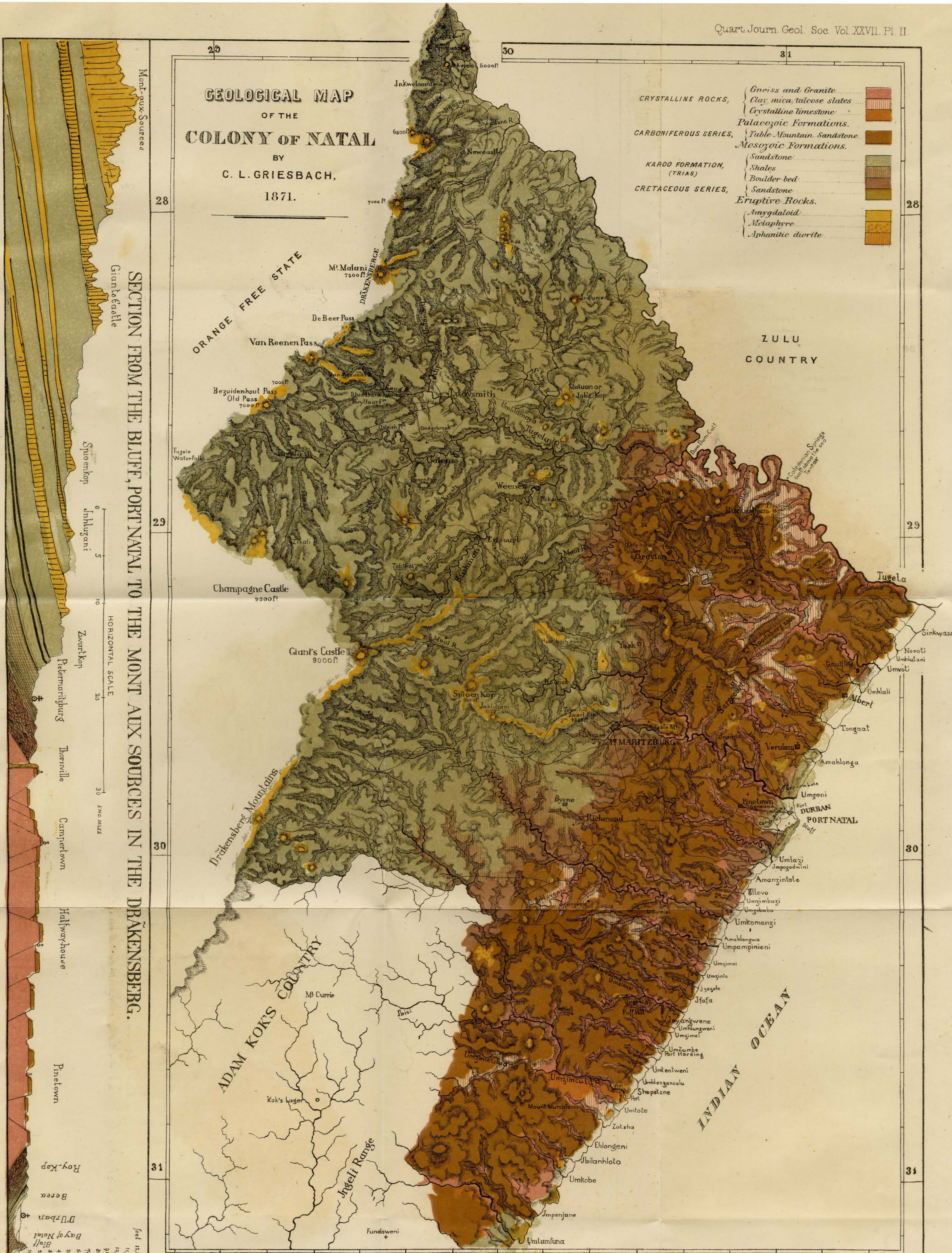

GEOLOGICAL MAP
OF THE
COLONY OF NATAL
BY
C. L. GRIESBACH,
1871.
CRYSTALLINE ROCKS,
Gneiss and Granite
Clay, mica, talcose slates
Crystalline limestone
Palaeozoic Formations.
CARBONIFEROUS SERIES,
Table Mountain Sandstone
Mesozoic Formations.
KAROO FORMATION, (TRIAS)
Sandstone
Shales
Boulder bed
CRETACEOUS SERIES,
Sandstone
Eruptive Rocks.
Amygdaloid
Melaphyre
Aphanitic diorite
SECTION FROM THE BLUFF, PORT NATAL TO THE MONT AUX SOURCES IN THE DRAKENSBERG.
HORIZONTAL SCALE
ENG. MILES
Mont aux Sources
Giants Castle
Spioenkop
Jnhlugani
Zwartkop
Petermaritzburg
Thornville
Campertown
Halfwayhouse
Pinetown
Roy-Kop
Berea
D'Urban
Bay of Natal
Bluff
feet
ORANGE FREE STATE
ZULU COUNTRY
INDIAN OCEAN
ADAM KOK'S COUNTRY
DRAKENSBERGE
Drakensberg Mountains
Newcastle
Mt. Malani 7200 ft.
De Beer Pass
Van Reenen Pass
Bezuidenhout Pass
Old Pass
Tugela Waterfall
Ladysmith
Colenso
Weenen
Estcourt
Champagne Castle 9500 ft.
Giant's Castle 9000 ft.
Spioen Kop
Jnhlugani
Mooi R.
Tugela
Greytown
Pt. MARITZBURG
Richmond
Byrne
Verulam
Albert
Tongaat
Amahlonga
Umgeni
Pinetown
Fort
DURBAN
PORT NATAL
Bluff
Umlazi
Amanzintote
Illovo
Umkomanzi
Umpampinioni
Umzinto
Ifafa
Umzumbe
Port Harding
Umzimculu
Shepstone
Umtote
Zotsha
Ehlongeni
Jbilanhlota
Umkobe
Jmpenjane
Umtamsuna
Sinkwassi
Nonoti
Umhlutani
Umvoti
Umhlali
Mt. Currie
Kok's Lager
Jngeli Range
Fundasweni
Mount Murchison
Table Mt.
Colenso Springs
Dum Dum Cati
29
30
31
28

[*From the* QUARTERLY JOURNAL *of the* GEOLOGICAL SOCIETY *for May* 1871.]

ON THE

GEOLOGY OF NATAL

IN

SOUTH AFRICA.

BY

CHARLES LUDOLF GRIESBACH, Esq.,

CORR. MEMBER OF THE K. K. GEOLOGISCHEN REICHSANSTALT, AND OF THE K. K. GEOGRAPHISCHEN GESELLSCHAFT, VIENNA.

(Communicated by Henry Woodward, Esq., F.G.S.)

[PLATES II. & III.]

I. GEOGRAPHY OF THE COUNTRY: WATERSHEDS.

THE colony of Natal presents the appearance of a series of terraces; the first terrace begins to rise about thirteen to twenty miles from the coast, and forms a hilly country, about 1000 feet above the level of the sea. It forms plateaux in abrupt rising steps until it reaches the height of about 2300 feet, after which the country sinks gradually again to the level of Pietermaritzburg (2080 feet above the sea); but

it soon rises again to the high plateaux of the Town Hill and Zwartkop (about 5000 feet high). In a very few steps it forms the long and mighty range of the Draakensberge, which form the great watershed line between the rivers of the Atlantic and the Indian oceans. We find in this range the Mont aux Sources (12000 feet above the level of the sea), a knot of mountains, which sends spurs in five directions, forming the Witteberge and the Quathlamba Mountains. All these great steps and plateaux run parallel to the coast, and consist of more or less broad belts of country. The small belt on the sea-shore shows tropical vegetation. The sugar-cane, the coffee, and now recently the tea shrub, and the greatest variety of tropical fruits find here suitable climate and ought to be sources of immense riches to the country if properly managed. When we ascend the first terrace, the change in the landscape is at once remarkable, and the vegetation has quite a different character. The sugar-cane and exotic creepers disappear, and their place is taken by more European plants; but the coffee-shrub and many a fruit-tree strange to the eye of the newly arrived European still remain. At a still higher point these remains of subtropical vegetation also disappear, and nothing is visible to the eye but vast plains of "*veldt*," stretching for miles, covered with coarse-looking grass, and only interrupted by ant-hills and deep holes made by the ant-bear (the worst foe of those most industrious insects). Nothing more cheerful meets the eye in these vast tracts than small hills and grass—grass everywhere—only occasionally a lonely cattle-farm with the surrounding never missing gum-trees, which give the place a still more lonely and cheerless appearance. This belt is about thirty miles broad, and runs through Kaffirland, Natal and the Zulu country. The succeeding, third district is the most salubrious one, whose climate agrees best with the constitution of Europeans. The soil is covered with a luxuriant grass vegetation, which supports a strong and fine race of cattle. The higher the ground ascends, the more fruitful it becomes; and on the elevated plains, in the district where the yellowwood-tree flourishes, wheat and almost all our European fruits will grow magnificently. Here the winter, although not so severe as in northern Europe, is more like the climate we are accustomed to, and is therefore a real paradise to emigrants, who not only find a country where their labours receive their best reward, but also a more genial climate than the coast-district affords. Natal's rivers flow to the Indian ocean and supply the colony with abundance of water, which makes its soil superior to that of the "old colony," with its vast plains, "karoos," and dreary "veldts."

II. Geology.

The geological structure of the country is shown by the map and section on Plate II., in the preparation of which the author has supplemented the results of his own researches by those of Dr. Sutherland and M. Franz Gröger.

1. *Granite and Gneiss.*—Granite in South Africa does not form the centre of the country or the most prominent of the elevations.

It is only visible at the lowest parts of the river-valleys and near the coast, in fact wherever the river, by its erosive action, has removed the sedimentary rocks. If we draw a straight line from the Umtwalumé river due north, we shall touch all those parts of the country where granite and gneiss reach the surface through the covering of stratified rocks. Granite, as Livingstone correctly observes, forms the bones of the country, which at places are seen through the skin. It only forms hills and the bottoms of river-valleys. The granite is mostly a fine-grained grey variety; sometimes it becomes very coarse and contains large crystals of feldspar; altogether it has the same appearance as the granite at the Cape, which Hochstetter first described as similar to the Karlsbad granite. At some places there is a red variety, in which the quartz and mica nearly disappear, being a mere feldspathic rock, in which decomposition reaches a great depth, when it presents a kaolin-like appearance, similar to that found by me at the Umzinto and at the Jfafa river. Further to the south, at the Umtwalumé, Ehlongeni, and Umkobe rivers in Alfredia, the belt of granite becomes broader, and represents a distinct zone. The greatest elevation is reached by the granite in the counties of Victoria and Umvoti, where the Noodsberg group of mountains and all the surrounding country, and the bottoms of the valleys of the rivers Umvoti and Tugela, in the latter very far up, consist principally of this rock. I have found gneiss at several places, as, for instance at the base of the Sluten-Konga (Mount of Mist), at the head-waters of the Umtwalumé, &c.; but nowhere was it practicable to map it, as the high grass vegetation rendered surveying quite impossible. The granite is traversed in all directions by quartz-veins, which seldom have a thickness of more than from about 1 inch to 2 feet. The quartz itself is a beautiful white variety, almost like glass, which, besides occurring in veins, is very frequently met with in large masses, called "reefs," which usually very soon thin out towards their base. These quartz masses were always a subject of great interest in Natal, as it was thought that they would yield gold in paying quantities. Such is actually the case at almost all places, but not in sufficient quantities to yield a profit for crushing it. At the Umzinto-river valley, after a long time occupied in searching, I succeeded in finding small traces of gold in a variety of grey granite, which also reminds one much of the granitite of Bohemia. The alluvium there also contained gold, but only in traces, and not nearly sufficient to pay any one to work at it.

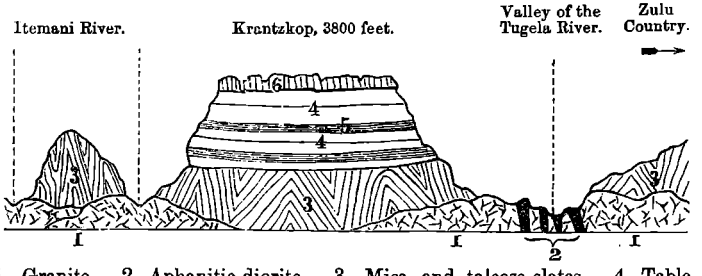
2. *Mica-schists, Clay-, Chlorite-, and Talcose Slate formations.*—All these slate formations are to be met with at places where the granite base is laid bare; and everywhere the slates stand nearly upright, at an angle of 70–75°, with a strike from north to south. The clay- and talcose slates are very well seen at the Umzimculuana (little Umzimculu), in the county of Alfred, and at the Tugela, at the junction of this with the Umziniaty river, and also at the Itemani, a small tributary of the Tugela. At the Umpampinioni river a dark grey clay-slate, dipping at an angle of about 40° and striking from south to north, possesses considerable thickness (about 200 feet or more). It rests on granite, and underlies and is conformable

to the overlying sandstone, to which it belongs, as I think, and not to the older clay-slate formation. It is remarkable that at the Tatin (so-called "goldfields") the slate formations have the same strike and are elevated at the same angle of about 70°. At the mouth of the Umzimculu, about seven or eight miles from it, and north of the young township of Murchison, the river breaks through crystalline limestone of enormous thickness, but whose position relative to the neighbouring strata is not clear. On both sides of the valley the limestone forms precipitous walls of some 1000–2000 feet, which are luxuriantly covered with vegetation. Also the bottom of the river consists there of the same rock, the thickness of which towards the base is not known. On the surface it only covers a space of about four square miles.

3. *Table-Mountain Sandstone.*—The sandstone plateaux, which are so characteristic of the African landscape, lie perfectly horizontally upon the old slate formation, and at some places upon the granitic base. The sandstone, forming precipitous tableland, has never been disturbed; nowhere is a folding of the deposits visible; only fractures run through the zone, in which masses of Aphanitic Diorite are seen, which have burst through the granite and slate formation; but nowhere is the sandstone raised up at an angle, or folded by the greenstone. The high plateaux are covered with a dense grass vegetation; and numerous herds of cattle feed on the level summits of the tableland. The soil is extremely poor, and there is not even a shrub to interrupt the endless uniformity of the landscape. The rivers have made their way through the beds and strata of this sandstone, thus forming precipices, at some points several thousand feet in height. The sandstone shows the same lithological peculiarities as the Table-Mountain Sandstone of the Cape, after which it is named. The tops of many of the "table mountains" of the Colony are crowned by beds of a dark basaltic greenstone (fig. 1) which also possesses the same pillar-like structure as our basalt. It contains fragments of quartz, granite, and gneiss. In a variety of this igneous rock, from the "Great Karoo," I found small traces of gold. I never found any organic remains in the sandstone of the Colony itself, except in a thin soft shale, with much mica in it, which seems at the Krantzkop (fig. 1) to be a bed in the sandstone, from which I got some small bivalves and a finely striated *Patella*, both too indistinct for determination. Such shale is also exposed near the upper drift of the Umkomaz river, near Richmond, and at several other places in the Colony. The Sluten-Konga, Table Mountain near Pietermaritzburg, Inanda, and Noodsberg are examples of the regular-shaped table mountains of South Africa. The same shales and quartz-sandstone form the Krantzkop, which drops nearly vertically down to the Tugela river, about 3800 feet. The high plateau of it is capped with melaphyre-like greenstone. The basis of the Tugela valley is granite, intersected by dykes of an aphanitic diorite. The slate formation, the layers of which stand almost vertical, rests on the granite and is covered with the so-called "Doorns," the celebrated mimosa vegetation of South Africa: the great mass of the mountain is built up of sandstone, and crowned

with basaltic greenstone. In this locality, but on the Itemani side of the Krantzkop, I found the small traces of organic remains in the shaly bed of the sandstone which I mentioned above.

Fig. 1.—*Section through the Krantzkop Mountain.*



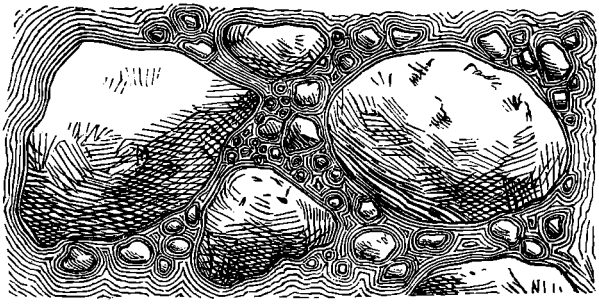
1. Granite. 2. Aphanitic diorite. 3. Mica- and talcose slates. 4. Table-Mountain Sandstone, with, 5, thin layers of a soft shale containing a few traces of fossils. 6. Melaphyre.

4. *The Karoo Formation.*—So called after the Karoos, the immense plains of the interior, as they are principally composed of strata of this formation, which has its greatest height above the sea in the Draakensberg range (see Section, Pl. II.). The lower part of the land on the Natal side of this range rests partly upon the Table-Mountain Sandstone, but not conformably. The Karoo sandstones and shales occupy the largest portion of South Africa, as they compose the whole of the interior, forming the high elevated plains of the Kalahari, the Free States and the Transvaal, as well as the countries to the north as far up as the Limpopo; they are also to be met with at the Zambezi. As Mr. Tate, and Profs. T. R. Jones, Owen, and Huxley have already so ably described this formation with its fossil contents, little remains for me to say. The dark-grey and blue shales of Pietermaritzburg, containing oxide of iron in great quantities, represent the Ecca-beds of the great Karoo. Further up it passes gradually into sandstones of much the same lithological character as the Table-Mountain Sandstone, with intervening layers of shale, which at Ladysmith, Newcastle, in the Tugela valley, &c. contain beds of coal. Numerous remains of reptiles and plants are described, which come from the Natal side of the Draakensberg; and therefore the age of these beds may be determined. Mr. Tate regards them as Triassic, whilst Mr. Wyley thinks that they belong to the Carboniferous period; but as the coal from Tulbagh, in the Cape Colony, is decidedly carboniferous (*Calamites*, *Equisetum*, and *Lepidodendron* in the sandstone), and the succeeding Karoo formation (which is a freshwater deposit) does not lie conformably on the former, Mr. Tate's opinion seems the most acceptable. Also the same formation, with *Dicynodon* and *Glossopteris Browniana*, occurring in India at the base of the cretaceous series, is proved, by a careful examination of its flora, to be a Triassic deposit. There can certainly not be the slightest doubt that the Natal coal belongs to a far younger period

than the Tulbagh coal, which is an equivalent of our Coal-measures.

The "Karoo formation" also occurs in a small belt on the sea-coast of Natal, which belt is never broader than from seven to eight miles, if so much. Beds of the Karoo series are well exposed at the Umgeni mouth and also at the Ifumi river. Any one who has been to Pietermaritzburg must have observed cuttings on the road, about seven or eight miles before he reaches the capital, in a dark shaly rock, with large boulders of older rocks imbedded, of granite, gneiss, slate, and also frequently of greenstone (fig. 2). These boulders are so characteristic of African scenery that they have received general attention. The boulders, often of very large size, are imbedded in a soft grit and shaly clay, containing small particles of mica.

Fig. 2.—*Irregular boulders of Greenstone, sometimes Granite or Gneiss, imbedded in clay and grit.*



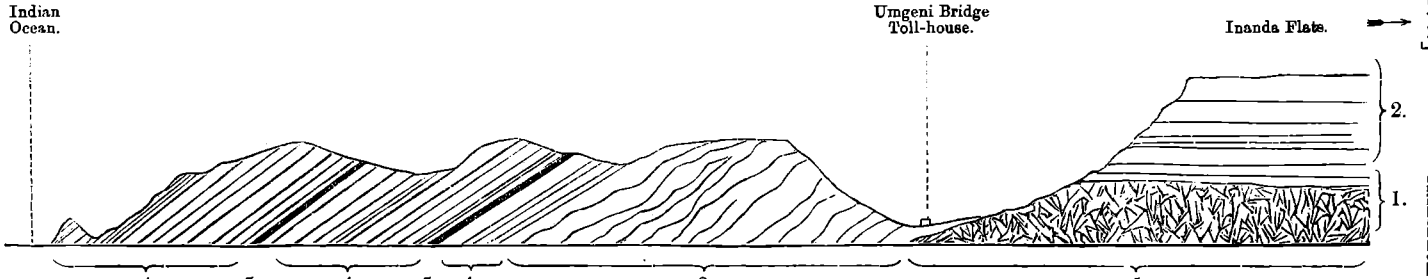
The boulders seem to have been formed on the spot, or at least have not travelled very far, as many of them have kept their angular shape, and they seem to have undergone rather a process of decomposition than of rolling. These beds ("boulder-beds") extend often over a very large area, and pass everywhere beneath the dark shale, which represents the base of the Karoo plant-beds. This is proved by a section at Thornville, and also on the sea-coast of Natal at several places, amongst them at the Umgeni valley and the Ifumi river. At the Umgeni and Durban the sections are as in figs. 3 & 4.

Both these sections show that the plant-bearing shales and sandstones rest unconformably on the older Table-Mountain Sandstone, and also that the boulder-bed lies at the base of these plant-beds.

The same is shown at part of the road between Pietermaritzburg and Thornville (see Section, Pl. II.).

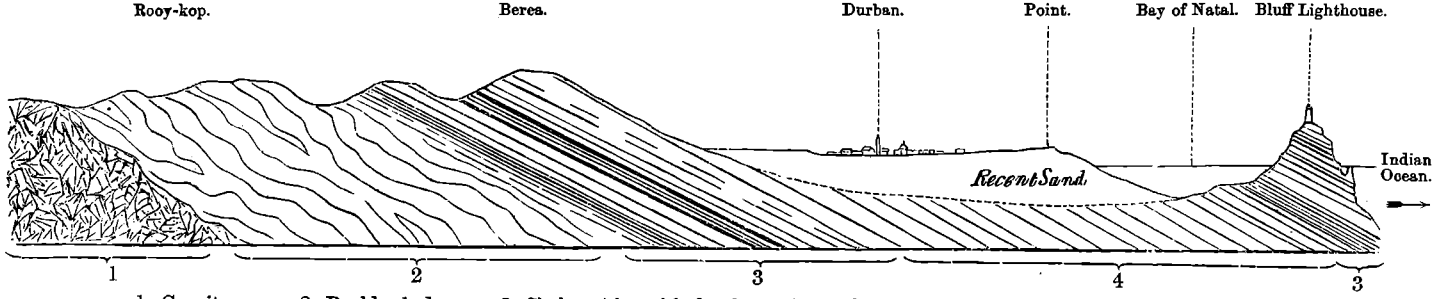
The boulder-bed here, in the same way as in the other sections, passes gradually into the shale of Pietermaritzburg, which, as I think, belongs to the lowest bed of the Karoo series. We learn from the Geological Survey of India that almost the same formation of

Fig. 3.—*Section exposed by the Umgeni river, north of Durban.*



1. Granite. 2. Table-Mountain Sandstone. 3. Boulder-bed. 4. Shales with faint plant-impressions and, 5, thin coal-beds.

Fig. 4.—*Section between the Bluff, Port Natal, and the Rooy-kop.*



1. Granite. 2. Boulder-bed. 3. Shales with coal-beds, alternating with, 4, Sandstone-beds belonging to the Karoo series.

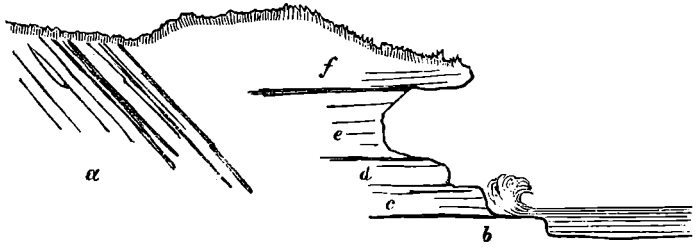
shales, sandstones, and calcareous grit contains the same forms of plants, as well as reptilian remains of *Dicynodon*, and lies conformably on a boulder-bed, which gives the impression that it was formed on the spot, and was not transported by the action of water. It is also remarkable, and an observed fact, that this boulder-bed of Southern India passes gradually into the succeeding shales and sandstones, which have been termed by the Indian geologists "the Ootatoor plant-beds." A lithologically similar boulder-formation I have also seen at the same horizon in the Cape Colony, passing beneath the blue Karoo shales; and I am pretty certain that Mr. Bain and many of our African geologists have taken this boulder-bed, at many localities, for an igneous trappean rock. Mr. Bain (see his map) calls this boulder-bed, which dips under the "Ecca-beds" of the "Pataties Revier," "Claystone Porphyry." There is certainly a basaltic melaphyre, forming beds of considerable extent in this lowest part of the Karoo formation, as, for instance, can be seen near Platte-fontein, in the great Karoo; but this trap does not belong to the extensive beds of boulders at the base of the "Pataties Revier" shale. At first sight the trap and the boulder-bed have many similarities, as the material of the boulders is partly derived from igneous rocks. Dr. Sutherland thinks that the boulder-bed was formed by glacial action, and tries to prove it by the observed fact of grooves and furrows on the plateaux of the Table-Mountain Sandstone. These grooves, quite similar to those in our Alps, occur in great abundance on the sandstone of the Ifumi river, about twenty miles south of Durban.

The greenstone (melaphyre ?) has found its way through this formation at many places, and forms beds between the strata of it. The greenstone contains a great quantity of pebbles of older rocks imbedded, which give it a speckled appearance. But it seems that the greenstone eruption happened at the earliest period of the forming of the Karoo beds, as the "kopjes" of greenstone are only found in the lowest strata of the "Pietermaritzburg shales," and in the succeeding sandstones. The series of greenstone "kopjes," which runs from the Ingeli Range in Kaffirland up through Richmond, York, and Greytown to the Tugela river, is of practical importance, as in it, or in the direction of its strike, the occurrence of copper ores can be traced through the whole of South Africa. Besides this Trappean greenstone, a second igneous formation may be found within the Karoo series, the so-called amygdaloid rock, which caps many of the heights of the upper Karoo beds, and often forms extensive beds between them. From it are derived the various kinds of chalcedony, agates, rock-crystals, and topazes which are so plentiful in the rivers of the Free States and Natal.

5. *The Cretaceous Rocks of South Africa.*—Between the rivers Umtamfuna and Umzambane, about five miles from the southern boundary-line of Natal, on the south-eastern coast of Africa, some deposits are found which at first sight seem to be of the same ma-

terial as the underlying stratum. They consist of sandy marls and hard sandstones of a greyish-brown colour, with a few calcareous concretions. These rocks are partly covered at high water by the sea, which has hollowed out small cavities in them (Fig. 5). They have probably served at some period as a shelter for white people, as the natives of this district call them "Izinhluzabalungu," houses of the white men. These rocks only extend for a short distance, and only form isolated cliffs. They are found, too, at the Impengati river, and at some of the more southern rivulets which run into the sea between the boundary of Natal and the St. John's river (Umzimvooboo). The same are also recognized in the bed of a small stream, running into the St. Lucia bay, in the Zulu country. The strata forming these deposits are perfectly horizontal, and they rest upon a sandstone of much older age, which belongs to the very interesting series of the Karoo formation. It is remarkable that the Izinhluzabalungu rocks do not rest conformably upon the older formation, the plant-bearing sandstones.

Fig. 5.—*Izinhluzabalungu Caves.*



a. Karoo shales and sandstones. *b*. Sandstone with fossil wood &c. *c*. *Trigonia*-bed. *d*. Ammonite-bed. *e*. Gasteropoda-bed. *f*. Zone of *Ammonites Gardeni*.

I have been enabled to distinguish no fewer than five distinct faunas. The lowest stratum is a hard calcareous sandstone (*b*), very much worn by the sea breaking against it at high water. Large trees and branches are imbedded in it, lying about in all directions. The wood is traversed by large masses of *Teredo*, whose holes are filled with iron pyrites. Resting on this stratum is a bed of softer brown sandstone (*c*), with great abundance of *Trigoniæ*. This bed is more exposed near the Umzambane river, and nearly concealed at the northern end of the deposits. It is overlain by sandstones and grits (*d*), containing Ammonites, resting upon which is a softer sandstones and grits (*e*), containing many fossils, mostly bivalves and Gasteropods. The roof of the caves is formed by a harder limestone stratum (*f*), which has not been so easily worn away by the sea as the underlying sandstone stratum. This limestone contains *Ammonites Gardeni*, Baily.

Fauna of the Izinhluzabalungu deposits.

Species.	Stratum.		Equivalent in Northern Europe.
Ammonites Gardeni, *Baily* Fossil bones, wood, &c.	Harder brown limestone (*f*).	Cretaceous period.	White chalk most probably.
Pugnellus uncatus, *Forb.* Fasciolaria assimilis, *Stol.* Fasciolaria rigida, *Baily* Tritonidea trichinopolitensis, *Forb.* Scalaria turbinata, *Forb.* Solarium Wiebeli, nov. sp. Chemnitzia undosa, *Forb.* Euchrysalis gigantea, *Stol.* Solariella radiatula, *Forb.* Avellana ampla, *Stol.* Natica multistriata, *Baily* Pollia pondicherriensis, *Forb.* Lagena nodulosa, *Stol.* Cerithium (Fibula ?) detectum, *Stol.* Cerithium kaffrarium, nov. sp. Turritella multistriata, *Rss.* Dentalium, spec. Ostrea, spec. Pecten quinquecostatus, *Sow.* Pecten amapondensis, n. sp. Arca capensis, n. sp. Arca natalensis, *Baily* Pectunculus africanus, n. sp. Trigonia elegans, *Baily* Cardium denticulatum, *Baily* Cardium Hillanum Venus arcotensis, *Forb.* Astarte, sp. Inoceramus expansus, *Baily* Hemiaster Forbesii, *Baily* Holaster indicus, *Forb.* Diadema, spec. Ammonites umbolazi, *Baily*	Soft brown sandstone and grit, with numerous fossils (*e*).		Probably Upper Greensand.
Ammonites Soutoni, *Baily* Ammonites Stangeri, *Baily* Ammonites rembda, *Forb.* Ammonites Kayei, *Forb.* Anisoceras rugatum, *Forb.*	Sandstone and grit, very much like the above (*d*).		Lower Greensand.
Trigonia Shepstonei, nov. sp.	Hard sandstone(*c*).		
Fossil wood, with *Teredo*	Hard sandstone, very much water-worn (*b*).		
Faint plant-remains	Karoo sandstone and shales (*a*).		.....Triassic?

Description of Species.

Genus AMMONITES.

There are four species described in Mr. Baily's paper, to which I have to add two more, both of which are found in the Cretaceous series in Southern India.

One of the commonest species in this formation is

AMMONITES UMBOLAZI, Baily. Pl. III. fig. 1.

A fine and characteristic form, which is not quite distinctly figured in Mr. Baily's paper. The flexuous ribs on the well-preserved shell are not so strongly marked as in the figure, and do not show the least tendency to form tubercles near the back, but gradually die away in all the specimens I have seen. Number of specimens 26.

Locality. Umtamfuna river, South Africa, from bed *d*.

AMMONITES REMBDA, Forbes. Pl. III. figs. 2, 3.

The whorls are higher than wide; it possesses a remarkably shaped keel. The shell is well preserved. It has distinct furrows, which are about 6 to the whorl, and are slightly bent near the keel, towards the mouth. The suture is easily detected; 6 lobes and 6 saddles can be made out. The dorsal saddle is tripartite, the next two lateral saddles bipartite, and the next three only single saddles. The dorsal saddle is double the height of the dorsal lobe; the lateral lobes are very deep; the lateral saddle is of the same height as the dorsal one; but the succeeding ones decrease very rapidly in size. Forbes's figure of this Ammonite is very indistinct; so also is the fragment which is figured in the 'Memoirs of the Geological Survey of India.'

Ammonites rembda, from Pondicherry, is in every particular like our African specimen. The shell is perfectly smooth, and shows in some places beautiful colours. There are some small specimens amongst the collection, which seem to me to be only young individuals of *A. rembda*. Number of specimens 3.

Locality. Cliffs on the sea-shore, between the rivers Umtamfuna and Umzambane, in Kaffirland, from bed *d*. Pondicherry, in India.

Age. Probably Cenomanian. India, Valudayur group.

AMMONITES KAYEI, Forbes.

An excellent specimen, with flexuous ribs, and a few furrows parallel to the ribs. The ribs are very fine and narrow, and generally divided into two or three at about the middle of the whorls. There cannot be the slightest doubt about the identity of the African specimen with *Ammonites Kayei*, as it shows all the remarkable peculiarities of Forbes's original specimen in the Collection of the Society.

Locality. Umtamfuna river, from bed *d*. Pondicherry, west of Penangoor, and north of Odium, in the Trichinopoly district.

Range. Cenomanian. In India, the Valudayur and Ootatoor groups.

ANISOCERAS RUGATUM, Forbes. Pl. III. fig. 4.

My specimen shows sharper ribs than the Indian form; and as it is only a fragment, it does not allow a very distinct specification.

Locality. Umtamfuna river. Bed *d*.

In India. The Valudayur group.

Remarks. Altogether there are 15 species of Cephalopods described out of this bed, three of which are also found in the Valudayur group of Southern India. Only two species belong to a higher horizon, one of which occurs in India in the Arrialoor group.

Name.	In India.	Relationship.	Range.
Ammonites Soutoni, *Baily*.	Ootatoor ?	A. implatus.	Ootatoor group.
—— Stangeri, *Baily*.			
—— Gardeni, *Baily*.....	Arrialoor	A. Gardeni.	Arrialoor group.
—— umbolazi, *Baily*.			
—— rembda, *Forbes*	Pondicherry.	A. rembda.	Valudayur gr.
—— Kayei, *Forbes*	Pondicherry and Trichinopoly distr.	A. Kayei.	Valudayur and Ootatoor group.
Anisoceras rugatum, *Forbes*	Pondicherry.	A. rugatum.	Valudayur gr.

There is only one quite strange form; all the others are found or have their representatives in the Indian Cretaceous series. We see that four out of *seven species* belong to the lowest beds of the Indian Cretaceous formation, to the Ootatoor group and the Valudayur group, and only one, *A. Gardeni*, belongs to a higher horizon, the Arrialoor group, which resembles our white chalk.

CERITHIUM (FIBULA ?) DETECTUM, Stol.

Pal. Ind. fig. 192, pl. xv. vol. i.–iv.

This species is found in the same deposits. Shell perfectly smooth, with scarcely visible lines of growth, and very thick.

Locality. Umtamfuna. Bed *e*.

CERITHIUM KAFFRARIUM, nov. sp. Pl. III. fig. 5.

Spiral angle 40°. Number of whorls 9.

The shell is very characteristically ornamented—coarse and transverse ribs, which are intersected by thin spiral lines. Each of the whorls is contracted near the suture, forming a deep furrow.

Locality. Umtamfuna river, from bed *e*.

TURRITELLA MULTISTRIATA, Rss.

—— *Sowerbii*, Forbes.

—— *Bonei*, Baily.

Mr. Baily, in his paper, looks upon this *Turritella* as a new species; but it agrees perfectly with Mr. Forbes's original in the Collection of the Geological Society; his figure is not very clear, which may account for the making of a new species, as the African specimen has nothing in its characteristics which could enable any one to distinguish it from the Indian species.

Locality. Umtamfuna river, bed *e*. Pondicherry, Trichinopoly group.

SCALARIA TURBINATA, Forbes. Transact. Geol. Soc. vii. p. 127, pl. xii. fig. 18.

Scalaria ornata, Baily.

Mr. Baily's specimen not only agrees with the Indian *Scalaria* in the description and figure, but more so even upon a careful examina-

tion of the well-preserved original; it seems, therefore, to me not reasonable to create a new species because it is derived from a different locality, but shows again the coincidence of the African and Indian Cretaceous deposits.

Locality. Umtamfuna river, bed *e*. In India: Pondicherry.

SOLARIUM WIEBELI, nov. sp. Pl. III. fig. 6.

Angle 130°. Number of whorls 5.

The surface perfectly smooth, only the lines of growth are faintly visible; but neither transverse striæ nor ribs can be distinguished, as in *Solarium pulchellum*, Baily, from the same stratum; in shape also this species varies much from Baily's *Solarium*, which possesses gradually widening whorls, whilst in the present species each whorl is double the width of the preceding one.

Locality. Umtamfuna river, bed *e*.

CHEMNITZIA UNDOSA, Sow., spec.
Chemnitzia undosa, Forb.
Scalaria undata, D'Orb.
Turritella (*Chemnitzia*) *Meadii*, Baily.
Chemnitzia Sutherlandii, Baily.

Mr. Baily calls a small *Chemnitzia*, which shows slight spiral lines, *Turritella Meadii*; but it is, I think, only a young individual of his new species *Chemnitzia Sutherlandii*, which can be identified with some varieties of *Chemnitzia undosa*, Forbes. The last whorls do not show the transverse lines so distinctly; and altogether it is impossible to find two specimens which show exactly the same ornamentation of surface. The older whorls are always more distinctly ribbed, but not the later ones. In full-grown specimens, the spiral lines, which even in young ones are very feeble, disappear.

Locality. Umtamfuna river, bed *e*. In India: Garudamungalum, Kulligoody, Alundanapooram, Serdamungalum, Anapaudy, Andoor. Trichinopoly group.

EUCHRYSALIS GIGANTEA, Stol.

This is the species erroneously referred by Bailey to *Turritella Renauxiana*, D'Orb.

Locality. Umtamfuna river, bed *e*. In India: north of Alundanapooram, east of Anapaudy, Comarapolliam. Trich. & Arr. Gr.

DENTALIUM, spec.

A small fragment of a smooth *Dentalium*, which it is not possible to identify with any already described species.

BIVALVES.

Fam. I. OSTREIDÆ.

OSTREA, *L.*, spec.

Numerous small specimens, imbedded in the sandstone with Ammonites and other shells, beds *d* and *e*.

PECTEN QUINQUECOSTATUS, Sow.

Very numerous in this locality, resembling in every respect the specimen from Pondicherry in Mr. Forbes's Collection in the Geological Society's Museum.

Number of specimens obtained by me, 11.

Locality. Umtamfuna river, bed *e*.

PECTEN AMAPONDENSIS, nov. sp. Pl. III. fig. 7.

The right valve very slightly concave, finely striated concentrically, with broader radial ribs. Towards the end of the valve, two distinct concentric lines, which divide the surface of the valve into two or three areas.

Locality. Umtamfuna river, bed *e*.

ARCADÆ.

ARCA CAPENSIS, nov. sp. Pl. III. fig. 10.

The valves very thick, surface nearly smooth, very slightly cancellated, margins smooth. Hinge-teeth numerous, the lateral ones very strong. The ligamental area with numerous but very narrow grooves; for the cartilage is much smaller than in *Arca natalensis*, and the interior umbones nearly touch each other in closed valves. *Arca trichinopolitensis*, Forbes, is very nearly allied to this species. Mr. Baily's figure of *Arca umzambaniensis* does not suffice to enable me to decide positively whether the present species is distinct from it; but it seems to me that Mr. Baily's figure represents a much flatter specimen than mine.

Number of specimens 9.

Locality. Umtamfuna river, bed *e*.

PECTUNCULUS AFRICANUS, nov. sp. Pl. III. fig. 8.

A small bivalve; length about from $\frac{1}{2}$–$\frac{3}{4}$ of an inch. Surface finely radiately striated, showing lines of growth; margins denticulated; hinge semicircular, teeth transverse; ligamental area very small. This species is most nearly related to *P. subauriculatus* from Pondicherry (see Mr. Kaye's Collection); but the latter is more circular in form than *P. africanus*.

Number of specimens collected, 41.

Locality. Umtamfuna river, bed *e*.

TRIGONIADÆ.

TRIGONIA SHEPSTONEI, nov. spec. Pl. III. fig. 11.

This species stands between *Trigonia crenulata* and *scabra*, Lamk. The surface shows strong lines of growth, with thick transverse ribs, which run quite straight from the beak to the margin, and form right angles with the ventral margin. The ribs have very pro-

minent tubercles, which become stronger near the ventral margin. The teeth are 2—3, the left divided and striated. The surface is divided near the posterior margin longitudinally by two or three furrows into as many areas, transversely striated and ribbed. The ribs are slightly curved, and in the inner carina they stand perpendicularly to the posterior margins. *T. Shepstonei* shows distinct differences from *Trigonia elegans*, Baily, in its strong and thick tubercles, in the general rough surface of the valves, and also in its shape. Our species is thicker, and the ventral margin is plicated. Very common, forming entire beds in the sandstone. This species seems to have been commoner at the base of the stratum; but the bed is not divisible into different horizons.

Named after the Hon. Theophilus Shepstone, the Secretary of Native Affairs in the Colony of Natal.

Locality. Umtamfuna river.

Cardiadæ.

Cardium denticulatum, Baily. Pl. III. fig. 12.

To Mr. Baily's description I have only to add that the pallial line is simple, and not in the least sinuous. Cardinal teeth 2; lateral ones 1, 1.

A small *Astarte* seems to be not uncommon. A *Teredina* is also found in large masses in fossil wood at the lowest part of the deposit.

Echinodermata.

Hemiaster Forbesii, Baily.

Holaster indicus, Forb.

Diadema, sp. Pl. III. fig. 13.

Table of the Range of the Fossils of the Umtamfuna River.

	Cephalopoda.	Gasteropoda.	Bivalves.	Echinod.
New species, or peculiar to the African locality.....	1	4	7 3 of these nearly allied to Ind. sp.	1
In the Arrialoor group ...	1	3	2	2
Trichinopoly group.....		11		
Ootatoor and Valudayur groups, India	4	1		...
Total of species which also occur in India	5	13	2	2

Gasteropoda of the Umtamfuna River which also occur in India.

Name.	Localities in India, where the species also occur.	Range.
Pugnellus uncatus, *Forb.*	Parchairry, Kulligoody	Trichinopoly gr.
Fasciolaria rigida, *Baily*	Andoor, Coonum, Shutanure	Trich. group.
Fasciolaria assimilis, *Stol.*	Olapaudy	Trich. gr.
Tritonidea trichinopolitensis	Anapaudy	Trich. gr.
Pollia pondicherriensis, *Forb.*	Alundanapooram	Trich. gr.
Lagena nodulosa, *Stol.*	Olapaudy	Arrialoor gr.
Cerithium (Fibula) detectum, *Stol.*	Karapaudy	Arrialoor gr.
Turritella multistriata, *Rss.*	Pondicherry	Trich. gr.
Scalaria turbinata, *Forb.*	Pondicherry	Trich. gr.
Chemnitzia undosa, *Forb.*	Pondicherry	Trich. gr.
Euchrysalis gigantea, *Stol.*	Alundanapooram, Comarapolliam	Trich. & Arr. gr.
Solariella radiatula, *Forb.*	Vylapaudy, Olapaudy, Comarapolliam, Arrialoor	Arrialoor gr.
	Andoor, Kalakonuttom	Trich. gr.
	Puravoy, Moraviatoor, Odium	Ootatoor gr.
Avellana ampla, *Stol.*	N.W. of Veraghoor	Trich. gr.

It is quite clear that most of the species obtained from this African locality ("Izinhluzabalungu") resemble in every respect those of the Trichinopoly series of India. The Trigonia beds with *Ammonites Kayei*, *A. Rembda*, &c., show the true character of the Ootatoor beds of the Trichinopoly district, whilst we have the Trichinopoly group represented by eighteen species, which also occur in India. The Arrialoor group is proved only by *Ammonites Gardeni*, which was first described from Africa, but has since been found by Stoliczka in the Indian Cretaceous series.

The plant-beds with *Teredo* find their representative in the lower beds of the Ootatoor group of the Trichinopoly district; and from this, and also the fact that the preceding plant-bearing Karoo formation finds its analogue in the Indian Ootatoor plant-beds (not the Ootatoor group), the conclusion is easy to arrive at, that both Africa and India were, after the development of the Table-Mountain Sandstone, one continuous continent, which afterwards was covered by the Cretaceous sea.

Between the deposition of the Table-Mountain Sandstone and that of the plant-bearing blue shales and of their Boulder-bed, which form the base of the extensive *Dicynodon*-sandstones, a long time must have elapsed.

The large area, now covered by the Indian Ocean, must have been the basin for an extensive series of lakes, which would explain the occurrence of the same plants and large reptiles which were then living in India and also in South Africa. It must have been a period of long-enduring tranquillity, and no great disturbance whatever seems to have occurred. These periods of repose, which wit-

nessed so very few changes during the deposition of at least 5000 feet thickness of strata, must have lasted through the Triassic age right up to the Upper Jurassic; as in India the highest of these beds seem to belong to the Jurassic formation. The greater portion of the Indian Ocean must, at this period, have been depressed, together with a large part of India and Southern Africa, which were covered with the shallow Cretaceous sea, having a peculiar fauna of its own. The Cretaceous deposits of Southern India and Africa were all shallow-water and coast-deposits, as is proved by the species of fossils they contain and also by the quantities of wood imbedded in them, which give evidence of a formation on a shallow coast, where the wood was soon covered with sand and mud and in this way preserved. Since that period the coast has been gradually rising, or the sea retiring. The portions of the Cretaceous sea nearest the old coast-line had become dry land; and we see the remains of these deposits in Southern India and Africa. There cannot be the slightest doubt that the upheaval of the country is still going on; for along the whole coast of South Africa, from the Cape to Durban Bluff, and still further north, even as far as Zanzibar, modern raised beaches *, coral-reefs, and oyster-banks may everywhere be seen. At the Izinhluzabalungu Caves is such a point, where the rising of the coast is plainly visible; recent oyster-banks are now 12 feet and more above high-water mark. The same can be observed on the whole line of the Natal coast. Van der Decken has observed the same thing at Zanzibar, and is of the same opinion as myself, viz. that the eastern coast is rising. Early in the present year I had the opportunity of observing at the Bazaruto Islands, about 90 miles to the north of Inhambane, on the east coast of Africa, a series of raised coral-reefs round the island of Marsha, containing many living shells and quite recent oyster-banks. In fact, I believe that the Bazaruto Islands only owe their existence to the circumstance that the coral-reefs have been upheaved, and that their surface was naturally covered with loose sea-sand, which is the only soil of these desolate islands. Everywhere, at about 12–14 feet depth, water is to be obtained at Marsha; wherever the sand is removed the coral-rock is reached.

What with this constant rising of the land and the consequent shallowing of the river, I do not believe that the Port of Durban has much hope for the future, as some day the entrance to the harbour, which is not very deep at present, must be blocked by a bar across it like most of the African ports. The only exception to this rule is the large Port of Delagoa Bay; the port is cleared of sand and mud by nature itself. It was evidently formed by the north and south current of Mozambique, which has gradually hollowed out this fine bay. Between Elephant Island and the *terra firma* the current enters the bay, and, turning round in it, returns to the sea between Elephant and Inyack Islands, in this way always keeping the entrance open by its scouring-out action.

* The writer has seen implements of early man which were obtained by Richard Thornton and others in old raised beaches at Natal, near Inanda, and at the mouth of the Zambesi River.

If we take a vertical section of the Natal formations, we shall find them as follows:—

Brown soft sandstones and grit, with great numbers of fossils.	Cretaceous Series, Lower Greensand up to White Chalk.
Sandstones and shales, with coal-beds, shales, and *Boulder-bed* (greenstone dykes).	Karoo formation: probably Trias, reaching as far up as the Jura.
Quartzose sandstone with shales; containing only traces of fossil remains.	Table-Mountain Sandstone. Coal-period.
Clay- and talcose slates, mica-schists, dykes of diorite.	Primary slate-formation.
Granite and gneiss, dykes of diorite.	Primary rocks.

III. Economic Geology.

Industry and the fine arts are still in their childhood in Natal; otherwise the raw materials are there in abundance. Natal possesses good building-material in the quartzose sandstone of the Table Mountains, and an excellent slate which is found at some places (for instance, at the Umpampinioni river). The lower parts of the crystalline limestone would, I have no doubt, afford a good statuary marble.

1. *Graphite.*—A very good quality of pure graphite is found south of Springvale, in Natal—in gneiss, as it seems. As the working of the graphite is not expensive, a ton of pure graphite costing only about £30, it would probably be a lucrative undertaking to ship graphite at Durban. Graphite is not very rare in South Africa; traces of it are found at several points in the "old colony." A considerable amount of this mineral is to be met with, as I have been informed not very far from the Mission-station of Inyatin, about 20° S.

2. *The Coal* of Natal, which belongs to a younger series than the more newly discovered one near Tulbagh, in the Cape Colony, seems to form extensive fields in the sandstone and shales of the plant-bearing Karoo formation. Although it is a good steam-coal, it is still cheaper to import the coal from England or Australia, whence it may be obtained at 27–55 shillings the ton at Durban.

3. *Metals.*—a. *Gold.* Every body remembers the great excitement which was caused by the first "discoveries" of gold in South Africa. Since then companies have been formed, shares sold and bought, diggers have been sent out, and the colonies hoped for better days; but suddenly the gold-fields turned out to be imagination, as it became pretty certain, and indeed an ascertained fact, that gold was not in sufficient quantities to pay the working of the quartz. Not only in the interior, but also near the coast, within the boundary of the colony, gold was sought for. Traces of gold are to be seen in the quartz-veins and quartz masses ("reefs") in the granitic and slate-formation, but not sufficient to pay the expense of crushing. I have visited most of the localities in Africa which were called auriferous; but nowhere did it seem to me likely that it would pay for working, as the quartz-veins (supposing they would yield a paying quantity)

are everywhere of very limited extent and thickness, and the so-called "reefs" everywhere thin out rapidly towards the base; and, lastly, there is no extensive alluvium anywhere in these districts which yields gold.

It is a well-known fact that gold has actually been exported from the east coast for centuries by the Portuguese in large amounts; and the question may be put, Whence does this gold come? Gold is there; but the question is, Would it pay white labour or not? The Portuguese trader in Quillimane has perhaps one thousand or more slaves, which cost him only a trifle, as they live by their wives' labour; when the dry season sets in, the Quillimane traders send their slaves to their work; they are supplied with old flint-guns, and sent into the interior to hunt elephants. Some are sent to trade, and a great part to the diggings in the rivers which flow into the Zambezi, near Tette, and in those running from the south to the Zambezi, coming from the fabulous country of Manico. There the wives work at fields of rice, which support them sufficiently, whilst the men wash the gold from the rivers in small kalabashes in quite a primitive manner. As the gold itself has no value to them, they bring it faithfully to their masters, who reward them with beads and white Salempore (calico). In this way the master gains a good deal, as all the gold he receives is a clear profit. If he has only 150 slaves engaged in the diggings, and he receives only 1 ounce per head in the season, he makes a profit of £581 5*s*.! Of course white labourers would never find it practicable to undertake gold-washing there under such circumstances.

b. *Copper* is already well known in many districts of South Africa, and is also worked. I found copper at several localities in Natal; but nowhere, I should think, would it be found practicable to work it. Near the Ifumi river, south of Durban, a highly decomposed gneiss occurs which shows traces of copper at the surface. It is situated just along a fissure in the gneiss, and it possibly might lead to a richer point; but this is not probable. In the Insiswa Mountains, in Kaffirland, richer copper-ores have been known for a very long time, but have never been worked out. This locality is situated at the above-mentioned line of greenstone, which strikes from south to north, near the base of the Karoo beds. It is remarkable that along this greenstone line copper is found. Thus, for instance, it occurs near the Tugela valley, in greenstone which intersects the granite.

EXPLANATION OF PLATES II. & III.

Plate II.

Geological Map of the Colony of Natal.
Section from the Bluff, Port Natal, to the Mont aux Sources in the Draakensberg.

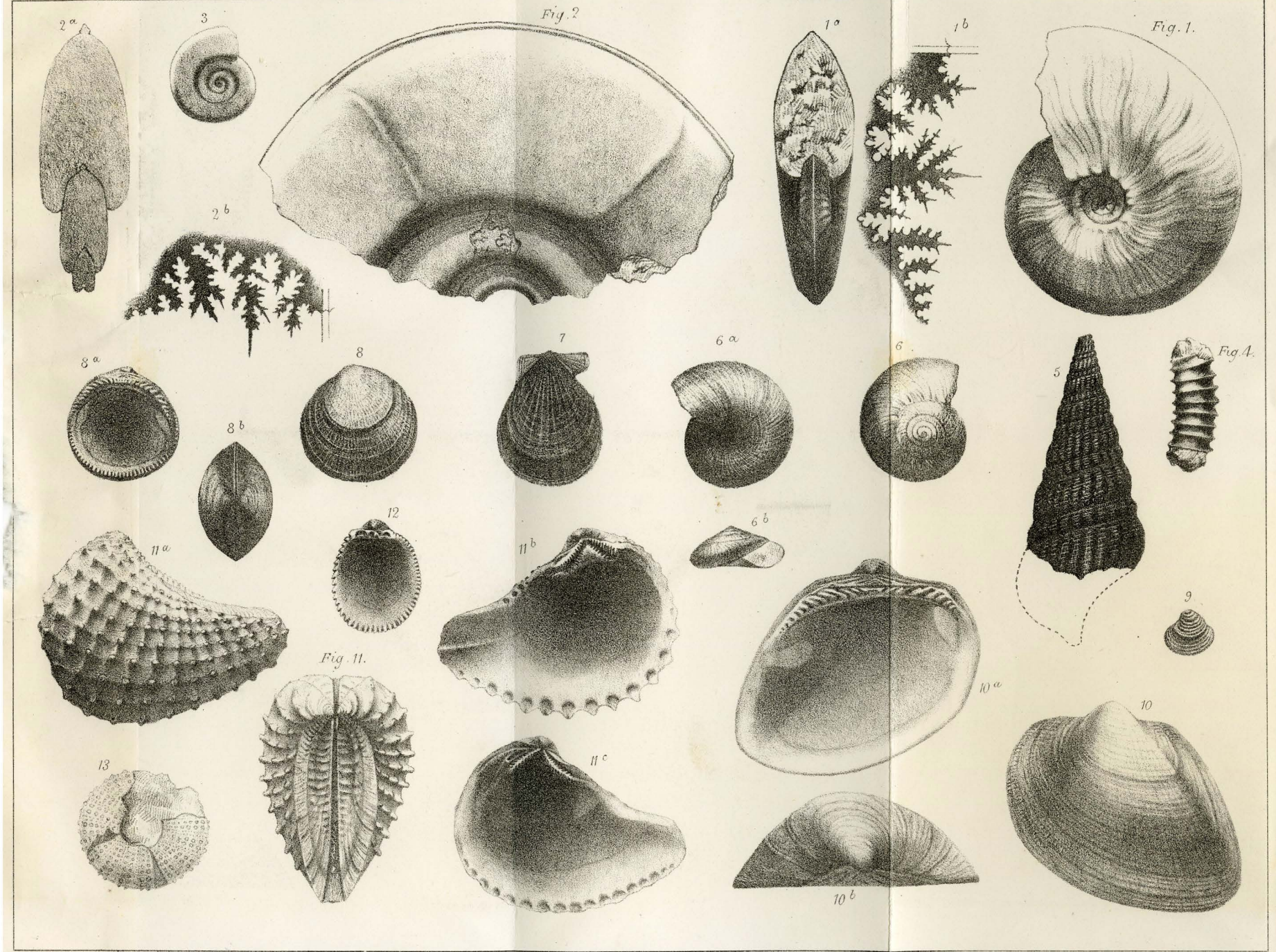
Plate III.

Fig. 1. *Ammonites umbolazi*, Baily: *a*, dorsal view; *b*, sutures.
Fig. 2. *Ammonites rembda*, Forbes: *a*, section; *b*, sutures.
Fig. 3. The same, young individual.
Fig. 4. *Anisoceras rugatum*, Forbes.

Fig. 5. *Cerithium kaffrarium*, n. sp.
Figs. 6, 6 *a*. *Solarium Wiebeli*, n. sp., enlarged; 6 *b*, natural size.
Fig. 7. *Pecten amapondensis*, n. sp.
Figs. 8, 8 *a*, 8 *b*. *Pectunculus africanus*, n. sp.
Fig. 9. *Astarte*, sp.
Figs. 10, 10 *a*, 10 *b*. *Arca capensis*, n. sp.
Figs. 11, 11 *a*, 11 *b*, 11 *c*. *Trigonia Shepstonei*, n. sp.
Fig. 12. *Cardium denticulatum*, Baily.
Fig. 13. *Diadema*, sp.

Discussion.

Prof. T. Rupert Jones commented on the importance of the paper as throwing so complete a light on the geology of Natal, and proving the geological sequence to be similar there to that in other parts of Southern Africa. He remarked that the author had done special service by the great increase of information furnished by him regarding the Cretaceous rocks of Natal, and their equivalence to those of India. He also pointed out that Mr. Griesbach had proved that the Karoo formation was continuous to the other side of the great dividing range, and formed the floor of the Orange and Waal valleys, and remarked that as Mr. Stow had indicated glacial action on the south side of the Orange valley, it was quite possible that the gravels containing the diamonds were of local origin, as Dr. Grey had suggested.



C.L.Griesbach, del & lith.

M & N Hanhart imp.

CRETACEOUS FOSSILS FROM NATAL.