

II.—*On the Discovery of the Fossil Remains of Bidental and other Reptiles in South Africa.*

By ANDREW GEDDES BAIN, Esq.

*Abridged from a letter addressed by the Author to Sir Henry De la Beche, For. Sec. G.S., and dated "Fort Beaufort, April 29, 1844."*

[Read January 8th, 1845.]

PLATE II.

HAVING been employed, during the last seven years, under the Officers of the Corps of Royal Engineers, in superintending the construction of military roads in the colony of the Cape, more especially on its eastern frontier, and having also travelled far beyond that frontier in a northerly direction, I have had opportunities of observing the geological structure of that part of South Africa; and I venture therefore, although only a self-taught geologist, to submit the following observations to the Geological Society.

My principal field of research has been the tract of country extending northwards from the sea-coast of the county of Albany to the heads of the rivers which enter the sea on that coast\*. The sea-boundary of this county, commencing about 450 miles to the east of Cape Town, at the mouth of the Boschman's river, runs in a north-easterly direction about seventy miles, to the mouth of the Keiskamma river. In this length of coast are the mouths of the Great Fish and Gualana rivers, the former about 500 miles east of Cape Town, the latter about fifteen miles further to the north-east. The portion of the tract of country above described which I have examined with most attention, lies between the coast and the northern foot of the Winterberg mountain, whose summit is at the distance of nearly ninety miles from the sea. Respecting the country further in the interior I have also given some geological notices.

In this eastern extremity of the colony no granite has been observed; but the lowest rocks seen near the coast belong to a stratified series. Since their dip, though variable, is, in the main, from the sea inwards toward the land, it is the lower members of the series that are found nearest the coast; and of these the fundamental rock is a red quartzose sandstone, highly crystalline in parts, and alternating with a talcose slate. Its strike is east-south-east and west-north-west, and this direction is very constant; but the dip is extremely variable. An instance of this occurs near Graham's Town, the capital of the eastern province, where,

\* See the Maps, Plate II. and in page 55.

within a distance of 280 yards, measured at right angles to the strike, I counted six anticlinal axes; and found the strata at the summit of each axis bent at an acute angle, like a ridge-tile, and the rock highly crystalline.

The only data I have obtained, which may serve to indicate the age of this sandstone, are derived from a few vegetable casts and impressions, first discovered by Dr. G. Atherstone, and which appear to belong to a *Lepidodendron*. The best specimen of these markings in my possession is too bulky for transmission to England.

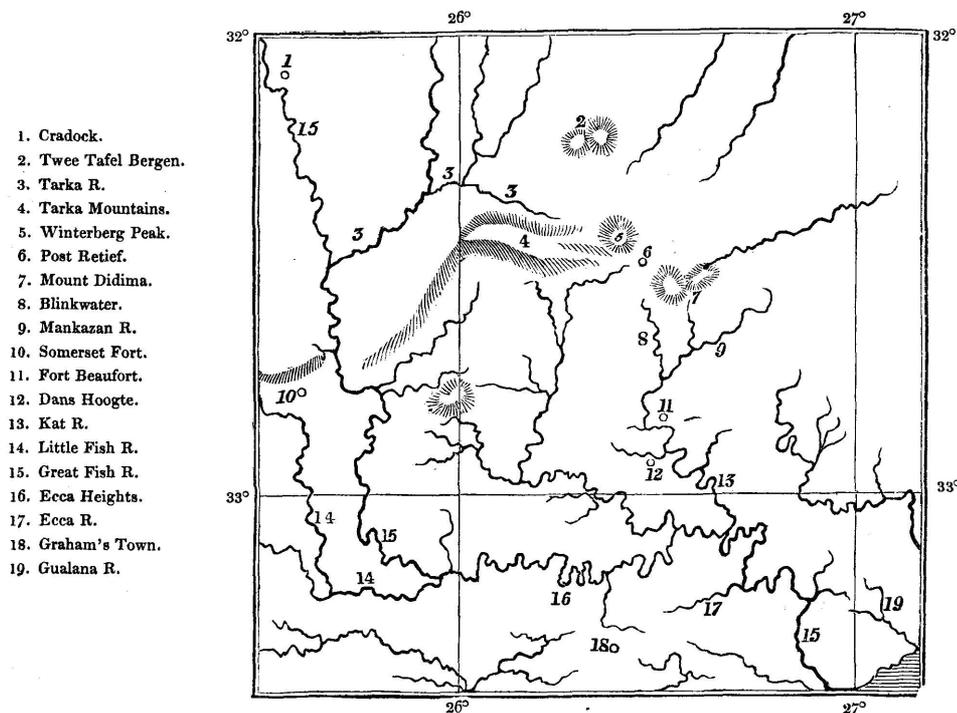
This rock is found on the coast at the mouth of the Great Fish river. Its northern boundary passes eight miles to the north of Graham's Town, that is, about thirty-five miles from the coast. To this formation belongs the rugged mountain chain, the *Zwarte Berg*, which runs about seventy miles inland, in a line parallel to the southern coast of the colony. I have also traced it further westward to the mountains on the Hex river, near Worcester, about sixty miles north-east of Cape Town. There it turns to the north-north-west, in the direction of the country of the Namaquas.

The next rock, in ascending order, is a claystone porphyry, consisting of a clear blue base, with numerous imbedded pebbles of quartzite, claystone, &c. It occupies the troughs in the undulating sandstone just described, which are bounded by parallel mountain-ranges of the same rock. In the hollows of some of these troughs it is from 300 to 500 feet thick, and, when seen in mass, has no appearance of bedding. It thins off towards the sides of the troughs. It often appears on the surface in small tongue-shaped portions, projecting from the ground at an angle of from  $70^{\circ}$  to  $80^{\circ}$ , and looking like gravestones in a churchyard.

I have traced one of the ridges of this rock through a distance of eighty miles, from the point where the ridge emerges from the sea, at the mouth of the Gualana river, to the point where the Great Fish and Little Fish rivers unite. The formation extends, I believe, much further both to the east and west. Its northern boundary, like that of the quartzose sandstone, passes eight miles to the north of Graham's Town.

I shall now take my course from Graham's Town, along the military road called the Queen's road, which runs northward to Fort Beaufort, forty-six miles. At the eighth mile the clay porphyry is overlaid conformably by a formation of great thickness, consisting of an argillaceous slate alternating with sandstone, and containing thin laminæ of hard, blue, impure limestone. Further northward, at the *Ecce* heights, this slate contains a stratum nine inches thick, consisting entirely of vegetable remains. At the Great Fish river the dip of the slate, which at the eighth mile was  $30^{\circ}$ , is reduced to  $5^{\circ}$ . The same formation continues northward about four miles further along the left bank of the river. Then a valley of elevation occurs, as if to allow the river a passage, and the slate is replaced by a green-

ish sandstone containing a number of blue calcareous nodules. Further north, the road traverses a second valley of elevation, and at the fortieth mile is the signal-tower of Dans Hoogte, standing upon a vein of greenstone.



At the further distance of six miles we arrive at Fort Beaufort, originally only a military post, but now a thriving town. It stands in a sort of basin surrounded by picturesque hills, on the right bank of the river Kat, one of the tributaries to the Great Fish river. Its height above the sea is about 1700 feet.

It is immediately to the north of Dans Hoogte that the district begins which has furnished the remains of the remarkable bidental reptiles, the discovery of which has induced me to make the present communication. Many of these are found in the basin of Fort Beaufort, and also at the Mankazan Post, twenty miles from that Fort in a north-easterly direction. The prevailing rock of this district is a slaty sandstone, readily disintegrating, and containing nodules of a greyish-blue argilliferous limestone, resembling septaria. In these nodules the fossils are found thinly coated with limestone, the bone and its stony matrix being often so thoroughly amalgamated as to render it difficult to distinguish between them. At the Mankazan Post, in the same strata which furnish bidental remains, my friend Mr. Borchers has lately discovered small bivalve shells. I had not procured specimens of these shells when my collection was shipped for England.

Passing on from Fort Beaufort, you find, at the entrance of the gorge of the Kat river, a bed of greenstone about fifty feet thick, which rests conformably on the stratified sandstone; and this remark applies to all the masses of greenstone on the south of the Winterberg mountain. On quitting the gorge you turn to the north and arrive at the Winterberg new road, which follows the course of the beautiful Blinkwater valley; and in this valley you meet with another bed of greenstone. It was near the Blinkwater Post that, while superintending the construction of the road, I succeeded in extracting from the scarp of a steep hill of sandstone the lower part of the pelvis, a fragment of the bony cuirass, the head armed with sixty teeth, and other bones of a large reptile.

On reaching the first elevated platform of the Winterberg region, another bed of greenstone occurs. This sandstone region, though cold and bleak in winter, is healthy and beautifully verdant, and produces corn and wine in considerable abundance. In this, as in all other sandstone districts of the colony, the water is pure, but the grass is sour; whereas in those districts where argillaceous rocks prevail, the water is brackish, but the grass is sweet. For this reason, the tracts where clay predominates, are greatly preferred for breeding sheep and cattle.

The road, as it ascends above this platform, passes to the west of the lofty and serrated edge of the Didima, which forms the northern boundary of the Hottentot settlement on the Kat river. Near the military station, called Post Retief, a trap dike crosses the road; and as you ascend higher, the dikes increase in number, and the strata of sandstone become intermixed with greenstone. The dip has here diminished to  $3^{\circ}$ , and it goes on lessening towards the north. The base of the escarpment of the peak of the Winterberg is covered with dense forests of timber. The southern and eastern escarpments of the peak consist of a buff-coloured, soft, stratified sandstone, intermixed with basalt, greenstone and syenite. The summit of the peak is a flat tabular mass of trap, about 6000 feet above the sea.

To form a notion of the geological structure of the singular country which you survey from this lofty eminence, and which forms part of a similar district of great extent, you have to imagine a plain between 500 and 600 miles long from east to west, and about 200 miles broad from north to south, and this plain elevated from 3000 to 4000 feet above the sea. Let there be superimposed on this plain, in some parts long continuous ranges, in others detached table-topped mountains capped with trap, these ranges and mountains rising to a further height of from 500 to 3000 feet. Let all the stratified rocks within this area be perfectly horizontal, and be intersected with a network of trap dikes from eight inches to 100 yards broad, and many of them more than fifty miles long. Such is the character of the country which, at a variable distance from the sea-coast, extends from the Roggeveld, about  $1^{\circ}$  east of Cape Town, to the Amatembu territory,  $8^{\circ}$  further to the

eastward; and of this country the portion within view from the summit of the Winterberg presents a correct epitome.

The northern side of the Winterberg is without a vestige of wood, and is less steep than the southern. The Tarka river rises on the descent to the north-west, and after flowing in that direction about thirty miles, and then nearly the same distance to the south-west, (in which course it passes through the extensive level plains, named, after the river, the Tarka plains,) it falls into the Great Fish river. These plains are bounded by a number of fantastically-shaped mountains, among which are the Twee Tafel Bergen, twenty miles north-north-west of the Winterberg peak. In descending towards the military station, called Tarka Post, the peculiar forms of the detached hills, with their basaltic cappings, begin to attract attention. I append an outline sketch of this singular district, representing these cappings formed of huge columns from 50 to 200 feet in height, resting on horizontal strata, and the



basaltic dikes which traverse the strata. If we suppose the whole of these tabular summits to have been once continuous, denudation, in order to reduce them to their present disconnected state, must evidently have operated on a very gigantic scale.

In the Tarka mountains, which may be regarded as a prolongation of the Winterberg range, a calcareous pisolite is found, unfit for lime-burning, owing to the quantity it contains of alumina and oxide of iron.

On the northern side of this range, at Tarka, I found remains of Bidentals; and I made the same discovery in the Graaff Reinet division, nearly 100 miles to the west of Tarka. Moreover I have little doubt, from the recollection I have of some osseous remains which were found some years ago in the district of Beaufort, about 100 miles further westward, that these also belonged to the same group of reptiles.

What may be the geological position of the formation containing these reptilian remains is a point not easily determined, in consequence of the difference there is, in composition and external appearance, between the strata of South Africa and the known and described strata of other countries. The difficulty is the greater, from the extremely rare occurrence of fossil shells; for throughout the whole of the extensive area in which reptilian remains occur, not a single shell has been discovered, so far as my own researches have gone; and except the instance of Mankazan, I know only of one other in which such a discovery has been made. I here refer to an Ammonite, which a friend of mine, dwelling at Cradock, found *in situ*, at the summit of the Spitzkop, or Compass Berg, 7000 feet high, and the loftiest mountain in South Africa; it lies 100 miles west-north-west of the Winterberg peak.

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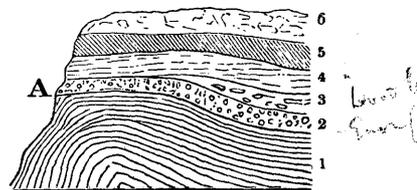
This fossil is now in my possession, and agrees, I believe, with *Ammonites planulatus*. There are, it must be acknowledged, no sufficient data for determining with precision the age of the formation in which the bidental remains are found.

Returning once more to the Winterberg peak as a point of departure, and then passing on towards the north, we arrive, after traversing seventy miles, at the Bambus Bergen, a mountain chain in which the most northerly of the feeders of the Tarka river have their source. After a farther distance of seventy miles, in the course of which we meet with detached hills separated by extensive and dreary plains, we arrive at the magnificent Nu Gariep, or Orange river, in whose bed are rounded pebbles of serpentine, steatite, asbestos, agate, and amygdaloid both of black and white colour; these minerals being entirely different from those which form the materials of the pebbles occurring in the river-beds within the colony. In the country beyond the Nu Gariep, extensive coal-fields have been discovered; and I have received from the neighbourhood of the Modder or Alexander river, which enters the Ky Gariep in south latitude 29°, the head of a bidental reptile\*.

I propose in the next place to describe an overlying conglomerate and some tertiary deposits which occur in Lower Albany; after which I shall proceed to notice the detrital deposits of the basin of Fort Beaufort. The conglomerate manifestly consists of the debris of the red quartzose sandstone, described at the commencement of this paper; the debris being cemented together by oxide of iron, which abounds also in the parent rock. The bed lies unconformably on the sandstone and clay porphyry above described [see the next diagram], and has not been observed to the north of the northern limit of those rocks; but numerous detached portions of it appear throughout the lower part of the district of Albany. It has not been found to contain organic remains.

Of the tertiary deposits a fine section is displayed on the estate of Mr. Onslow Peché, and is represented in the annexed diagram.

In this sketch, (1) is the underlying quartzose sandstone, on which rests the conglomerate (2); and at the junction of the beds are three caves (A), containing capillary crystals and stalactites of alum. (3) is a soft friable sandstone, containing large masses of fossil wood; and it is covered, first by a calcareous marl (4) and then by a shelly limestone, abounding in shells like those still existing on the South African coasts. The last and uppermost bed (6) is a soft calcareous rock, filled with gigantic oyster-shells. I have reason to believe that tertiary formations similar to these extend all along the coasts, and I hope to enjoy further opportunities of examining them.



\* *Dicynodon testudiceps* of Owen. See the next memoir.

A vast diluvial deposit is found in the basin of Fort Beaufort, rising in many places more than 100 feet above the banks of the Kat river. It is made up of fragments of the rocks that compose the neighbouring mountains, the fragments being well-rounded by attrition. A considerable quantity of calcareous tufa, and also of detached calcareous nodules, differing in texture from those occurring in the neighbouring strata, are also present in this deposit. In the lower parts of the basin alluvium is found of considerable thickness. No fossils have hitherto been obtained from either of the above modern deposits.

From an alluvial deposit on the banks of the Modder river, before noticed, there was obtained, about five years ago, the skull of a kind of Buffalo, retaining the bony core of a pair of horns, which it is calculated must have measured full fourteen feet from tip to tip when perfect. This fossil is now in Cape Town.

[N.B. *Professor Owen, in compliance with the earnest wish expressed by Mr. Bain, having undertaken to examine and describe the principal specimens in Mr. Bain's collection, it has not been deemed necessary to publish the original catalogue of specimens which accompanied the foregoing paper.*]

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### III.—*Report on the Reptilian Fossils of South Africa.*

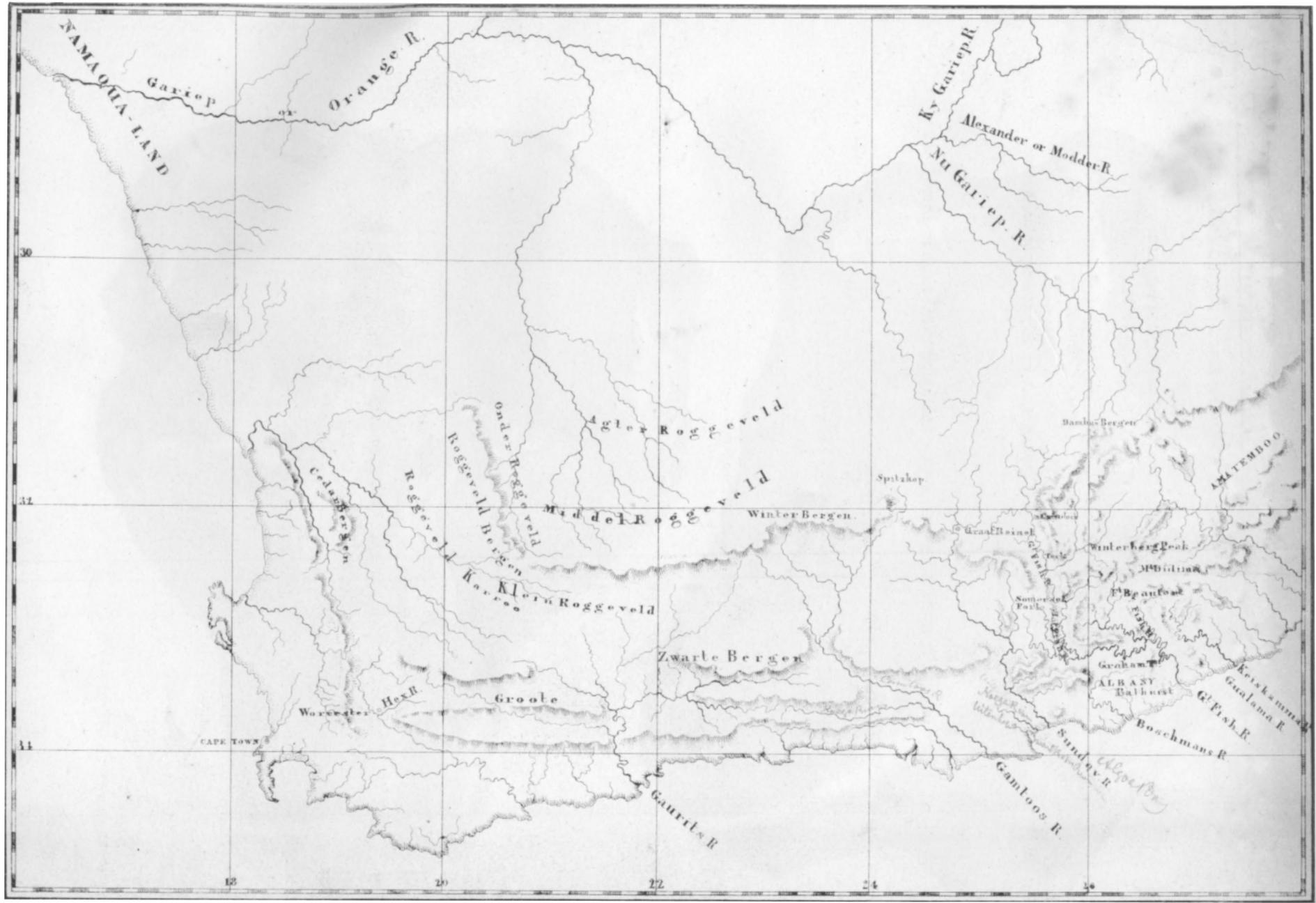
PART I.—*Description of certain Fossil Crania, discovered by A. G. Bain, Esq., in Sandstone Rocks at the South-eastern extremity of Africa, referable to different species of an Extinct genus of Reptilia (Dicynodon), and indicative of a new Tribe or Sub-order of Sauria.*

By RICHARD OWEN, Esq., F.R.S., F.G.S. &c.

[Read January 8th, 1845.]

PLATES III. TO VI.

**B**EFORE commencing the present Report, I must express my great obligation to Mr. Bain for the opportunity of studying the extraordinary fossil remains which form its subject, and for the favour which that zealous explorer of South African geology has conferred on me, by coupling, with his transmission of the fossils to the care of the Geological Society, the request that I would undertake their description.



MAP of a portion of Southern Africa

*From Brothers in the Sculpt*