokatini. Here the outcrops are very rare, the area being covered by sands. Limestones and hard sandstones yielded a few pelecypods.

Rennie analysed the pelecypod faunas from the above-mentioned outcrops and deduced their range as being Neocomian-Cenomanian. Many of the faunas have been recognized elsewhere, in Central and South America, in India and in the Cape Province (Uitenhage series) as mainly Neocomian, but they are found in Zululand associated with Albian ammonites, and in India they have been proved by Spath (1935) and Cox (1935) to extend farther upwards than the Neocomian. At Lombangwenya Spruit the pelecypod fauna is very similar to the Uitenhage fauna, which is Neocomian in age. A few specimens, which were attributed to higher horizons, are poorly preserved and their identification is not positive. The Myesa Spruit fauna is very similar to the Lombangwenya Spruit fauna except that it does not contain any element which might be attributed to a higher horizon.

The faunas recovered from the Mfongosi Spruit and from the Pongola River appear to be Neocomian to Albian or even Cenomanian in age. Here the Senonian is absent. On pelecypod evidence alone it is not possible to state whether the succession is complete. The few fossils recovered from Mokatini seem to point to a Cenomanian age for these outcrops.

Smitter (1957a) described a foraminiferal fauna from Sandy Point, St. Lucia Bay. He observed the mixing of planktonic forms, which by themselves indicate very deep sea, with benthonic forms, which, if they are the exclusive components of a fauna, usually indicate shallow water. He therefore concluded that there was mixing of faunas from two different environments,

with horizontal displacement of planktonic forms and that the sediments were probably deposited in an open and shallow body of water[1]. The fauna is dated as Upper Campanian.

Smitter (1957b) described an evolutionary lineage which he found to take place within the genus Epistomina, from E. caracolla to E. pondensis and finally to E. zululandensis, through progressive increases of height of the ventral side and of ornamentation. According to Smitter, these evolutionary changes took place during the Campanian-Maestrichtian-Montian. Epistomina is not present in the Maestrichtian or in the Campanian in Borehole A, but is abundant in the Coniacian, as has been proved by studies subsequent to this thesis, and at deeper level in the borehole.

Van Hoepen (1929) studied the outcrops at the Umsinene River "where it has an easterly course". His work concerns mainly Ammonites and Pelecypods collected from seven miles of outcrop on the banks of the Umsinene and in its dry affluents. He found that the beds represent an unbroken sequence from the Aptian to the Senonian included. This formation he subdivided into seven zones, most of which bear local names.

The Ndabana Beds occur a little more than one and a half miles after the great eastward bend of the Umsinene and are formed of

[1] On the continental shelf there is mixing of planktonic and benthonic forms (Upshaw and Stehli, 1962; Loeblich and Tappan, 1964). It is not therefore necessary to postulate horizontal transportation of organisms.

sandstones and coarse conglomerates. Van Hoepen attributed this zone to the Lower-Middle Aptian. The Umsinene Beds outcrop about one hundred yards downstream from the Ndabana Beds, the interval being formed of soft beds which are not visible. The Umsinene Beds consist of sandy clays or clayey sands alternating in their lower part with banks of blue limestone and higher up with marls. This zone presents a notable change in its upper part, which is found upstream of a small dry tributary of the Umsinene and consists of calcareous sandstone. Its fauna presents great similarities with the overlying Skoenberg Beds. The Umsinene zone is correlated with the Upper Aptian-Albian. The Skoenberg Beds outcrop about a mile farther east, near the confluence of the Munyuana (Manuan Creek of Anderson?) and the Umsinene on the western side of Skoenberg Hill. They consist of soft, whitish and yellow limestones and have been compared to the Cenomanian. The change from the Skoenberg fauna to the Munyuana fauna occurs suddenly on the same Skoenberg Hill, and on its eastern flank the Munyuana Beds outcrop, lithologically undifferentiated from the Skoenberg. These beds are dated as Turonian because they follow the Cenomanian, because they are followed by Lower Senonian beds and because their fauna, although not identical, is considered sufficiently similar to known Turonian faunas to allow a correlation. About a mile below the Munyuana confluence a low bush limestone bank occurs. This outcrop forms the Peroniceras Beds which are of Lower Senonian age. The Itweba Beds which occur farther down, are formed of soft limestones, and were correlated with the Middle Senonian although zone fossils were not found.

The Umzamba Beds are of Upper Senonian age. They are correlated with the Umzamba Beds of Pondoland. They consist of loose stones found on a hill on the northwest coast of False Bay, between two

and three miles south of the Umsinene.

Other papers on Zululand by Van Hoepen treat Ammonite taxonomy. In these later works he did not insist on the presence of the Turonian in Zululand.

4. Techniques.

The Cretaceous rocks of Zululand borehole "A" become harder with depth. While the disaggregation of rock from relatively shallow depths can be easily accomplished by boiling it in water for approximately an hour, the deep-lying indurated sediments require more forcible methods of disaggregation. A method of macerating hard rock elaborated by Z. M. Kirchner (1958) was used. This method involves the use of Glauber's Salt and is based on the fact that Glauber's Salt expands when it crystallizes. Kirchner's method has been modified as the initial results were unsatisfactory. The technique now used to prepare Zululand Cretaceous rocks is:-

(i) 50 Grams of core are broken into pieces of about one inch diameter.

(ii) The sample is wetted, put into a refrigerator and left overnight.

(iii) The sample is then transferred into an oven at approximately 120° centigrade and left overnight.

(iv) A hot saturated solution of Glauber's Salt is poured over the sample.

(v) The sample is put back into the refrigerator and left overnight.

This modified technique has proved more satisfactory than any other so far used on the Zululand material, although it is some-

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