Bat. Gen.
XV
81

Low.

Notes on the geologic features of Singapore and some of the islands adjacent





PERPUSTAKAAN NASIONAL R.I.

Tanggal : 15-07-2010
Nomor Induk : 6817/PN/Umum
BIB - ID :
ITEM - ID :
Asal : Museum Pusat

Low XV 1
XV 81

THE

# JOURNAL

OF

# THE INDIAN ARCHIPELAGO

AND

EASTERN ASIA.

---

## NOTES ON THE GEOLOGICAL FEATURES OF SINGAPORE AND SOME OF THE ISLANDS ADJACENT.

By Lieut. Colonel Low, C. M. R. A. S. & M. A. S. C.

I SUBMIT my imperfect notes to the public in the hope that they may prove of some utility to any scientific and more practised geologists than myself who may wish to examine the Island. I cannot here avoid adverting to an observation made by one of the greatest geologists of the day, Sir R. Murchison, while adverting to a paper on the geology of Pinang by the late Dr. Ward, and to which he was, I suppose, led by that writer. He remarks, "Although we may regret that the Malayan Archipelago offers no other than primary rocks, here and there covered with their disintegrated materials, we must hold up as highly worthy of imitation that good spirit which prompted the Resident, Mr. Kenneth Murchison, to take all the means at his disposal to obtain for us this amount of natural knowledge,—as it is obvious that similar efforts on the part of the chief officers in any distant colonies would prove of inappreciable value."* I think it probable that it will hereafter appear that the above restriction has been overhastily made, and that little has yet been done by English Geologists in the countries lying East

* Address by R. I. Murchison, Esq., to the anniversary meeting of the Geol. Soc. 15th Feby. 1833, page 22.



BAT.

The specimens of these granites on both hills shew

1. Dark bluish quartzose granite, the mica hardly visible, the quartz being white,

2. Grey granite, about two thirds of the mass lamellar whitish quartz.

3. Dark bluish granite, close grained and quartzose, fracture of the quartz lamellar.

4. Very dark and compact granite, looking externally a good deal like basalt.

5. Granite on Scott's Hill, very quartzose and coarse grained, rest of a dark colour.

But, as I shall have again to notice, the general features of the sandstone strata induce me to believe that any upheaving force to which they may have been subjected, must have been exerted at intervals, and have been of varying intensity.

I found a coal black stratum at the foot of Búkit Timáh, in the alluvial or detrital level, of a substance which, if I may be allowed the expression, I will call an anthracitical compact clay. When exposed to a red heat in a crucible and exposed to the air, and the carbonaceous inflammable subtances had thus been dissipated, the clay was found to have lost about three fifths of its weight, and the residuum was a biscuit of white felspar or a light brown earth.

## THE SANDSTONE AND CLAYEY STRATA.

In so far as my observation has extended, these strata are not overlaid by any other rocks; while it would be impossible without boring deeply, for doing which we have no facilities in this country, to ascertain on what stratum they rest. Without the guage therefore which would be supplied were other stratified rocks associated with them, I shall only hazard an opinion, founded on their general aspect, that they do not belong to the *latest* sandstone formation. The total absence of organic remains, at least in so far as my experience has gone, and also of the usual concomitants of the fossiliferous and carboniferous series, would be in favour of this supposition. Does this sandstone belong to the group which lies immediately under the oolitic? I should be inclined to think that it does, were it fossiliferous.

There is one difficulty however. How does it happen that hard

and crystalline sandstones should be so close to the surface, and by what pressure, in the absence of other strata, were they consolidated? The clays which overlie them could hardly have afforded sufficient pressure.

The force which tilted these sandstones, seems, as I have already observed, to have been unequal. Thus at the Government Hill,—where a deep section of 40 to 50 feet was made during the construction of a road past its south end,—these strata, which I judge to have been from 12 to 15 feet thick each, appear to have been suddenly and violently disrupted, for large and very acute angled masses of what I suppose to have formed the lowest strata, have been pushed to the surface, and lie imbedded unconformably in the clays which were disturbed at the same time. Some of these blocks, indeed almost all of them, had to be blasted with gunpowder before they could be rendered manageable for the purposes of building. The effects of similar disruption may be seen on "Prinsep's Hill." These very irregular shaped and acute angled blocks are of a reddish, of a brown, or of a grey sandstone.

The clays consist of red iron clay, and its shades, white felspathic clay, purple and yellow ochry and grey clays, bluish and greenish, and slate coloured, clays, and clays striated with various tints resembling decomposed granite *in situ*, before it has become converted by exposure into *laterite*. Where not so broken up, these clays exhibit the common appearances of stratification, and have become somewhat indurated. These clayey strata, where the force has been even considerable, have, owing to their flexibility, been only bent instead of being broken to pieces. They afford therefore good indices of the volcanic or upheaving force which has been applied in different places.

The annexed sketch fig. 1. exhibits a section of the hill at the tank on the right of the road passing up the slope of Oxley's Hill beyond Government Hill, to the west. The angle of elevation is about 10° to 25°, the dip about N. E.

No. 1. Reddish soil, upper stratum, . . . . . 2 ft.
2. Ferruginous gravelly red soil with clay, . . 1 to 10 ft.
3. Yellowish, brownish and red sandstone, coarse and soft, . . . . . 1 ft. 6 in.
4. Lamellar variegated and indurated clays

and sandstone, soft, very whitish, greenish, yellowish &c., ..... 1 ft. 6 in.

5. More indurated & waving reddish, greenish, yellowish, brown and white clays, 2 to 2½ ft. very distorted.
6. Shades of blue and brown clays, ..... 1½ to 2 ft.
7. Greenish soft sandstone, ..... 1½ ft.

Behind the Institution there was a hillock about 40 to 50 feet high, but which, since the period when I examined it, has been quarried and carried off for building. It well exemplified the effects of the upheaving force alluded to. It lay on a flat sandy level and was composed of large acute angled masses of red and grey sandstone, mixed with, or supported by, white and red clays. The softer sandstones seem both at "Oxley's Hill" and at Tánjong Pagar to abut against the sandy strata now superior to them. Thus there will have been two contrary forces exerted, one upward, the other horizontal.

What I have termed red sandstone forms but a fraction of the whole series of strata, and its colour is neither intense nor uniform, passing into lake, dark brown and very light brown tints. According to Captain Franklin, the new red sandstone of Bundlekhund includes the laterite which is found reposing on the first rock or red marle. I shall have perhaps occasion hereafter to revert to this account, as I at present incline to the belief that an extensive formation which I have traced to the north of Pinang, bears a close analogy in point of position to the New Red sandstone. The exposed blocks lose in time their external colour, which changes to a whitish or a light yellow tint,—such pervading to several lines or even an inch in thickness,—owing I suppose to some chemical combination with oxygen of the iron contained in the mass.

The very dark colored stratum rapidly decomposes into a yellow clay; although, when fresh from the quarry, it is applicable to building.

The blocks do not separate into lamellar fragments, but into unequal ones,—the harder sort yielding with difficulty to the hammer and requiring gunpowder to break them up,—thus resembling old transition sandstone.

Frequent rounded masses of a white or grey sandstone, and of

a more crystalline texture than the blocks themselves, lie imbedded in the latter; and in several of the large blocks I have found, after they have been split, nodules of the size of a two pound shot, and nearly as spherical, of black iron stone, slightly glimmering, not magnetic and reluctantly yielding to the knife.

That the slightly reddish crystalline sandstone is very durable may be inferred from the fact that there was a rock of it, bearing an ancient inscription, extant on the narrow point on the left of the entrance to the Singapore river, but which was demolished several years ago in clearing the spot for some building. The inscription, fragments of which I possess, was only legible in a few places, the character appertaining to the Peninsula of India, and probably it may be that described in the Malayan annals in these terms "Rájá Súran of Amdan Nagárá after conquering the state of Johore with his Kling troops [Kling is the term applied to the people of Coromandel] proceeded to Tamsak. When he returned to his country of Kling or *Bejaneegar*, he left a stone monument of his victories on which was an inscription in the language of Hindoostan. Tam Sak is also called Singhápárá." * This was about A. D. 1201 Singapura, observes Mr. Crawfurd, was first settled in A. D. 1160 by Sri Súrá Bawáná.

All of the sandstones seem more or less impregnated with iron, but I could not discover by the usual tests any lime in them.

With respect to these spherical nodules I am alluding to the fractured strata before described, in which alone I found them.

The stratification of the clays may be well observed close to the tank on the S. face or end of Dr. Oxley's ground.

A very instructive display of the strata of sandstones which have been forced over on their edges,—and thus now rest vertically—may be found, when the tide is at an ebb, below the rather bluff points stretching along the sea beach to the east of the town just beyond "Guthrie's Hill." These here form a rough and extensive platform. I did not observe, if I recollect aright, the hard red sandstone. The variety of the colours of the strata is here very distinctly defined. Their cleavage too appeared generally to be transverse to the stratification.

* Leyden's Translation, Annal 1st and 2d.

I have not observed any upheaved tabular sandstone formation resembling that so common in India.

The order of the above vertical strata passing upwards was originally, and, reckoning them laterally, now is, as follows.

1. The massive crystalline red sandstone assumed to be the deepest.
2. Clay.
3. Then the layers of other sandstones varying in thickness from one to four feet, with clay intervening.
4. Strata of clay.

Lastly, soil produced by the decomposition of these strata, and mixed with vegetable matter where these are not laid bare by the sea.

To whatever group this sandstone formation may be assigned, it is still plain that it exhibits none of the strata associated with coal beyond itself,—no example of the fossiliferous or carboniferous strata. If coal existed here, it should, unless very deeply seated, crop out along with the other vertical strata. But the usual European geological tests of the presence of coal appear to be often absent in these Eastern countries. The coal measures of Borneo may be prolongations of the sandstone formation we are describing. I have not seen any professedly scientific description of them. But from replies which I was favored with to written queries given by me to Captain Man M. N. I. and Captain Congalton, Com. of the H. C. Steamer *Hooghly*, and from specimens kindly procured by them, I gather that it is associated at Pulo Chirmin, which is about 200 feet high, with a ferruginous sandstone, and that a mass of red sand and clay overlies the coal.

At Pulo Kang Arang, again, from the specimen received from Captain Man, the stratum immediately overlying the coal, which is common coal, is a soft white sandstone; next, according to Captain Congalton's specimen, is a grey shale, but, as far as the specimen would determine, not fossiliferous; next a slaty, bituminous coal with sulphuret, I believe, of iron betwixt the laminæ; then a glistening light bituminous coal rather iridescent. The slaty coal exhibits the iron pyrites either in thin films or in cubical pieces. The strata, as far as I can gather, are horizontal or nearly so. Above the sandstone lay earths. The Borneo slaty

coal appears to be common coal, burning with a good deal of not very bright flame, and leaving a brownish earthy residuum.

On looking at the specimens already described after a lapse of about five years I find the surface and the interstices betwixt the laminæ covered by copious groups of crystals of Alum. It does not ignite very quickly. Specimens of the accompanying strata shew yellowish clayey sandstone tinged by iron of a brownish colour; whitish sandstone; a fawn colored earth; and a bluish white clay; none of which exhibit, under a strong glass, any remains of plants or fishes.

I have been exploring, during the past ten years, for coal along the coast to the north of Pinang, and have lately ascertained two localities where I think the fields are promising. I have specimens also brought to me by my people from other localities. An excursion as a passenger, which by the obliging permission of the Hon'ble the Governer of the Straits, Lieut. Colonel Butterworth, I made in the H. C. S. *Hooghly* last May, was too short to enable me to do so much towards a minute description of the coal field of this section of the Continent and its Islands, as I wished; but this may be accomplished hereafter. If the Singapore sandstone strata were to lie betwixt the lias and the coal measures, it might be inferred that the red variety is the new red sandstone. Mr. T. Lay describes the same coal, I believe. He observes that it lies at an angle of 45° and is 6 feet broad, covered by powdered sandstone, hills or ridges of soft sandstone forced up into ridges by volcanic action. He supposes that the hard red sandstone which crops out was the original rock.

The variety of soil in Singapore which is often found within the area of twenty or thirty yards is very apt to puzzle the agriculturist who has not adverted to the cropping out of the sandstones.

The reddish coloured sort does not yield a red, but a whitish, a yellowish, or a grey, soil.

The white kind gives a light coloured sandy soil. The yellow produces a brownish one, while the blue and variegated clayish strata afford a great deal of red soil.

I believe that it has been considered that the new red sandstone yields by decomposition a very fertile soil. I have not, however, been able to find in the Island any red soil directly derived from

that rock. There are a few scattered patches, it is true, of red or reddish soil, but they appear to belong to the clays.

I find, after a careful examination of seven of these sandstone strata and an equal number of their respectively superincumbent soils, that they all contain very nearly the same relative average proportion of silex, or 48 per centum:—thus evincing that nothing else could have intervened betwixt the outcropping strata and the soil, now overlying them, which could have formed that soil. The maximum of silex is 87, and the minimum 5 per cent. The average of three of the most crystalline was 78 per cent., and of three of the other most distinct strata 19 per cent. There is a great absence of quartz veins in all of these sandstone strata of the Island, but they become more common upon the islets lying off the harbour. I have observed, however, on splitting large blocks, that some of the fragments had been cemented, as it were, by a solution of very fine white silica, a few lines only in thickness.

The vertical strata above described seem to have been thrown into their present position by a different force from that which heaved up the Government Hill,—for these have not been disrupted; and although the force which tilted them over must have been great, they have maintained their parallelism, and doubtless their original direction, for the dip appears to have been about E. and W., varying to S.E. and N.W.

The plain upon which the suburbs and part of the town of Singapore stand is chiefly composed of deep beds of sand,—sometimes white, occasionally bluish or reddish; averaging from 90 to 95 per cent of silica. The rest is aluminous. This sandy tract and some others lying along the seashore have doubtless been formed by a retreating sea, since its sand is mixed with recent shells and sea mud.

The vallies have a peaty superstratum, which varies in thickness from half a foot to a foot, or a little more. Below this lies generally a bed of cold clay, and below this a stratum of arenaceous clay. But near to the sea this last is exchanged for mud. This peaty earth is generally blacker than the peat of colder latitudes, where, as far as seems to have yet been discovered, perfect peat can alone be formed. It is also lighter, since its vegetable matter has not been sufficiently decomposed. It also wants

coherence being very friable. It seems however to aid in preserving the stems of trees which lie imbedded in it, but to a limited extent only.

When burned in contact with the atmosphere the result was

| | | |
|---|---|---|
| Carbon,..... | 43. | This specimen so examined was from the swampy flat at the base of the western slope of Mount Sophia. |
| Silex and other earths,.. | 2. 75 | |
| Very magnetic & minute grains of protoxide of iron, | .25 | |
| Loss,..... | 54. | |
| | 100. | |

Sir H. Davy shewed that, in general, peat is found to contain from 60 to 99 parts of inflammable or destructible matter, the residuum being similar to the components of the substratum, with some oxide of iron.

### THE IRON STONE.

Although the ironstone of the Island is most commonly found in detached masses, yet there are thin strata of it also. These last occur chiefly amongst the upper sandstone and clay layers.

I am inclined to believe that these masses in most instances are concretionary, but I have in several localities found them in situ, either in thin strata of irregular thickness, or forming a sort of dyke cutting vertically through the clays. This vertical appearance may be deceptive, for the clays may have been similarly inclined at first, but decomposing and mixing afterwards, may have left the harder ironstone by itself.

This ironstone, which has been called by some laterite, has not I believe been analyzed. It has been considered I understand to contain Manganese, which is probable enough, since Umber, an ore of iron, contains that substance. It exists from the size of coarse sand, and smooth small pebbles, up to rounded masses of ten or twelve feet in diameter. It has a black or dark clove brown aspect externally; sometimes it is scoriated; and I have found it botryoidal, and this at the depth of six feet from the surface of the ground.

Internally it is cellular like ætites—the cells containing the same substance as the mass but in a pulverulent state, and of a reddish yellow colour. It varies in density, and where hardest does not

easily yield to the knife. It is not magnetic in the mass, but, when pulverized, grains of magnetic iron appear. The powder is a dark brown earth. It resembles a good deal the very magnetic ironstone found by me in the Tavoy Province, Tenasserim, in 1825. But amongst the sand and gravel in which these ironstone masses lie imbedded, I have found grains of highly magnetic oxidulous iron ore.

There is a good deal of this iron ore upon Búkit Julútong, which is a hill belonging to me in Province Wellesley, Pinang; and it was there generally used by the Malays to make iron. But it was not found rich enough to repay the trouble of working it.

The depth at Singapore of the iron clay and conglomerates rarely exceeds six feet, the average being about three feet, and they very seldom extend in any given locality over a greater surface than three or four acres. But where the ironstone does not appear superficially, it will pretty generally be discovered below, at the depth above given, provided the incumbent soil be of a reddish hue.

It is most common at the extremities of the ridges, and on their summits, in their lower slopes and in their hollows. In the latter case it is thickest in the centre, fining off towards the edges, but often terminating abruptly at its greatest thickness.

Where the ironstone stratum contains a large portion of the metal it is very steril, but where the oxide of iron is not in excess the soil there becomes the most fertile which the island possesses, although the limit is very confined.

Captain Francklin notices that the amygdaloidal iron clay at Bartia in India is steril and bare in some places, and apparently highly productive in others.*

It appears occasionally as if running in a superficial vein, but this seems to be merely owing to its superior hardness to the vertical strata which were in contact with it, and which have been disintegrated. The red iron ores chiefly belong to the secondary formation, those of a dark brown or black colour chiefly but not exclusively to primitive ones.† To this last class the one we are describing bears a close affinity.

The specimens before me are

* Page 70.

† Phillips Minerals p. 47.

1. Very dark and glimmering, cemented by brown pulverulent clay.

2. The darkest coloured, contains a good deal of quartz as may be observed by a miscroscope.

3. Small quartz grains connected by a ferruginous clay.

4. Hematites, reddish brown, slightly glimmering.

5. Brown coloured, mixed with blackish and very red, with whitish grains of quartz.

6. Mixtures of all these.

This scorious ironstone has been termed laterite by some enquirers, and in a few places it and its conglomerates a good deal resemble in external appearance, and partly in their internal structure, the original type,—the laterite first described by Dr. Buchanan, from its likeness to a brick. He found it on the Peninsula of India, and particularly I believe on its western coast, Malabar.

I have seen extensive beds of it at Cannanore on that coast, and it there materially differs from this Singapore stone, and that also of a similar nature found at Malacca. The Indian laterite, if we are to be guided by that observers description, ought to be deemed the true one. It is much lighter and more uniform in colour than the Singapore or Straits kinds. It is much softer than these when in situ, being dug out in small blocks and shaped like large bricks by a knife or hatchet or even a sharp piece of wood, It contains, Dr. Buchanan observed, "some lime." The quantity of lime will doubtless correspond to that contained in the felspar of the underlying granite. But it becomes equally hard by exposure to the weather. It is also internally more cellular and reticulated. I will not pronounce positively, after the lapse of many years, that the Cannanore laterite reposes in situ on granite, but I believe it does; and that it has been the result of the gradual decay of the latter.

Dr. Buchanan, observes that the laterite appears to be the argilla lapidœa of Wallerius, has no appearance of stratification, lies over granite in masses, is full of cavities and pores, contains much iron in the form of red and yellow ochres, can be cut with a trowell or large knife when in the quarry, becomes hard like brick by exposure, does not ever contain it is said any vegetable exuviæ, It is called in Tamul "Stria kulla" or brick stone, but its proper

name would be laterite from lateritus. The laterite of Malabar contains some lime.*

Captain Franklin observes, "that the granite at Herapore is capped by heaps of ferruginous conglomerate, which last is connected with a stratum of iron ore, and on this last the new red sandstone reposes." †

These two last strata were produced of course subsequently to the protrusion of the granite and the conversion of its outer portion into the conglomerate, if this last be not meant to imply a *breccia* containing fragments of other rocks than the granite.

This condition or assigned origin would be quite sufficient to stamp it with a distinctive and uniform character. Whereas the Singapore ironstone is the result of deposits in water of the debris of primary rocks. In this state in Malabar it looks originally like a gritty clay, mottled red and white. The Natives of Malabar build their houses with this substance. The iron it contains becoming further oxydized by exposure acts as a cement, and helps to change the mass from its original greyish colour to a dark brown or reddish brown, while the contraction of the clay in drying produces the internal cavities alluded to. The stratum of clay or decomposed granite which lies nearest to the parent rock on the Pinang hills much resembles externally this Malabar laterite, but it scarcely hardens on exposure. The Malacca rock of which the old Dutch fort was built, approaches much nearer than that of Singapore to the Malabar laterite.

I have traced this *lateritic* formation up to the latitude of Junkceylon, and I suspect that it exists in a more or less perfect state along the whole of the western coast of the Bay of Bengal where that is backed by granitic mountains, and perhaps where it is so by other primary rocks. When the granite is highly micaceous and felspathic, its decomposition may, I think, be expected to afford a perfect laterite.

When the Singapore lateritic ironstone occurs as a substratum, it bears marks in its dark brown colour and its imbedded pebbles, of having been once a surface one. This stone is more continuously and extensively distributed on the small hills and undulations in

* As Res. vol. III. p. 440

† Geological Acct. of a Part of India, p. 75.

the vicinity of the Town and along the road to New Harbour, including the Government hill, than in any other locality on the Island, while the ochry earths and clays predominate in the interior. The white or porcelain clays are found [and I believe of good quality for the arts] in beds, in various spots and sometimes close to the iron clays.

There is a sort of soap stone looking substance, streaked red, white, and greenish, which is found in thin layers or massive amongst the clays. It is rather greasy to the touch, and has occasionally a fibrous texture.

---

Being desirous of comparing the strata already described with those of several small islands lying off Singapore, I got into a sampan on the 1st Oct. 1841, and rowed round several of them, not, however, without having been pretty well drenched with salt water, for these boats ship water when the sea is scarcely ruffled. I had, however, to repeat my visits, one day being insufficient for my purpose.

### PULO TIMMUKUL.

This little island is entirely composed of sandstone and clay. It is about 60 yards in diameter and is surrounded by coral beds, and it is about 50 feet high.

There are five distinct strata visible, (fig. 3.) inclined at an angle of about 30° to 40°, and the dip is to the SE.

No. 1. Whitish and reddish.
„ 2. red, 2 feet.
„ 3. yellow, 2 feet.
„ 4. „ 8 feet.
„ 5. red, 3 feet.
„ 6. Light red and brown soil.

A vein was here noticed of hematitic ironstone, and a very large block of ferruginous conglomerate lies unconnected at the base of the natural section of the Island. Is is intersected by veins of quartz.

### PULO CHIKUKOH.

The sandstone strata here dip as at Pulo Timmúkúl but they have been elevated to an angle of about 55°

At the sea level I observed a hard stratum having a sienitic aspect. At the east point of this island numerous small veins of quartz occur in the sandstone, and occasionally well defined quartz crystals.

The stratification is as follows—passing upwards.

No. 1. White sandstone, 16 feet.
" 2. Reddish and whitish, 17 feet.
" 3. Purplish and very argillaceous, 7 feet.
" 4. Yellowish red, 40 feet.

This island was decked with a tree named by the Malays *Susup*, having a bright scarlet flower.

### BLAKANG MATI.

This island is about 2½ miles long with a maximum height of about 308 feet. The name implies "Dead back" owing to the steril soil on its southern face.

The strata here shew themselves prominently some way up the hill. (fig. 4.) I did not ascend, being obliged to return before dark.

### PULO TOKONG.

This small island is from 15 to 20 feet high. The strata of sandstone incline at an angle of about 60°, towards the North or N. easterly.

They are whitish, yellowish, and green, 4 to 6 feet thick, with thin layers betwixt them of reddish and yellowish sandstone. There are several small caves in the lower part of the face of the rocks. The strata have been much disturbed.

### PULO BUAH SAGA.

So called from its fancied likeness to the *Indian pea*. The sandstone strata are here *vertical*, their line of direction being about NW. and SE. But at the east end of the Island there is a slight inclination, the inclination being to the NE.

### PULO UBI.

I found here a quartzose schist.

### PULO PANJANG.

There is on this island a hard, grey, and very quartzose stratified rock. The quartz white and lamellar, general colour, bluish, white, contains specs of black mica.

### BATU BÈRLAYAR.

This sandstone rock stands conspicuously off a *point* of Singapore island which flanks the inner harbour or passage.

The strata of this *point* are highly inclined, and in some instances almost vertical. They are all *waved*. The direction of their vertical line appeared to be NW. and SE.

### SECTION 1ST.

(fig. 5.)

| | | feet. | inches. |
|---|---|---|---|
| No. 1. | Yellow and red, ..... | 8 | „ |
| „ 2. | Purplish and white or mixed, ..... | 7 | „ |
| „ 3. | Red, purple and whitish, ..... | 8 | „ |
| „ 4. | Thin stratum of red *lateritic* iron ore,.. | „ | 8 |
| „ 5. | Purple, ..... | 20 | „ |
| „ 6. | Do. ..... | 20 | „ |
| | Total | 63 | 8 |

Some thin quartz veins are found in these strata.

### SECTION 2nd.

(fig. 6.)

| | | |
|---|---|---|
| No. 1. | White sandstone,..... | 7 feet. |
| „ 2. | Yellowish and red do. .. | 8 „ |
| „ 3. | Purple and white mixed, .. | 7 „ |
| „ 4. | Purple and whitish yellow— distorted stratum,..... | 7 „ |
| „ 5. | Purple strata, ..... | 50 „ |
| | Total, | 79 „ |

Proceeding near to the mouth of the Johore river, I examined two small islands or rather rocks, called Pulo Hantú "Ghost Islands."

Here are the first indications of (what I suppose to be) the secondary strata. The rock is a hard slate considerably fractured.

This rock dips to the southward at an angle of about 25°

The strata were a quartzose bluish grey *compact* slate, barely yielding to the knife; a darker coloured sort and harder; a grey quartzose and still harder slate, blue; a compact schist not yielding to the knife; a very hard lighter coloured and more massive schist, and lastly a dark blue compact stratum, quartzose and ferruginous, fracturing cubically.

JAMES LOW.

*Province Wellesley, 1st July,* 1847.

Fig. 1



Fig. 2



Fig. 3.




Fig. 4.




Fig. 5.

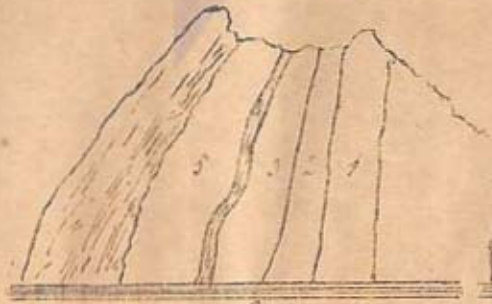
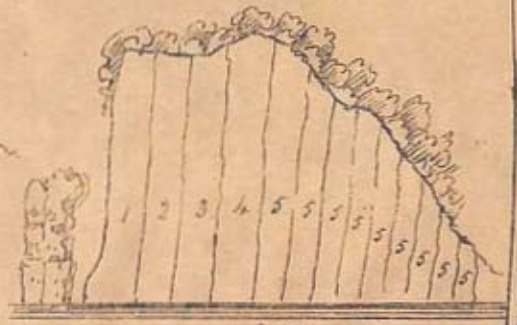



Fig. 6.




Lith. at the Miss. Press

Singapore, 1847.

