

XXIV.—*Geological Sketch of the Environs of Petersburg ;*

By THE HON. WM. THOS. HORNER FOX STRANGWAYS,

VICE PRESIDENT OF THE GEOLOGICAL SOCIETY.

[Read April 16, 1819.]

THE environs of Petersburg offer, at first sight, but few inducements to geological or mineralogical research ; a great extent of flat country, apparently covered every where by alluvial formations, and boulders of the primitive rocks, is all that strikes the eye of the traveller, who is seldom tempted to explore the wildernesses that yet surround this capital, from their want of any thing that may be called picturesque beauty. There are, indeed, some few spots which may be quoted as exceptions ; but they are mostly at some distance from the town, and are but little known even to the natives : and as the nature of the country gives no room to suspect their existence, it is not wonderful that they remain unvisited by strangers.

From this cause, perhaps, it arises, that there has hitherto prevailed an equal ignorance of the geology of the district to which the following observations relate. I have been told by some, that the whole country eastward from Narva consisted of a series of primitive rocks, which were said to shew themselves in the falls of the Narova above that town. Others have told me, that it was what is called a basin of the formations above the chalk ; a question, which, until chalk has been proved to exist somewhat nearer to

The Hon. Mr. STRANGWAYS *on the Geology, &c.* 393

Petersburg, than Podolia or Scania, it might be premature to decide. Others, again, believe it to be a country of coal measures, and are perhaps the most sincere in their opinions, having voluntarily put themselves to a great expense in boring for it in different parts of the country: these researches have hitherto been attended with results satisfactory to none but those who never believed in its existence in this quarter. Some appearances would connect it with the salt formation; others with the mountain lime. It has also been associated with the transition rocks, as they are called, more particularly grauwacke. Few, indeed, are the strata to which the name of the latter formation, the Proteus of geology, has not been applied.

The tract of country which it has been more particularly in my power to examine, may be comprised within a circle of about forty versts\* radius from the fortress of Petersburg, taken as a center, (Plate 28). I may have occasion to mention some interesting points beyond these limits, connected, as it will appear, with the district under consideration, but which connexion I have not had the opportunity of proving, i. e. of tracing it step by step; but I hope by so doing, to give indications which will be sufficient for those who may hereafter visit the north of Russia with the same views.

The Delta of the Neva, extending nearly nine versts from north to south, is entirely comprehended within the gates of Petersburg; the Taracanovca, † or beetle, branch, which is the most southerly, flowing close by the new gate or triumphal arch on the Peterhof road, and the Wyborg gate being placed beyond the little Nevka,

\* The verst, as now established, is equal to about three quarters of a mile English; formerly it was much longer, and still varies on different roads.

† So called from its abounding in taracans or beetles.

the farthest branch on the north. An alluvial plain extends for a short distance beyond the latter gate; it is probably part of the same deposit with the Delta, properly so called, but is at present joined to the first bank of the terra firma on this side, without the intervention of any branch of the river now remaining.

This Delta is not entirely built upon. The northern islands, in particular, are still low enough to be occasionally flooded, and their banks are in some places always marshy. The higher spots alone are covered with villas and gardens; the lower parts remain wooded. The southern islands, upon which the town stands, are considerably higher and drier; to this circumstance is owing its comparative freedom from the inundations, fogs, and countless swarms of gnats, to which the northern islands are exposed. The eastern extremities of the islands are the highest, as being the oldest; the western still low and marshy, being of a later date; while there exists, continually increasing between them and Cronstadt, a set of submarine islands, which form at present a dangerous bar, and will at no distant period make a considerable addition to the Delta.

A tract of low marshy land, in some places nearly two versts in breadth, of similar origin to that just described, borders the two shores of the gulph to a distance of about forty versts on the southern, and twenty-five on the northern coast. It does not appear to be every where gaining on the sea; it is in some places stopped by the approach, in a contrary direction, of the sea-sand, which not only arrests its progress, but being blown over and mixing with the loose and wet ground of the marsh, forms a soil firm enough for the growth of trees and for agriculture: examples of this posterior accumulation of sand may be seen on the north shore near the village of Lakhta, east of the great marsh on the

Cesterbeck\* road; and on the south shore at Peterhof, where a part of the gardens of the palace, and oaks, ash, and alder, of great size, are planted on the alluvial flat. The oak, if not the ash, are said to have been planted by Peter the Great; the alders, which both here and at Oranienbaum, as well as the pines at Becova, all planted on this alluvial plain, exhibit the marks of great age, may be still older, as they are natives of the country. It is remarkable, that between each of the three localities above given on the southern shore, there exists a small portion of the coast where the marsh still gains on the sea. This may perhaps be occasioned by a difference in the depth of water, which is in general very shallow.

This alluvial land does not extend far above the delta. The banks of the Neva, (at least of that portion of it which is below the sudden turn which it takes at Pella), consist of an accumulation of diluvian gravel, which will be hereafter more particularly described. Where these banks separate, the alluvial flats begin; the southern bank of gravel, being continued under a small portion of the town, is divided by the deep stream called the Chorny Bechka, or black rivulet (a common and appropriate name in this country for all the brooks whose waters are derived from peat bogs,) on the right bank of which stand the monastery and gardens of St. Alexander Newsky. About four versts from Petersburg, on the Peterhof road, the same bank makes its appearance, and is continued without interruption, except from ravines and brooks, to about fifty versts in the same direction, where meeting the present shore of the gulf, it forms the headland of Crasna Gorka, or the red hills. It will be seen that a change in its materials takes place at about half the

\* In the Russian maps, Cestroretsk, of which Cesterbeck is only a corrupt German translation. Cestra reca, or Cester Back, meaning only the river Cestra, on a lake at the mouth of which the village and iron works commonly called Cesterbeck are situated.

distance, with which the name of this headland seems to be connected; the present description, it must be remembered, is merely topographical. This bank is very well defined, and continuous throughout its whole extent, with the exception only of that part south of the town, where the rise is insensible. The western portion of it, now separated from the gulph by bogs and marshes, has evidently been its ancient shore, as the eastern is now that of the Neva. Its average height is from thirty to forty feet, gradually rising towards the west. The great road to Riga runs at its foot, and the slope is ornamented with villas and gardens, being no longer dangerous from the undermining of the waters, which still affects the banks of the river above Petersburg.

A similar bank skirts the northern shore till it meets the gulf near Cesterbeck. With the exception of the great marsh near Lakhta, which interrupts it, it is more continuous than that on the southern side of the town, leaving the river near Okhta, and being easily traced behind the Wyborg gate to the village of Colomyagy, meets the marsh opposite Lakhta.

This bank appears in like manner to have formed the northern shore of the gulf, at a period when the alluvial deposits had not yet risen to the surface of the waters, and when the apex of the delta was the real mouth of the Neva. Where the banks became wider apart, and the current consequently slacker, the first deposit of sand was formed: this, at first a bar, then shewed itself above the level of the river as an ait or island; many of these at last formed the delta as we now see it, and as it is now, by a repetition of the same process, extending itself towards Cronstadt. As the breadth of the channel becomes gradually wider towards the west, and the water deeper, this deposition takes place slower and slower as it advances; and the silt or sand of which it is composed, being also finer in

proportion to the distance from the original mouth of the river at which the depositions commenced, contributes to render the progressive increase of this, as of other deltas, apparently less rapid in these days, than it must have been formerly.

It has been proved by actual examination, that of three successive depositions which form the present bar, and whose slow but constant increase is become already a material disadvantage to the port of Petersburg, the first consists of small pebbles and all the coarser particles, the greater specific gravity of which has caused them to fall on the slightest relaxation of the velocity of the current; the second of a finer sand, and the third of the finest silt or lighter particles of earth, which have not been deposited until the stream, meeting the waters of the gulf, has thrown them wherever the eddies or still waters have become incapable of carrying them any further. It is not improbable, that the materials which form the basis of the older islands may be pebbles of a still larger size; even the isle of Cronstadt itself, which is also alluvial, may be accumulated over some great heap of boulders.\* The surfaces of all the islands, however, are covered with a fine sand, which has floated the highest, and which prevents the ascertaining of this point.

These alluvial depositions are certainly very considerable, for a river whose whole course amounts not to more than seventy-five versts; especially if it is considered that its waters flow directly from a vast lake in which all their previous impurities must have been left. In consequence, its waters are perhaps purer than those of any river of the same size. Its supply of water from this source is, of course, very steady, and the streams it receives are too

\* When the waters of the gulf are low, numbers of vast boulders may be seen stretching in reefs and banks to a great distance from the shore. The shape of the isle of Cronstadt agrees exactly with the idea of the alluvial tails described by Sir James Hall in the *Trans. R. S. Edinb.* 1813.

inconsiderable to affect it by their occasional irregularities of level. The frequency of floods is said to have greatly abated during the last century. Its course is remarkably free from islands, except at the mouth, there occurring but two or three in a bog at Astrafki, above Pella.

The silt brought down by the Neva is far from being a fertile soil; derived originally from two or three of the poorest strata in Europe for agricultural purposes, and lastly from the diluvian gravel, which form the banks of the river, in which sand greatly predominates.

Behind these banks, the course of which has been traced above, extends a level country on each side of the Neva to a considerable distance. On the north, it forms the isthmus between the gulf and the lake Ladoga. Its features are easily described. A ridge of hills runs due north from the great bend of the Neva at Pella to beyond Coltoushy, where it terminates. After an interruption of two or three versts, we find the insulated ridge of Biabova stretching in the same direction, and after another considerable interval, that of Toxova, which extends beyond Vola and Lembala to the chain of lakes called collectively the Voxa. A little to the south of Toxova, it turns to the eastward, forming the Capsala hills,\* and is continued behind the marshes of Cesterbeck, sending out a small branch to Diboun, and a larger one towards Pargola and the lakes of Souzdalskoe: this latter runs parallel to those of Coltoushy and Biabova; and like them, presents its steepest escarpment to the west. That of the Corpsala ridge is steepest towards the south; that of Toxova has a declivity nearly equal on each side. Thus there are three distinct plains between the lake

\* Spelt in the maps Caropselky called commonly Copsala or Copselky.

*Geology of the Environs of Petersburg.*

399

and the gulf; gradually rising in level towards the eastward.\* The country is thinly inhabited, being covered with forest, bogs, and marshes; the soil poor and sandy.

Behind the south bank there extends also a boggy plain, for the most part covered with coppice wood, from five to ten versts in breadth. From this rises a well defined but not lofty escarpment, which may be traced throughout the whole of this part of the district under consideration. Its general course is from west to east, till at Palcova, a village about thirteen versts south of Petersburg, the hill of that name, which forms a prominent feature in the escarpment, turns suddenly to the south-east, and the ridge is continued in that direction (with a few irregularities, to be described hereafter) to the village of Fedorovsky; thence across the great Moscow road, nearly eastward, to a little above Nicolskœ on the Tosna: further eastward, it skirts in like manner the southern bank of the Neva and of the lake Ladoga, always at a few versts distance. It is interrupted by the denudations of the Strelca and of the Ligozca, in its western half, and by those of the Slavencia, †Ishora, and Jossna, in its eastern. The only ill defined part is between the hills of Coirova and that of Cargasary, but it is of small extent; this may perhaps be connected with a remarkable change in its structure, which takes place in that part of it. A chain of low rising grounds may be traced west of Coirova in continuation of this line; but, as will be seen hereafter, has no claim to the name of an escarpment, considered either geologically or topographically. They pass along the wood and village of

\* Of these three plains, that of Lakhta is raised but little above the level of the gulf; that which is east of Riabova but little above the lake. The difference of level between the lake and the gulf is said to be eighty-three feet.

† The letters *sh* in Ishora, are to be pronounced hard, like *s* or *z*, in the words *vision*, *cohesion*, *brazier*.



Gorela or Gorelova, that of Niccory, Khamouzy, and some others, and may be discovered still further westward. The village Khamouzy is placed on the highest elevation along this line, west of Coirova. Some groups of low hills are also seen behind Peterhof and Oranienbaum, of which that of Bronna or Bronnaia is the most considerable.\* All these low hills are ranged in front of the principal escarpment described above, which seems to fall back a few versts, whilst the communication between the hills of Coirova and Cargasary is wanting to complete the chain. The vacant space is filled up by a gradual but boggy rise, in which the stream of the Chorny Rechka has its source. Behind this escarpment, or rather on the table land of which it forms the edge, is seated a group of hills of about eight versts in length, which begins at the east bank of the lake of Doudorof, and stretches towards Tzarscoe Celo. This group comprises the two hills of Doudorof and Teply Sad, two conspicuous landmarks over all the country, and the highest points in all this district. These hills, as well as the table land beneath them, are in general of a very dry but poor soil; there are, however, large tracks of cultivated land, especially west of

\* I have reason to believe that the following list of heights in the neighbourhood of Petersburg is correct. It was given me by an engineer employed in making a geographical survey of the country.

<i>Ingrian side of the Gulph.</i>			
	Barom.	Trig.	
Bronna (behind Oranienbaum)	31·5		sand
Soikina (beyond Caporié)	58·3		doubtful
Doudorof (church)	78·1	77·2	limestone
Visotsky (hill)	66·4	68·5	doubtful
<i>Carelian side of the Gulf.</i>			
Merstojersoy	39·7	42·4	sand
Voronina (opposite Cronstadt)		47·9	sand

These measurements are taken in sashenes or Russian fathoms, each containing seven English feet. The heights are computed above the Gulf of Finland, in which there is no tide.

the Ligovca river. West of it, as well as to the south of the hills of Doudorof, there are extensive and almost impassable bogs; further eastward, the country is again more peopled and cultivated. What I have called table land is not absolutely flat: that part west of the Ligovca is varied with narrow and parallel ridges of gravel, in the hollows between which are some deep but small peat bogs; while behind Coirova, where the whole country appears a bog, a few insulated villages, as Ruzina and Venerozy, &c. are seated on some accumulations of gravel, which rise as islands in the waste. Both in the boggy and in the dry district, the scarcity of running water is remarkable: west of Crasnoe Celo is a very considerable district, absolutely without it, contained within the Ligovca, the Strelca and the Poudost rivers.\* Nor are lakes frequent; although they abound in the country on the north of the Neva.

The general face of the country, as it will appear from the sketch and the sections, Fig. 1 and 2, Plate 29, consists of terraces of great regularity, but inconsiderable height, supporting different tracts of flat country, on which a few insulated hills are placed. This description is equally applicable to the country on the left as on the right bank of the Neva, although there is a considerable difference in the soil and its productions. Nothing can be more dismal than the general appearance of that district on the right bank of the Neva. Sands and bogs afford but a scanty vegetation in the few spots where the woods are sufficiently cleared to allow of some miserable attempts at agriculture; and in the remaining tracts, the forests are for the most part stunted by the continual cutting to which they are

\* The limestone escarpment, more especially that part between the denudations of Ropsha and Crasnoe Celo, is called in the old Russian maps, the Shoundorovsky hills, from the farm Shoundorova, still remaining on it, and which was probably the oldest settlement. The western extremity is the highest, and commands a magnificent view both towards the gulf and towards Doudorof, especially near the great oak. In the village of Rusky Coporsky, the limestone crops out in the street, yet the inhabitants send for limestone to Visotsky or Crasnoe Celo!

subjected for fire-wood. They consist exclusively of fir and birch, and occasionally aspen, the few oaks to be found at Toxova and Riabova being attributed, as all those trees are in this part of Russia, to the forethought of Peter the Great. Grass is rare, being commonly replaced by lichen rangiferinus; the sand, which here contains little or no mixture of clay or lime, produces nothing but rye and buckwheat in small quantities. Only the abrupt declivities of some of the principal hills, and the banks of a few lakes, present scenes, which though certainly picturesque, are of a melancholy character.

Nearly the same picture may be drawn of that portion of the tract on the left bank of the Neva, situated to the north and to the east of the principal escarpment; with the exception of those parts artificially adorned by the neighbourhood of the Imperial palaces, which are all on this side of Petersburg, and by the villas and summer residences of its inhabitants. But south of this tract, especially within the limestone district, the character of the country changes; large tracts of cultivated land and many populous villages are found along all the principal escarpment, and many parts of the country behind it; oaks, though perhaps not natives of the soil, are more frequent, and attain their full growth; even wheat is sometimes cultivated; the wych elm (*ulmus montana*), and a greater variety of plants become common, many of which belong to the Flora of central Europe, while those of the sandy districts before described belong principally to that of the north. In the valleys which lie upon the limestone and sandstone rocks, may be found many beautiful and picturesque landscapes.

If we examine the structure of the terraces and plateaus of which the surface of this country is formed, we shall see that they are, in fact, not table lands, fig. 3, pl. 29, but large shallow basins, the interior

of which, for want of sufficient drainage, is now filled with peat bogs, while the edges or lips of these basins, which are, of course, much drier than the interior, become better adapted for agriculture, and are in consequence, together with the banks of the rivers, where the same cause operates, the only tracts inhabited and cultivated. To these may be added a few insulated deposits of gravel in some of the great bogs. But in every part of this country, over whatever stratum or in whatever situation, the superficial or vegetable soil is scanty in depth and poor in quality. A dry situation in a country generally so wet, and a climate, if not rainy, yet extremely variable, seems to be the principal object in the choice of a spot for building. Soil is but little considered in a system of agriculture where the peasant leaves his unmanured field fallow every alternate year, and where the government unavailingly offers rewards to procure from the land a return of five for one.

---

#### ANTE-DILUVIAN FORMATIONS.

##### PRIMITIVE.

\*Although no members of the primitive formation occur *in situ* within the limits of the tract which forms the subject of these observations, yet it may not be unnecessary to mention the situation and

\* In the year 1819, a Synoptic Table of the different formations near Petersburg, was published in French, in one sheet, in that city, by the author of this memoir, accompanied by a table of lithographic sketches and sections coloured; also an old duodecimo map of the Academy was issued anew, and coloured by the Mineralogical Society.

From this table it appears, that with the exception of modern alluvium, and diluvian sand and gravel, the limestone No. I. is the most recent formation of that neighbourhood. From the nature of its animal and mineral contents it appears most nearly allied to the transition limestone of the English series. Beds connected with these deposits extend from Esthonia to the southern extremity of Lake Onega.

direction of that district of the primitive rocks which is nearest to it in geographical relation. This is the granitic country of Carelia, which approaches to within a hundred versts north of Petersburg, possibly still nearer, although it has not yet been detected *in situ* nearer than Souvenoya, two posts from Wyborg. These granitic rocks form the southern portion of the primitive chain of Finland, connected on the west with those of Sweden and Norway, and on the east with those of the government of Olonetz and Arkhangel, which are probably a connecting link between Scotland and the Oural moun-

## No. I.

Shelly limestone breaking into cubic fragments, disposed in beds moderately thick, and conformable to those of the subjacent schist.

*Characters.*

- a. hard, sandy, yellow
- b. hard, crystalline, black
- c. tender, argillaceous, whitish
- d. hard, dark red
- e. spotted with yellow, red & green
- f. argillaceous, greenish, passing into the subjacent schist, a.

*Mineral Contents.*

1. calcareous spar well crystallized
2. green carbonate of copper
3. sulphuret of copper
4. iron pyrites
5. grains of green earth disseminated

*Organic Remains.*

1. helix
2. pentacrinites (doubtful)
3. fungites, &c. (same as at Reyal)
4. orthoceratites
5. trilobites
6. encrinites (paradoxus)
7. terebratulites
8. hysterolesites
9. lemon-shaped bodies resembling heads of alcyonium

## No. II.

Schist argillaceous or sandy, usually in very thin laminae, and subject to great irregularities of level as well as of composition.

- |                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> <li>a. schistose greenish clay, resembling f. of the preceding</li> <li>b. alternating with sandy beds</li> <li>c. yellow grit stone, mammillated</li> <li>d. yellow sand, spotted with green</li> <li>e. quartzose grit, coarse grained</li> <li>f. ferruginous sand, black or red</li> <li>g. black schist, brown or green argillaceous, passing into (a) of the next inferior series</li> </ol> | <ol style="list-style-type: none"> <li>1. green earth, very pure</li> <li>2. yellow pyrites cubic</li> <li>3. bronze coloured pyrites octohedral</li> <li>4. Sulphuret of lead</li> <li>5. native sulphur and earthy ditto</li> <li>6. radiated nodules of bituminous limestone</li> </ol> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

1. chamites

## No. III.

Clay not distinctly stratified; has been penetrated to a considerable depth without discovering the subjacent rock.

- |                                                                                                                                                                                                                                                   |                                                                                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> <li>a. blue greenish clay, resembling g of the preceding</li> <li>b. spotted with red and yellow</li> <li>c. intersected by veins of yellow clay</li> <li>d. having a tendency to oolitic structure</li> </ol> | <ol style="list-style-type: none"> <li>1. pyrites in small quantity</li> <li>2. small flakes of mica</li> <li>3. veins of yellow clay</li> <li>4. grains of iron ore</li> </ol> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

No organic remains have yet been found in this bed.

tains. This tract is therefore at the northern extremity of what has been termed the Great Basin of the North of Europe. I shall begin the geological detail with the lowest stratum, and proceed with the rest in regular succession from below upwards, according to their order of superposition.

\* The basis or substratum of all this country is a blue clay, beneath which no other bed has yet been exposed. The highest stratum, both with regard to geological and topographical position, is a limestone, which presents no appearance of having been covered by any other original formation. Between these two, occurs an intermediate bed, whose presence is constant, but whose characters are by no means equally so. It is, in fact, a transition bed partaking of the characters of that above it as well as of that below it; to which are added some peculiarities of its own, which sufficiently distinguish it from the other two. In the blue clay there is no apparent sign of stratification, nor of organic remains; in the limestone are abundant marks of both; the intermediate bed in some of its forms is evidently stratified, in others that appearance is totally wanting; its organic remains are scanty and rare. These three beds are strictly conformable, as may be seen by their stratification wherever that is visible. Although perfectly distinct in general character, they pass into each other at their points of contact. I consider them therefore as members of the same formation.

\* There is some reason for apprehending that the blue clay, which I mention first as lowest in situ, does actually rest upon the primitive rock without the interposition of any other stratum. I shall have occasion to speak again upon this subject in the comparison of the secondary beds of this district with those of Sweden.

## SECONDARY.

*Blue Clay.* \*

Its colour is a pale blue or bluish white, generally with a tinge of green. In a few places (as on the Couzminka and on the left bank of the stream which flows through the old gardens of Soltikoff's Coirova) it is slightly sandy and micaceous, and variegated with red streaks; in which circumstance it resembles some of the clayey beds interstratified with the limestone. When dry it cracks into sharp angular fragments, usually affecting a square or cubic form, which is the common fracture of all the beds of this formation. It sometimes but rarely contains small crystallizations of sulphuret of iron, and at Samsonovsky an efflorescence of sulphur.

In that division of the clay district situated between the Coirova hills and the shore, there occurs a remarkable appearance in the

\* The three strata of this district bear the following names among the people of the country :

The Limestone .....	Pleta .....	in Finnish—Paas <sup>////</sup>
Sand .....	Pesok .....	
Sandstone .....	Brusok.....	Siroki .....
Clay .....	Glin.....	

The correct name for Limestone, as such, in Russia, is *Ezezkovoj Kamen*. That of this country is called *Pleta*, a name answering more nearly to our word *Flag*, than any other, without reference to its composition, but rather to its schistose structure. The following are their distinctive names for stones :

Flag .....	Pleta
Flint.....	Kremen
Boulder .....	Kamen

The latter word *Kamen*, which means simply *stone*, is applied to the primitive boulders *par excellence*, on account of their hardness. There is scarcely a peasant also but **knows** Granite by name, if not by sight.

clay, which merits particular attention. It is best seen in the sides and bottoms of the ravines which the streams Ivanovka, Coirovka, and Crasninka, have cut through that bank of diluvian gravel which skirts the Peterhof road from Petersburg to Strelna. The natural channel of the Ligovca has been so obscured in this part by artificial works, that the clay is not seen to advantage in it.

There is a low cliff on the right bank of the Coirovca, between the village of New Ligova and the Peterhof road:\* Immediately below the soil are some thin layers of a whitish clay, which cover a layer of pebbles slightly cemented together, and just hard enough to project a little beyond the beds above and below it. Thus far all seems to be diluvian, and agrees in character with that which is found immediately beneath the soil in all the neighbourhood. But under this we find the clay of the country, of its usual blue colour, with the exception of the upper part in contact with the bed of pebbles, which is yellowish; as are also certain veins by which the blue clay is traversed in various directions, though but seldom horizontally. These veins are from three to six inches, or even more in width; their substance is a yellowish clay somewhat like that which intervenes between the blue clay and the diluvian. Although these veins are not hard, they are of a firmer consistency than the blue clay which they intersect; they are usually very easily divisible in the direction of a ferruginous line which runs down the middle of each, and which separates, or is cut through, in exact conformity with the yellow clay veins themselves. The relative hardness, or rather solidity, of the blue clay and its accompanying veins, is beautifully shewn in every instance where they occur in the bed of the stream, or in places

\* See Sketch of the clay veins on the Coirovca.



often under water. In such situations, the blue clay is uniformly washed out to the depth of about five or six inches; the large veins preserving that height round the holes thus formed. As the holes are gradually excavated, the upper part of the walls which surround them, not being strong enough to resist the stream, are carried away. The whole presents a sort of honey-combed appearance on a large scale, which I have endeavoured to express in the sketch. This may also be very well seen in the bed of the Ivanofka, and of the Crasninka above Crasnoe Cabac, the whole bed of which stream appears as if hollowed out of one vast septarium.

The three rivers abovementioned are the only ones in which I have found this singularity of the blue clay; it is not observable in the banks of the Ligovca, nor in those of the Chorny Rechka, either above or below Coupchina. In the former, we find only blue clay without veins, and in the latter, no blue clay whatever: the whole depth of its banks being composed of yellowish diluvian gravel.

The only good exposure of the blue clay, on the right bank of the Neva, is in a pit, whence the clay is taken for brick-making, by the side of the small stream called Chernavca in the great map of the environs of Petersburg, just where it quits the picturesque churchyard of Okhta. It is somewhat singular, that though visible here at so high a level, it should not be laid open in the lower grounds; the sand which forms the bed of the Okhta river is rather argillaceous, especially just below Mourina; as is that found on piercing the bogs east of Riabova, and that which forms the bottom of the larger lake of that name: but these being members of the same formation, it must happen, as in analogous cases, that they pass into and blend with one another.

South of the Neva, it skirts the shore of Peterhof and Oranien-

baum ; is seen in the beds of most of the streams which discharge themselves into the gulf on this side, especially those between Becova and Peterhof ; appears farther inland through some of the boggy soils ; may be followed up the Ligovca to the lower lake of Doudorof ; up the Coirovca and its tributaries above the villages, where it is in great strength ; further eastward, it is to be found in the ditches along the Tzarscoe Celo road to the foot of Pulcovca hill, on the Pulcovca above and below the remarkable outlier, and on all the streams cutting through that part of the escarpment. Again it is in great force on the lower part of the Ishora and Tosna rivers near Podolova and Nicolskoe. But further eastward, it seems the valley of the Neva and basin of the Ladoga, and with them the whole country, becomes too elevated to allow the denudations to lay bare this inferior bed.\* The blue clay is said to be traced along the whole southern shore of the Gulf of Finland, at least as far as Reval. Above it lies an

*Intermediate Bed,*

which I confess myself to be unable to designate by any name derived either from its appearance or from its composition ; as it not only varies considerably in both, but consists of a number of alternating strata of various colours and substances, some of which are not always present, and where they are, differ greatly in their relative thickness and position. In fact, they appear to have no fixed relative position *inter se*, although taken as a whole, the series which constitutes that which I have named the intermediate bed is very constant in its place between the blue clay below and the limestone above it. It is also strictly intermediate in composition

\* The blue clay has been pierced to the depth of sixty-three feet, at the paper mill at Peterhof, and to twice or three times that depth on the banks of the Neva, without finding any subjacent stratum.

between those two beds, the lower portion partaking of the nature of the clay, the upper of that of the limestone. A minute description will therefore be necessary, as it is only by the occasional presence of some one or other of its members, that it is to be traced throughout a very considerable tract of country; and as some of these members in some parts of the district increase greatly in thickness, to the exclusion of those which accompany them in others, it is possible that it may exist in other parts of the north of Europe, where it has not yet been noticed. It is fortunate, that in a part of Europe, so easy of access as the neighbourhood of Petersburg, we find some spots where all its varieties may be examined in the same natural section.

I shall therefore give the series of beds which compose this stratum, as they occur on the left bank of the river Ishora, exposed to view in a precipitous cliff partly overgrown with brushwood, but sufficiently accessible to allow of a minute examination of the rock, the variations of its character being in this spot more striking than in any other I could select. The banks of the Tosna, where they may also be seen to great advantage, are less accessible, whilst the thickness of the beds is so considerably increased, as not to allow of the whole series being seen in one vertical section; a circumstance which adds greatly to the value of those on the Ishora, in a practical point of view, as there can exist no doubt with regard to their relative position. Each bed is likewise of sufficient thickness to present a decided character, and the presence of both limestone and blue clay, one at the top, and the other at the foot of the cliff, determines at once the place of any of the beds wherever it may be met with.

The spot which I wish to point out for examination is a cliff about sixty or seventy feet in height, if not more, on the left bank

of the Ishora, a little above the village of Samsonovsky, or Oloseen Mekky, from which it is divided by a narrow ravine without water. At the river's edge appears the common blue clay before described, which forms the base of a wide meadow occasionally overflowed by the river. On reaching the foot of the cliff, it passes into a sandy mixture, gradually acquiring a greater degree of purity as it approaches the upper beds. The most remarkable character is that of a brilliant white quartzose sand, of the finest quality, in which are excavated small caves, supported by pillars left in the rock, for the purpose of procuring sand for writing, or for hour-glasses. It has just sufficient coherence not to fall in. Next above this white sand is a bed of the same substance, differing only in its colour, which is a bright and beautiful yellow. These two beds, which are sufficiently obvious, may also be seen on the banks of the Tosna, Slavenca, and Popovca; also at Mishkina, and in the neighbourhood of Pavloosk.

It is in this part of the series that there occurs a bed which I must mention here, though I have only found it *in situ* at the rocks above Nicolskoë on the Tosna. It is a yellowish white sand, differing but little from those sorts just described, excepting that it contains organic remains. These are only one large species of chamite, in very good preservation, usually of a brownish colour, and retaining the original polish of the shell. Where found *in situ*, it is of very loose texture, readily crumbles between the fingers, so that it is impossible to bring away a characteristic specimen; and on weathering, offers some indications of a mammillated or botryoidal structure, which, it will be seen hereafter, is a remarkable feature in another member of this formation. It was first found in rolled pieces, and in small quantity, near Tzarscoe Celo; I have since found it in large rounded blocks and pebbles of great hardness, and

affording excellent specimens, among the diluvian gravel on the summit of the hills bounding the north side of the vale of the Ishora, especially in gravel pits near Repolova, and Anteleva.

The two beds immediately above this consist also of a sandstone containing chamites: they are, in fact, a continuation of the last, but differ in some respects from it. The lowest is usually of a reddish or even rosy colour, and contains vast quantities of chamites, or rather fragments of them, strewed throughout its mass, in the direction of the planes of stratification. The upper bed is of a dark green or blackish brown colour, equally filled with chamites, some of which have a tendency to iridescence or metallic lustre. This circumstance, together with the regular laminæ in which they are disposed, gives them a certain resemblance to mica slate or gneiss, for which the rolled fragments, in which state this rock was first noticed, were taken. Its extreme hardness, even when *in situ*, the obscurity of the organic structure of the shells it contains, and its being found in company with rolled gravel entirely composed of masses of primitive rocks, some of which consist of real gneiss nearly resembling it in outward appearance, may account for this error. It is present on the Ishora *in situ*, but may be seen best where I first discovered it, at its outcrop in a quarry at the north end of the village of Slavenca, west of the river of that name, and south of Pavloosk.

Above these chamite beds the sandstone assumes a ferruginous aspect; its colour yellow, red, black or brown. It is seen in this state in the outlying ridge behind Peterhof and Oranienbaum; also throughout the neighbourhood of Pavloosk; and in a loose state, forms the hills situated to the north of Petersburg and the Neva.

Connected with this bed, is a mammillated or botryoidal sandstone, which occurs *in situ* in this part of the country, from the Popovca

to the Tosna. It forms large beds of various degrees of hardness, usually of a yellow colour, and more or less charged with iron. It may be found at Nicolskoë on the Tosna in every state intermediate between a simple botryoidal sandstone and a heavy mammillated iron stone. It is *in situ* on the Popovca a little above the village, and near the white sand.

The succeeding beds become more argillaceous, and are of a dark brown colour inclining to green. They contain as much iron as those immediately below them, usually in the form of irregular masses of pyrites radiated in the interior; sometimes in bunches of crystals, exhibiting both the cube and octohedron with their modifications, as well as the bronze red and brass yellow colours. The superior beds are thinner and more slaty; their colour ash grey or purple passing into green and black. They are bituminous, and contain layers of fetid calcareous spar, disposed in nodules of a dirty brownish white colour, and radiated from the centre. They sometimes appear like rugged balls, the apices of the crystals projecting at the circumference.

These pyritical and bituminous beds are always very thin and sometimes much contorted. Their upper portion contains a vast quantity of green earth of very fine quality, which might be used for painting. These beds of green earth differ in character, the lower being argillaceous, passing into green clays immediately below them; the upper, on the contrary, although in appearance the same, are hard, contain lime, and pass gradually into the lower and argillaceous beds of the Pleta limestone, through which green earth is also disseminated.

The topography of this *intermediate bed* must be described under two different heads: one of which will comprehend its outcroppings from under the limestone, which it skirts throughout; the other

its various outliers on each side of the Neva, which are not capped by any other antediluvian formation. I shall take the latter first, as the former will lead more naturally to the consideration of the limestone immediately above it.

All the chains of hills comprehended within that part of the district I am describing, which are situated on the right of the Neva, and which have already been mentioned in detail in the beginning of this memoir, are composed of the loosest and most sandy form of the stratum in question, as well as the plain which supports the bogs between the ridges of Toxova, Riabova, Coul-toushy, and the lake Ladoga. This will be better understood by the section, fig. 4, Plate 29. The sand on the banks of the Okhta, especially below Mourina, and that west of Pargola, I imagine to be diluvian, for reasons to be stated hereafter.

Its colour is in general yellow, and it much resembles the sands of Prussia and the north of Poland, as well in geological character as in the scenery it presents. Nothing can be more desolate than the little valley of Diboun, in which a stream of the brownest hue, formerly dammed up for the purpose of supplying with water an iron work now removed, forces its way with difficulty through a bog impassable to human footsteps (as are many others in this country) except after  $10^{\circ}$  Reaum. of frost. In summer, its moist and heavy exhalations, exposed for some months to the sun during eighteen hours a day, rarely disturbed by a breath of air, and confined between tall and gloomy forests of fir and birch springing from the arid sand which presents no trace of other vegetation on its surface, than grey moss and some species of ferns growing among granite boulders, nourish myriads of gnats or musquitoes, gadflies, and all the other disagreeable insects which swarm in this climate during the warm season.

Although this is the general style of country, yet there are some spots of a more pleasing character, which also present the best situations for examining the characters of this sand. Such is the dell in which the Okhta runs above Mourina, especially in the gorge in which it is confined in passing through the hills of Copsala: the hills and lakes of Pargola and Souzdalskoe; the environs of Toxova, and the western ascent of Riabova. In each of these places may be seen considerable cliffs of sand clothed with the most beautiful and fragrant flowers of the north in the greatest luxuriance, particularly *Convallaria bifolia* and *maialis*, *Andromedæ calycalata* and *polyfolia*, *Ledum palustre*, &c. *Pyrolæ*, *Orchideæ*, &c.

At the western foot of Riabova, and of Coultoushy, and on the banks of some of the beautiful lakes of Toxova, the sand assumes a deep red colour, and contains a considerable portion of iron. The streams which issue from these hills are strongly tinged with it, and transport particles of it to a great distance. This may be observed also in some other places.

Those outliers of this stratum which occur on the south shore of the Gulf, afford in general the same character as those on the north, just enumerated. But, in a few instances, the sand is considerably harder and more compact, and though it may in general be broken between the fingers, yet it sometimes passes into a real sandstone, of a fine grained sugary texture, white or yellowish. This exhibits some faint traces of stratification: but after frost, the laminæ are seen separating very distinctly in all the fragments exposed to its influence. It is sometimes found large grained, and may almost be termed a conglomerate of quartzose particles, each about as large as a grain of rice, strongly cemented by iron. The best localities for examination are, the valley at Peterhof, between the Emperor's English garden and the paper-mill bridge; and a small ravine and



brook between Sopsana and Becova, also remarkable for the finest oaks near Petersburg, planted by Peter the Great; and in some other ravines along that coast. I have reason to believe this portion of the sand skirts the coast at least as far as Crasna Gorka headland; its exact termination on the east I must be content to leave undetermined.\*

I must now proceed to that portion which may be called the principal mass of this stratum; and which underlies the limestone which it may be seen skirting along its whole escarpment. My farthest certain locality to the westward is Caporié, where it occurs in its state of purest green earth; thence it is traced westward by Ruditzza, Gastilitzi, along the Shoundorovsky escarpment; in the ravines on the west side of the valley of the Ligovca, at the foot of the heights of Crasnoe Celo, in its most bituminous state; in the ravine of the Poulcovca in its most pyritical state, a character which it preserves along the Tzarscoe Celo escarpment as far as the brook Coshelevka: on the Popovca it begins to be sandy, which character increases rapidly as it advances to the eastward. The sandy beds increase in strength on the Slavenca, the Ishora and Tosna rivers, and wherever they may be seen in the escarpments between those points, where at last it totally banishes and occupies the place of the bituminous and clayey beds; and from the Popovca eastward it contains chamites and the beds of globular concretions.

In two places it occurs under a character still different from any that has been mentioned. On the upper part of the Ishora, in the neighbourhood of Anteleva and Lukozy, particularly at a cliff well known to those who fish in that river for trout and grayling, by the name of the red bank; it is much like the red ground of the

\* The sandstone is seen distinctly in the ravines between Peterhof and Strelna, but seems to have ceased before we arrive at the ravines and lakes of the latter place.

central parts of England: for instance, on the banks of the Teme, in Worcestershire, to which this part of the Ishora bears some resemblance. Again it is seen with the same characters near the entrance of a considerable ravine or hollow in the Shoundorovsky escarpment, where the road from Gorela to Ropsha crosses a brook near the village of Niccozy; it is here slightly micaceous, and offers to the attention of the botanist the beautiful *Epilobium hirsutum*, the only spot where that plant is found near Petersburg. Towards Ropsha the outcrop is covered up (as are most of the eastern slopes of the vallies of denudation) by a thick bed of granitic gravel. The hill of Khamouzy, and the heights near it, are so covered with gravel and soil, that their composition cannot be exactly ascertained.

#### *The Pleta Limestone*

Covers the intermediate bed last described. It is a coarse limestone, the lower beds of which are very argillaceous, and contain a large portion of green earth: they are, in fact, only harder beds of the same substance as that which forms the upper part of the intermediate bed. The most common colour of this limestone is a yellowish grey, sometimes spotted or variegated with green, red, dull purple, and bright yellow, or even orange of different shades. The great mass of the limestone also contains much clay, which seems to have been favorable to the preservation of the organic remains contained in it; but the upper beds are considerably harder and more sandy, and contain much fewer traces of a former world. As there is no one section which gives so distinct a view of its beds and their peculiarities, as the cliffs of the Ishora do of those forming the intermediate bed, I must describe them in their order, referring to localities where they may be examined and identified.

Where the intermediate bed is argillaceous and charged with green earth, as may be seen in the ravines of Crasnoe Celo, the limestone in contact with it presents only modifications of the same characters. Thus in ascending the ravine of the Colomenca brook at Crasnoe Celo, from its mouth, the green sand beds become more solid as we ascend, and at last give way to a grey argillaceous limestone, sufficiently hard to form steps across the stream, which are very convenient to the geological examiner. This argillaceous limestone occupies nearly the whole mass of the heights of Crasnoe Celo: it abounds in organic remains, of which the following are those which are sufficiently distinct to have been named.

A species of orthoceratite of great size, being sometimes a yard in length, and six inches in width. Their outer shell, when preserved, which it rarely is, is channelled in the direction of the septa of the interior. A good specimen of this is in the cabinet of the Mineralogical Society at Petersburg. The casts of the siphunculus shew it to be channelled spirally; the inner shell is very thick, and large specimens are often procured; but the termination at either end is always wanting, having probably been too thin to resist violence. We are still therefore in doubt whether it was curved, or continued in a straight line to its extremity. They are seen in great quantities lying in the direction of the beds of limestone, but traversed by its perpendicular fissures.

Two species of trilobite; one, which has been called *trilobites caudatus*, is the most common; it has a head with two projections which have been taken for horns, but are probably prominent eyes like those of the lobster, with which this animal appears to have had some analogy. It has usually eight, or not more than nine plates, disposed in three rows, which in specimens well preserved appear to be jointed, part of each being double. It has also a large

flap tail, which is often found preserved when the rest of the animal has perished: the shape of this tail is triangular, with a strong ridge or continuation of the back running down the middle; it is often protected by a thick shell, still remaining, under which the surface of the cast of the animal itself appears furrowed like the skin of the human thumb. The tail, when found alone, somewhat resembles a butterfly in shape.

The other species, which has been named *trilobites capitatus*, is much rarer; and has only been found as yet in the eastern part of the district. It differs from *trilobites caudatus* in having no tail, the plates being continued to the very extremity. In this it resembles some of those found in the grauwacke of South Wales and limestone of Dudley. But its most remarkable distinction is its head, which bears a remarkable face or figure. These figures were at first found without the body, as were the tails of the other species, and exercised in vain the ingenuity of naturalists, until they were at last luckily discovered attached to their respective animals.

Both these species appear to have possessed wonderful powers of flexibility, and are occasionally found rolled up with their tails in their mouths, and disposed in other singular attitudes. Their colour is usually brown.

I have found also some small terebratulites, and helicites, in the limestone of the Colomenca ravine. The latter are rather uncommon.

These argillaceous beds contain also balls of an unknown origin. They are round, oval or lemon shaped, with a knob at one or at each end. Their interior structure consists of a mass of radiated calcareous spar; and on the outside the pyramid of some of the crystals, which is very low, sometimes projects beyond the

circumference. These have been supposed to be heads of alcyonites, analogous to those of the green sand of the Isle of Wight, and to be connected in origin with some obscure traces of stalks which the limestone sometimes presents on its weathered surfaces. But these stalks having never yet been found together with the balls, this is still only a conjecture. They may perhaps be only concretions of calcareous spar, similar to those contained in the black clay below, but in which the bitumen is wanting. They are found commonly in all parts of the limestone district.

Another variety of these argillaceous beds, which appears to be confined to the eastern borders of the limestone, is that which is thickly sown with brown grains of clayey iron ore, as some other beds are with green earth.\* These grains have a slight resemblance to those in the red or upper beds of the inferior oolite of the south coast of England, and which also occur in France, but are not so black. I have not been lucky enough to find this variety *in situ*, but fresh fragments of it are not uncommon in the Popovca, Coshelevca, and other brooks.

Perhaps the most singular appearance which this limestone presents, is that so common on the Pulcovca and other places, where a yellow bed is, as it were, blotted with various colours, and where sometimes beds, coloured differently, alternate; as is the case on that stream with the red and yellow magnesian, and greenish varieties.† The contiguous surfaces of these beds are very rugged,

\* Perhaps they are the same substance with the iron which it contains, in a different state of oxydation.

† The limestone as well as all the beds of the whole formation including the blue clay, have a tendency to a cubic fracture. The upper surfaces of the limestone beds are often crossed by two sets of parallel fissures dividing it into square pieces easily separable. Where the highly coloured beds abound, as on the Pulcovca, the quantities of red, green, yellow, and grey cubic fragments, which are often mixed together, resemble the tesserae of a Roman tessellated pavement.

although they separate without much difficulty: this circumstance renders this stone very unfit for paving, the use to which it is commonly applied in Petersburg. This form does not appear to have been favorable to the preservation of organic remains, as only small fragments of an encrinus, the vertebræ of which have a cinquefoil perforation, and terebratulites, and some indistinct traces of other bodies, are found in it.

In the quarry at Alexandrovsky, close to Tzarscoe Celo, thin seams of brown clay alternate with the beds of limestone. In this quarry has been found, though but rarely, a body supposed to be the head of that encrinus whose remains are found sparingly in the neighbourhood. It is a sort of irregular polyhedron, the angles of which are marked with treble ribs, and the faces slightly fringed with lines issuing from those ribs.\* It has been called *E. Paradoxus*.

Sometimes the limestone of the upper beds is of a dark red colour, in which case the orthoceratites and other animal remains are often white. I have never seen them so in fresh specimens, which are as red as the rock they come out of, but only in places which had been many years cut and used as marble, which its superior hardness and compactness qualifies it for. I cannot therefore answer for their colour on being taken from the quarry, but it is not impossible that the organic remains lose their colour on exposure to the air, as is the case with those of the black marbles of Kilkenny in Ireland, and Caermarthen in South Wales. These red limestone strata may be examined with great ease on the summit of the cliffs along the left bank of the Ishora, from the quarries opposite Cordelova to Podolova. These, as well

\* Bodies much resembling those here described, are figured in the plates which accompany Mr. Cumberland's account of the fossils and strata near Bristol. *Geol. Trans.* vol. 5. pl. 2. f. 8. &c.

as the purplish beds, have a texture sometimes crystalline, and the cavities are lined with minute cubic crystals of brown spar, of a red colour, together with well defined nail-headed crystals of white calcareous spar. The brown spar frequently encrusts the orthoceratites, and though forming a mass by no means compact, is of considerable hardness.

The highest beds of the limestone, and which are at the same time at the greatest elevation above the level of the sea, compose the hills of Doudorof and Taply Sad. They are dry and sandy, of a pale straw colour, much resembling that of the English and Irish magnesian lime. The cavities which it contains are lined with very perfect crystals of white calcareous spar, and often with brown spar and pearl spar, of a pale, or sometimes of a bright yellow. It contains but very few organic remains; and those which are found in it are not common in the lower beds. I must particularise

A very large helicite, found by Mr. Havenschild, near Gatchina, in whose collection it now is.

A species of elongated terebratulite, never quite perfect.

A circular indented body, probably a fungite, the nature of which I cannot exactly ascertain, which I found near Poudost.

Hysterolites, sometimes with wrinkled edges. These are found in the other beds, but rarely.

Entrochi, very rarely. I found them at Skoovitza.

It is evident that the summits of Doudorof and Teply Sad are only outliers or portions of these upper beds which have perished, the fragments of which are found scattered over the plateau, especially towards Gatchina.

The heights of Tocotela and Paiola, which connect those hills,

and those of Shoulcova, which are but a prolongation of them to the eastward, partake of the same nature.

Where the upper beds of the subjacent stratum are sandy, the limestone is also sandy to a great degree.

Hippurites and fungites, of small size, are not rare; in a few places they are mixed with small corallines and terebratulites, and joints of encrini in a confused mass. This resembles much some other limestones of the interior of Russia.

The strata of the limestone are seldom above half a foot in thickness, and although, where tolerably solid, it is raised in blocks of a foot and a half, yet the lines of junction are always easily to be traced. Their general position throughout the country varies but little from the horizontal, except in a few cases, which will be hereafter specified.

In the cabinet of the Mineralogical Society at Petersburg, are two small specimens of galena enclosed in a mass of pyrites, said to have been found in the limestone: place unknown. Pyrites itself occurs but rarely in this stratum.

Copper was formerly dug for at Doudorof: I could never find the precise spot, but suppose it to have been near some pits at the east foot of the hill not far from Varexila. A specimen of the green carbonate is in the cabinet before mentioned.

This limestone is called *Pleta* by the Russians, and *Paas* by the Fins. Its principal mass occupies the great plateau or table land of the central part of Ingria, as described in the beginning of this memoir: its outcrop running just within that of the intermediate bed, which may be traced all round it, except where covered by gravel or bogs. It is remarkable, that those denudations which penetrate farthest within the outlier of this mass, shew the subjacent intermediate bed in its thinnest state, while round the



edges, and in its outliers, it nearly equals the limestone itself in thickness.

It is said to contain magnesia as a constant ingredient, and the appearance of many of its beds agrees with that of similar limestones in Britain. Its Flora differs greatly from that of the other soils, and may even serve as a help to the geologist. It is marked, even to the beginning of November, by the purple flowers of the *Geranium cicutarium*, by which I have often distinguished it; the streams are accompanied by the beautiful tufts of *Anchusa officinalis*, *Polemonium cœruleum*, *Aconitum lycoctonum*; the woods contain fewer firs, and in some places many wych elms, as on the Tosna.

The only outlier of this stratum, with which I am acquainted, occurs on the brook Pulcovca, above the village of Pulcova. Although its outcrop occupies but a small space, yet it may be satisfactorily traced by means of the marked character of the bituminous clay which supports it. As certain irregularities of dip, for which this spot is remarkable, affect equally both strata, I shall leave them to be described together hereafter.

I must also notice a tract on the upper part of the Ishora, where for the space of eight or nine versts at least the limestone fails, and a red sand rock, sometimes approaching to the character of red marl, fills up the interval.\* The last place on ascending the course of the Ishora where the limestone appears *in situ*, is in the bed of the river, a little below Pilny Milny, whence it is dragged up in considerable quantities. I cannot decidedly name any spot where it may be seen *in situ* on the other side of this tract of sand, but on the

\* I was not able to decide satisfactorily whether this red rock was a protrusion of the intermediate bed, or an outlier of the red ground of the interior of Russia, incumbent on the limestone. Its lying at higher level than the limestone at Pilny Milny, favours the latter supposition.

road to Anteleva from Gatchina, and on the hills behind Lukozy, the quantity of fresh fragments of limestone is such that it must be in the neighbourhood. The rising level of the country favours this supposition; but the valley is too much covered with alluvia to allow of accurate examination.

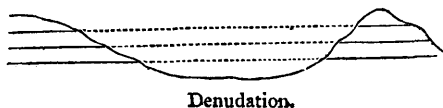
### DILUVIUM.

Having thus described all those formations which occur in this district, and which belong to the class of Antediluvian depositions, the next which presents itself is that which is properly called Diluvian, and which, in contradistinction to the more modern accumulations or Alluvium, may be termed Diluvium or Diluvian gravel, by which latter name it has been long known, at least in this country.

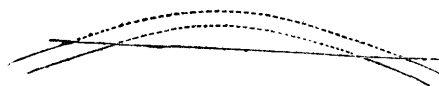
I need not say what is intended by this term; it is meant to express that superficial deposit which covers every thing, and is composed of almost every thing.

Its composition and thickness are very various: the latter amounting to thirty, forty, or even fifty feet. In some instances it

The protrusion of an inferior bed through a superior one, where entirely owing to an elevation in the strata, independent of any denudation, is a circumstance of frequent occurrence, and which it is absolutely necessary to distinguish from the appearance of subjacent rocks, laid bare by simple denudation, without change of dip in their stratification.



Denudation.



Protrusion.

appears to form entire hills, as at Penty, &c. It is usually thickest in the vallies, or on the flat summits of some of the hills. Its composition, much as it differs in different places, may be considered twofold; first, as the debris of rocks upon which, or in the neighbourhood of which, it is accumulated; secondly, as that of a set of rocks totally foreign to the country, the analogies of some of which have been recognized *in situ* at a vast distance, while others remain yet to be identified.

The principal foreign ingredient is a granitic sand, from which it is seldom perfectly free. In some parts, particularly on the right bank of the Neva, it is a pure granitic gravel or sand, partly derived from the same source as the primitive boulders themselves, and deposited at the same time with them; partly from the daily decay of those blocks from the action of the weather. This character becomes stronger on approaching the borders of Finland.

Parts of the country north of the Neva, and the environs of Peterhof and Pavlovsk, are covered with a superficial sand derived principally from the sand of the *intermediate bed*, which it either immediately covers, or abounds in the neighbourhood. When it lies upon that sand, where the latter, (as it is in many places, especially beyond the Neva,) is perfectly loose and exhibits no signs of stratification, it is extremely difficult to distinguish them, except where the presence of boulders, or rolled fragments, removes the difficulty. I am willing to confess that some parts of the map, as I give it, may hereafter be found inaccurate as to the boundaries of the intermediate bed on the Carelian side of the country, owing to this circumstance: yet where the two sands are perfectly alike in colour, and without coherence, when the upper part contains no boulders, and the lower no shells, we must have some very infallible criterion to be able to distinguish them.

*Geology of the Environs of Petersburg.*

427

The clay district is usually covered by a yellowish sand, which I conceive to be principally formed in the same manner as that above mentioned. It is sometimes ferruginous, as on the first hill on the Wyborg road; sometimes rather argillaceous, as on the banks of the stream that flows through Coupchina, and on the hill of Penty. Its most argillaceous form resembles the blue clay as nearly as the sandy form does the sand *in situ*; and is equally difficult to distinguish from the original formation. On the Tzarcoe Celo escarpment it is used for bricks, and these, as well as on the cliffs opposite Cordelova, covers the upper beds of the Pleta limestone. This occasioned its due share of difficulty in making out the structure of the country; till, happily, in the last mentioned situation, I found rolled pieces of granite and other rocks buried in this clay, which, it was then clear, could only be a superficial or diluvian deposit. The decayed felspar of the primitive boulders may perhaps enter into the composition of this argillaceous variety, as the sand formed by the disintegration of their quartzose and micaceous particles does into that of the sandy one.

That which lies above the limestone is a light brown earth, containing fragments of the subjacent rock, though in general in a very small proportion to the primitive pebbles. Its thickness is sometimes very considerable, particularly on the flat tops of the hills; at Crasnoe Celo, &c.

In the country immediately south of Petersburg, behind the bank of gardens on the left of the road to Strelna, the diluvium consists of a whitish dry clay, sometimes slightly sandy, lying in beds or layers of half an inch or an inch in thickness, to the depth of twelve or thirteen feet. They are nearly horizontal, except that the upper layers seem to follow the outline of the present surface of the earth, and where they join the vegetable mould are rather disturbed in

their position. This however may be the effect of cultivation, as the soil is extremely shallow, (Plate 29, fig. 3.)\* This is very well seen immediately below the gardens of a great house, formerly belonging to Count Czernicheff, on the Peterhof road, where the banks of the stream Coirovca present some excellent sections on both sides of the valley in which it flows. They are remarkable, not only for these layers of diluvian earth, but also for some of the best examples of the veined clay, described in an early part of this paper. Between the two formations occurs a bed of pebbles, eight or nine inches thick, agglutinated together by a ferruginous sand. This bed, though it does not form a hard stone, is yet solid enough to project beyond the softer substances, both above and below it, and also to fall in large pieces to the foot of the cliff, which may be from fifteen to twenty feet high, without breaking. These pebbles being primitive, both this pseudo-conglomerate, and the clayey layers above it, must be referred to the formations I have called diluvian. It can excite no wonder that a diluvian deposit should be stratified, although it is but rarely their stratification is distinctly perceptible; a circumstance which is probably owing to the purely mechanical nature of the deposit, the comparative rarity of chemical combinations on the great scale since the formation of the solid strata being notorious to every geologist. To this cause also, as well as to their hasty accumulation, may be referred the looseness and want of coherence in the diluvian formations. On the Crasinca, where the layers of clay are grey, or brown and white, and the rolled pebbles absent, it seems difficult at first sight to believe that it is not some variety of the intermediate bed, in its place above the blue clay. They continue every where along this line,

\* See Sketch of the clay veins on the Coirovca.

immediately under the soil, to some distance beyond Peterhof, where they cover the sandstone of the intermediate bed. The outcrop or termination of which towards Strelna is so covered up by them, that I am not satisfied as to the exact point where it should be laid down ; although, as the same diluvium covers the veined clay again on the Ivanovca, and occurs on the Ligovca, we may place it perhaps in the neighbourhood of Strelna without much error. The increase in elevation of the bank about that place would favour this supposition.

The hills of Khamouzy, Coirova, Penty, and the ridges which connect them with that of Pulcova, shew only diluvian gravel down to their foundation, although their elevation is very considerable.\* It is possible that the hill of Pulcova contains the extremities of the Pulcova outlier, but nothing is apparent except diluvian gravel. The deep gullies and cliffs of the streams of Great and Little Coirova, which unite and form the Coirovca on issuing from the hills, are hollowed out in diluvium to two-thirds of their depth, and barely one-third at the bottom is scooped out in the blue clay.

This gravel in like manner reaches up to the foot of the ridge of Shulcova and Doudorof (Plate 30), and is spread over all the rising ground of Carlina behind Tzarscoe Celo ; it thus so completely obscures the junctions of the limestone and subjacent rocks, and the shape of the ground is so calculated to deceive by presenting escarpments where there are no outcrops, and no escarpments where it conceals a considerable outlier, that I cannot give the outlines of the

\* The height of the hill of Khamouzy would lead to a suspicion that there existed in it an outlier of the limestone, or at least of the intermediate bed, which is seen at the mouth of the denudations of Tarelova and Remeleva, in the escarpment opposite. The hill being thickly wooded and presenting no sections, I must leave it for the present as a point meriting further investigation.

strata from Cargasary to Tzarscoe Celo as accurately determined, though they cannot be far wrong.

The most striking phenomenon attending this branch of geological research, is the enormous quantity of boulders, or large rolled blocks, found either on the surface of the soil, or half, or entirely buried in the diluvian gravel, of which they must be considered as members. I cannot pretend to enumerate all their varieties; the following are the principal.

#### *Primitive Rocks.*

Large grained glandular granite, containing much black hornblende and red felspar: much used for ornamental purposes when sound, but in it general disintegrates easily by the action of the atmosphere, crumbling between the fingers without difficulty. Some of these, though retaining their upright position, are cut down and quarried for the gravel they afford for the roads: they are sometimes found in a rugged heap of gravel, and their surface in general retains little of its waterworn smoothness.

*In situ*; Baron Nicolai's quarries near Wyborg.

*Rolled*; passim; perhaps the most common species: coarse grained gneiss or granite slate, grey and red, with iron.

*In situ*; Imatra, and interior and western parts of Finland.

*Rolled*; frequent near Petersburg.

*Yellowish green felspar* rock, with garnets of large size.

*In situ*; said to be so between Kexholm and Cerdopol.

*Rolled*; near Strelna.

*Small grained* grey granite, hard, often irregularly laminated.

*In situ*; unknown.

*Rolled*; common.

*Geology of the Environs of Petersburg.*

431

*Red felspar, thickly spotted* with hornblende. A handsome stone.

*In situ* ; Borgo, in Finland.

*Rolled* ; Moscow road, one verst from Petersburg.

*Dark granite, with iridescent felspar.* When the felspar is well crystallized, the colours range themselves round the edges of it, if cut transversely : the blue in the centre, the green and yellow round it.

*In situ* ; unknown. That of Norway is of a whiter colour.

*Rolled* ; Peterhof.

*Black mica slate, with crystals of staurolite*—rare.

*In situ* ; said to be so near Cuopio in Finland.

*Rolled* ; near the Moscow gate.

*Hornstone, or coarse jasper, red clouded with yellow.*

*In situ* ; unknown.

*Rolled* ; I have seen only one large block on the shore close to the summer-house at Becova.

*Basalt.*

*In situ* ; said to be in the north of Finland, Lapland, and Norway.

*Rolled* ; one small fragment of a pillar was found on the Moscow road, and is in the cabinet of the Mineralogical Society at Petersburg.

*Secondary Rocks.*

*Limestone* of the country ; sparingly ; only the hardest varieties, and never far from the same stratum *in situ*.

*Sandstone* of the intermediate bed ; very sparingly, in various parts of the country, and only the hardest sorts.



*Green chamite bed*; of the same; along the Tzarscoe Celo escarpment.

*Pale brown chamite bed*; on the summit of Shulcova hill; much weathered: also on Penty.

*Hard sandstone with large chamites*; near Anteleva, in the quarry of Repolova. In situ only on the Tosna.

*Rolled masses of slaty clay*; upper beds of the same; only in a ravine a little west of Samsonovsky, on the Ishora.

*Doubtful.*

A red sandstone, which resembles that of the neighbourhood of the Lake Onega; sometimes much coarser and larger grained; almost to be called a conglomerate. As decided boulders of what is called in England, old conglomerate, are found (though rarely characteristic) on the banks of the Volga, I am inclined to refer these to the same class of rocks.

*Common on the Moscow Road.*

It is evident that all these rolled stones may be found in any part of the country, although we cannot be sure of finding them in any particular spot. I have therefore mentioned only such localities as happened to be known to me.

On meeting with these blocks of stone scattered over the face of a vast extent of country, and usually lying on rocks of a nature totally different, it naturally becomes a matter of inquiry, whence they were derived. Without entering at large into the discussion of this interesting question, which is one of the most important

and wonderful that geology affords, it will be sufficient to state a few particulars with regard to their situation in the neighbourhood of Petersburg.

By the specification of the principal varieties which I have attempted to give above, it will be seen that all the primitive boulders, the analogues of which have been recognized *in situ*, appear to have been transported from the north. They are scattered universally over hill and dale; on the highest summits of the hills, and on the shores, and under the waters of the gulf; and are found not only on both sides of the Neva, but far to the south, to the east, and to the west of the boundaries of the district I am describing. Their waterworn surfaces, their enormous size,\* and the remoteness of what, without a great stretch of credulity, may be believed to have been their ancient seat, seem to leave no other supposition to account for their appearance in their present situation, than that of their being the gigantic pebbles, rolled and accumulated by the greatest aqueous revolution to which this globe has ever been exposed, the Mosaic deluge, of which they furnish the most striking of the material evidences. This is not the place to enlarge upon this subject; but I may add that the environs of Petersburg, as well as every other country, shew those traces of the superficial action of vast currents of water, which can only be attributed to the same cause. I need only instance the Ropsha and Crasnoe Celo

\* The celebrated block out of which the pedestal which supports the statue of Peter the Great, in the Isaac Place, in Petersburg, was a rolled boulder of the red Finland granite. It was not brought, as has been asserted, from Siberia, nor, by human means at least, from Finland; but was found, among many others of smaller size, in a bog between Petersburg and Cesterbeck. It was diminished two thirds, before placing the statue on it.

A boulder of great size supports a summer-house on the sea shore at Becova, which is ascended by a ladder.

denudations, and the numerous combes and vallies now destitute of water, along the edges of all the escarpments. Such examples occur every where; but they are more easily remarked in secondary than in primitive countries, owing to the greater softness of the materials.

The blue clay is never sufficiently solid to admit of being rolled into pebbles.

The intermediate bed occurs rolled but seldom; never on the Carelian side of the Neva: on the Ingrian side are found sometimes small rolled fragments of the sandstone which is *in situ* between Peterhof and Oranienbaum, but in no great quantity.

One of the most remarkable circumstances respecting the boulders of this stratum, is that rolled pieces of the smaller grained chamite beds are found on the summit of a steep ridge forming the extreme point eastward of the heights of Shulcova. They lie principally on the western brow of the hill, where it overhangs a deep ravine filled with an impassable and mossy bog, and looking towards Doudorof. The great elevation of this ridge, which apparently yields only to Doudorof and Teply Sad in height; the geographical distance from the nearest point where the chamite bed appears *in situ*, which is at the Slavenca quarry, or possibly on the Coshelevca;\* and the great thickness of the limestone in that part of the district, make it a question of no easy solution, how rolled fragments of a rock three hundred feet or more below that on which they are found lying, could ever have arrived at their present situation.

\* I have been told it exists there *in situ*; but I never could distinguish it myself, otherwise than in rolled pieces. This stream is overgrown, and almost buried in tangled brushwood, which renders the examination of a small protrusion of the intermediate bed through which it cuts, not only difficult of access, but unsatisfactory where accessible. See the conclusion of Mr. Weaver's paper, Geological Trans. vol. 5.

Their present perishable appearance is not so great an obstacle to this supposition as might at first be imagined; since this rock is extremely hard when *in situ*. The difference of hardness and colour observable in the rolled fragments may therefore be the effect of weathering.

On the Ishora, the rolled pieces of different varieties of the intermediate bed become more frequent. In a dry ravine close to the village of Samsonovsky,\* are found in the diluvian gravel, almost every description of boulder known in the country. Among them are round balls of the grey slaty clay of the upper part of the intermediate beds, a substance which hardly seems ever to have had sufficient solidity to withstand the shocks to which it must have been exposed in the diluvian current, especially in the company of the much harder pebbles by which these masses are surrounded. Since the period of their being lodged in this spot, they seem to have undergone considerable disintegration: although their outline is entire, as they are seen wedged in with the rest of the pebbles composing this gravel, not one of them could be taken out whole; they are all now splitting in the direction of their laminæ, and would fall to pieces as easily as the small rounded fragments of the same substance which are found in the brooks immediately beneath their parent rock.

Near Anteleva, the gravel pits of Repolova deserve attention for the fine blocks of the large chamite bed which they contain, and which have been already described.

\* In Finnish *Oloseen Mekky*. As a great many of the villages retain their old Finnish names, even although they have received others from the Russians, I have thought it advisable to give both, as the Fins will not always acknowledge the Russian names for villages inhabited exclusively by their own nation.

Near the village of Lukozy is a vast accumulation of fragments of the limestone of different varieties.

The limestone boulders are never found north of the outcrop of that stratum whence they are derived, and rarely on the table-land itself. Such as are found there are chiefly fragments of the harder varieties, which occur *in situ*, in the hills of Doudorof. They are more numerous about Gatchina, and increase in number along the Ishora, and in general towards the south. On the surface of the limestone plateau, particularly south and west of the upper lake of Doudorof, are several long low ridges, which appear to be entirely composed of heaps of rolled pebbles of various descriptions. They are on a large scale, exactly like what are deposited by counter currents and eddies in running water.

At the quarries near Mishkina, belonging to Count Camerofsky, on the escarpment between the Ishora and Tosna, I have seen the surface of the limestone, when scraped bare of superficial accumulations which are ten feet thick, presenting hollows and steps from one bed to another, the edges of which are all rounded as if waterworn. The diluvium in this instance is entirely free from stones.

From the situation of the parent rocks of such of the primitive boulders as yet have been identified, and from the increase in quantity of the secondary pebbles on approaching the south, it seems that the great debacle, or stream of transportation, came from the north; while, from the great height at which the rolled blocks are found, it is evident, not only that portions of rocks, whence they have been brought, once existed at a higher level, but also that they were deposited in their present situation before the excavation of the Gulf of Finland and the vale of the Neva. These great denudations, together with those smaller ones which open into them, were not

hollowed out till the diluvian waters began to draw off and drag the slopes of what had been the bottom of the ocean. The heavy blocks had already settled, and the streams carried back with them only the softer materials. This accounts for the seeming incongruity in the direction of the diluvian currents; just as a great wave of the sea will transport pebbles large and small in a great body in one direction; then, retreating, drop the heavier and scoop channels in the lighter materials which it has itself just deposited, and in whatever is below them; into some of which channels a few large pebbles fall back again.

This also explains the remarkable circumstance of the existence of large deposits of diluvian gravel on the summits of insulated hills, as at Doudorof. The gravel has been equally deposited at first on the surface of the strata, by the great débâcle; and as it draws off, certain portions of the solid strata with their new diluvian covering have been removed, and other portions of the same strata, insulated or connected, have been left with whatever was above them. I imagine the eddies, currents, back streams, and whirlpools of the diluvian waters to have had as much share in the shaping of the surface of our present earth, as any supposed difference of hardness between one portion of the same stratum and another. The fragments which remain to attest the solidity of many vast masses of strata which have been broken up and carried away, seem to countenance this supposition.\*

\* This part of Russia appears to be as poor in the remains of quadrupeds usually found rolled in diluvian gravel, as other parts of the same country are rich in them.

I can only mention a scull said to be that of a rhinoceros found in Petersburg, in the mud of the Moika canal, in 1818; now preserved in the Academy of Sciences; a tooth, of doubtful origin, said by some to be that of a wild boar, (an animal now a stranger to this climate) found near Pavloosk, now in the cabinet of the Mineralogical Society; and the report that an elephants tooth had once been found near the Moscow road.

## ALLUVIA; OR POST-DILUVIAN FORMATIONS.

The formations which I comprehend under the term alluvial, in its most confined sense, now claim our attention. As they are contemporaneous, their position can give no system of classification; I shall therefore begin with that which resembles the antediluvian formations more closely than the rest.

Tufa or Tuf, a calcareous deposit from the waters of lakes or rivers rising in or flowing over a calcareous district, is found in several places on the Ingrian side of the Neva. I shall only mention Gastilitzi, where it forms arborescent incrustations resembling corals, to which moss probably gives their peculiar shape and appearance: Ropsha, where the waters of the Strelca and tributary streams abound in stalactitic depositions; Poudost, between Doudorof and Gatchina, famous for its quarries; and Anteleva on the Ishora, where the Tuf occurs in the form of distinct balls, of the size of a large turnip, being concentric crusts of calcareous matter adhering to a nucleus usually very small in proportion to the entire mass, and which is commonly a pebble fallen from the diluvium on the river side.

A little above the village of Poudost, situated on a stream which rises near Kipent and falls into the Ishora at Gatchina, is an open valley, about a verst in width through which the river flows. For the space of two versts it is accompanied on each side by calcareous depositions, which form also its present bed. There are some considerable quarries on each bank, which are now worked chiefly for lime: but which have formerly furnished much stone for building. The colonnade and porticos, if not the whole of the Cazan Church at Petersburg, the Palace at Gatchina, the colonnade

in the garden, opposite the north front of the palace at Peterhof, and many smaller ornamental buildings which decorate the environs of Petersburg, are constructed of this stone. Though coarse and porous, it is the best building stone in this part of Russia: its colour being a fine yellowish white, and its substance light and easily worked. Unfortunately it is hardly durable enough to withstand the vicissitudes of spring or the severity of winter in a climate where the thermometer often ranges 24° of Réaumur, up and down, partly above the freezing point, partly below, in as many hours. It may be added, that stone building is as yet so very rare in Russia, that this material is neglected in many other situations besides this.

I have only been able to find two species of shells, sometimes preserved in this stone, never in great quantities. They are a species of the helix and a buccinum, both fresh-water varieties, and yet to be found in a recent state on the banks of the river. There is a ford which crosses the river nearly in the middle of the valley, formed by two ledges of this rock over which the water falls as clear as crystal. In this situation they seem at first to be rocks of the soil, and any thing but recent depositions. The quarries and the flat land in which they lie are now never covered but by high floods. Trees and thickets are scattered over the surface of the tufa, remarkable for some handsome species of *Campanulæ* and some dwarf willows uncommon in other parts of the country.

The greatest depth to which this bed has been quarried is only six feet; it probably does not reach much lower, although the substratum is not laid bare.

It is remarkable that, of all the waters of this country, those which deposit tufa, are apparently the purest. Perhaps the lime is held in perfect solution, and the sediment is to be considered as



partly of chemical, partly of mechanical origin. In great floods, the quantity of water would be increased and take up more lime, which it would deposit as it lowered by evaporation. Hence the great purity of this limestone and its fitness for burning into lime.

The whole valley from Skvoritza, down to Poudost, or even beyond those two places, seems as if it might formerly have been a lake, which by the raising of its bed had run out towards Gatchina.

The next important member of the post-diluvian formations occurring in this country are the great bogs, which are of vast extent, but in general of no great depth. They exactly resemble those in England, except that there is less mountain peat, most being of the coarser kinds usually found in vallies, and that they are more covered with wood. The firs, birch, and alder, and sometimes aspen, arrive at various heights according to the wetness or dryness of the bogs. Some, as those near Shulcova and Carlina, are so wet as to resemble a half liquid black paste, scarcely supporting even the common mosses from which it derives its origin. Many are absolutely impassable before the middle of winter. The dried bogs support a kind of coarse grass and most of the herbaceous plants peculiar to woods.

It is not yet used for firing, but some English farmers have proposed it as a good material for burning bricks. Of late some attempts have been made at draining.

The marsh land or alluvia formed by earthy depositions at the mouths or on the banks of rivers, lakes, &c. has already been noticed in the general description. It exists only on the shores of the gulf and in the mouth of the Neva.

The sand thrown up by the sea may be noticed in this place, because it covers, at a small depth, the blue clay which may be seen here and there on the Oranienbaum shore. Many substances are dug up in the alluvium, coated with phosphate of iron.

\* Within each bog, usually near the centre, is almost always found a lake or small pool, gradually filling up. In many cases, as at the Finnish lake Lindo Jervy, in the woods of Riabova, the spot where land ends and water begins is not to be determined, except the gradual dwindling of the trees is taken as a criterion. Stunted birch and alder bushes grow into the water, and encroach every year on the retreating waters of the lake. Some such cause may be connected with the quantities of old wood found in many places beneath the superficial soil, as on the lower Coirovca and Crasinca, in a soft and moist state, dark brown, and easily cut in all directions with the spade, like cheese. †

Blocks of a hardish, white, rugged stone, are found on the banks of the Tosna: they resemble tufa, but I cannot discover it there in situ.

It remains for me to describe more minutely a few of the more remarkable spots situated within this district, and to which I should wish to draw the attention of any future geologist who may happen to visit the environs of Petersburg.

\* Phosphate of iron is not the only alluvial metallic substance found in this district. The waters of this neighbourhood, (especially of the sandy part of it) are very commonly impregnated with oxyd of iron, a character by no means unusual throughout all the north of Russia. This iron is deposited in great quantities at the bottom of almost all the lakes, bogs and rivers, on the Carelian side of the Neva, more sparingly on the other. Large masses have been raised even out of the bed of the Neva itself. It is in the state of bog or marsh iron ore, and supplies some iron works. Where the waters are very strongly charged with iron, they communicate a bright red or orange colour to pieces of wood which they meet with in their course: the iron itself being often deposited in the interior of the branch or between the bark and the wood, by very slow infiltration. This is a beautiful instance of what is vulgarly called petrification. Branches of the birch afford better examples than those of any other tree.

† A layer of old wood is also frequently found under the soil throughout the flat country east of Riabova.

The first excursion he should make is to the valley of Crasnoe Celo. There, in the three ravines which cut the western side of the valley, passing through each of the three villages of Pavlovsky, Bartashinsky, and Colomensky, \* sections of the three strata of limestone, black clay, and blue clay, give a perfect idea of the regular and undisturbed position of the principal mass of the limestone formation and subjacent beds. The limestone fossils are also abundant and well preserved in this neighbourhood. The lakes of Doudorof present but little interest in themselves, but on the eastern bank of the upper lake rises the hill of Teply Sad, covered with a fir wood, remarkable for the beautiful and rare plants to be found beneath its shade. East of this hill, a branch connects it with Doudorof, a hill of equal or greater elevation than Teply Sad, and consisting, like it, of steep terraces of the upper limestone beds, rising from the plateau formed by the lower ones. The escarpments of these terraces, especially the precipice west of the Fin church, looking towards Teply Sad, are on a scale far surpassing what the general view of the country gives reason to expect. The summits of this hill are very peculiar in their form, and are very well laid down in the great map of the environs of the Capital. They appear to have been formerly covered with wood, as Teply Sad still is. In every hollow is seen a small pool or lake, or the

\* These three villages, together with the heights on which they are placed, are called collectively by the name Crasnoe Celo, or Red Seat (red and beautiful being synonymous in Russian). The custom of calling a number of villages or hamlets by one common name is very general in this country. Thus half a dozen, having each distinctive appellations, between Doudorof and Teply Sad, go by the name Paiola; the hamlets called Toxova extend several miles; three villages compose what is called Cabozy; three more Tocotela, &c. This is perplexing to the stranger, but is now in some degree remedied by the erection of posts, on which the name of each village or hamlet, however small, is written up at each end of it, together with the name of the proprietor, and the number of houses or inhabitants.

traces of one. The branch stretching to Shulcova, and the detached ridge opposite its termination, possess the same characters, and are almost inaccessiblely steep. The rock appears every where through the soil, and in the latter instance there is reason to believe it is highly inclined,\* though no good section can be obtained. These detached summits, Cargasary, Teply Sad, Doudorof, and Shulcova, all possess a similarity of character sufficiently striking even at first sight.

The ravines of Great and Little Coirova, especially that which runs through the dell in the old Solticof garden, also the lower part of the Coirovca and neighbouring streams, should be visited for good sections of the blue clay, and in the localities mentioned in their proper place, for examples of the clay veins.

All the streams along the eastern escarpment merit particular attention: the Pulcovca, Couzminca, Goumolosarka,\* Coshelevka, Popovca, Slavenca, Ishora, and Tosna, should each be followed up from the places where each respectively quits the escarpment to where they rise to the level of the land around them. The Pulcovca, as exhibiting certain remarkable phenomena connected with an outlier of the limestone, I shall leave to be more particularly described at the end. The Couzminca is remarkable for the total absence of any thing but blue clay in its banks, since it flows within

\* A disposition of this rock to separate into cubic fragments has already been noticed. In this instance, the western escarpment shews the rock peeping through the soil; no stratification is visible as in the case of the precipices at Doudorof and similar situations, but what appears to be the back of the beds is seen with its remarkable cross fracture dividing it like a network of irregular veins. The slope of the back of these beds, if I am correct in terming them such, coincides with that of the hill itself.

\* The Russian name for the rivulet which waters the village of Houmolosarry. This name is Finnish, but the Russian alphabet being unable to express the sound of the letter H as the natives are to pronounce it, they have prefixed their usual guttural, which is unknown to the Finnish language, and added the common Russian termination.

a short distance of a considerable body of limestone on either side ; the Goumolosarka for its organic remains ; the Coshelevka for a small burst of the black clay which pierces the limestone during a short space, but which cannot be seen without walking in the bed of the stream. The Popovca has already been mentioned ; its banks are very picturesque, and abound in beautiful flowers ; and afford an instance of disturbance on the left bank, a little below the village of Popova. Two masses of limestone strata are divided by a fault or slip ; the stratification of the portion on the left is contorted, that on the right regular.

The Slavenca is worth visiting for the chamite beds, which are seen in perfection in a quarry on the right bank of the river, near the brow of the hill. The road from Grafsky Slavenca on the opposite side of the valley, leading through Popova to Tzarscoe Celo, passes down a remarkable dip of the limestone, which I suspect turns up again near the Popovca bridge. In the basin formed by its hollow back, is lodged a deep and impassable bog.\*

The Ishora has been sufficiently spoken of to give an idea of the importance of the sections on its banks. Besides the occurrence of the red sand, which, as has been stated, bursts up from beneath the limestone from Pilny Milny, below Anteleva, and is continued

\* At the junction of the Popovca and Slavenca below the village of Pezelova, the blue clay is seen *in situ* : the sandy banks and road sides above it, shew evident marks of the intermediate bed *in situ*, which may be traced on two sides to its place, dipping under the limestone on the Slavenca as well as the Popovca.

Limestone pebbles abound here, which seems as if it once extended across, i. e. above this valley ; it is not met with *in situ* till near the limekilns of Ontolovo, on the Slavenca, (not to be confounded with Anteleva on the Ishora, though both places are often spelt alike in the Russian maps, owing to the confusion in that language both in writing and pronouncing the letters A & O). On the Popovca are also found a sort of geode, of an elongated cylindrical shape, rounded at the ends, usually with one or two compressions on the sides.

to near the Gatchina road, and which is best examined near Verly, a smaller accident of the same nature is found lower down near Podolova, where the blue clay bursts from under the sand rocks. Of this I have given a small plan. The whole of this river is interesting, and the environs of Podolova and Cordelova even picturesque. Between Cordelova and Pilny Milny, I have not been able to inspect it myself. Fedorovsky is a high eminence of limestone, bounded by the sandy denudation of Pavlovsk, but offers nothing remarkable in itself.

But by far the most romantic of all these streams is the Tosna, whose banks present at once landscapes to the painter, beautiful and rare flowers to the botanist, and perfect specimens of organic remains, together with interesting sections of strata to the geologist. From the large and flourishing crown village of Nicolskooy upwards, the banks attain a height of about two hundred feet, the lower part of which consists of naked cliffs, and the upper of hanging woods. At the village blue clay is seen *in situ*, and a little higher up, are cliffs of it 30 or 40 feet in height, perhaps the greatest strength in which it is shewn in any natural section. The top of one appears capped with red sand, under which, a few yards further on, the blue clay sinks to rise no more. The different strata of the intermediate bed now occupy the banks of the river for a space of three or four versts or more; its subordinate beds are nearly the same as on the Ishora, but the entire mass is of much greater thickness. The bituminous clay beds are scarcely discernable. The red chamite bed is in great abundance, sometimes very hard. The larger chamites are found in a soft white or yellowish sand, which adheres to the lower part of some of the harder red strata, and when viewed from beneath some overhanging masses of rock, appear like black spots, the nature of which would not readily be

conjectured. This bed is rather difficult of access, but its true nature cannot be seen well without examining it *in situ*, as it is not sufficiently coherent in this place to fall in solid fragments like those of the red chamite bed. This spotted surface might be taken at a distance for a conglomerate. Whence those fragments of this bed which are found at Repolova have been transported, it is impossible to say, but their superior hardness makes it impossible that they should have been brought from the Tosna,\* as well as their situation, which is nearly east of that river, the general diluvian current appearing (as has been stated) to have come from the north. All this sandstone on the Tosna, though soft, shews distinct traces of the globular or botryoidal structure, which however is most apparent in those beds or fragments over which the water flows. The strata are very nearly horizontal: the cliffs form perpendicular façades of rock, usually continued into the water, but sometimes skirted by vast tabular fragments of all colours.

The limestone is seen at Cordelova and along the lower Ishora, occupying a distinct terrace above, and containing trilobites and other organic remains in great perfection. Near a ruinous old house, called Gertovo, there is a ravine on the left bank of the river, where a torrent falls over a series of broken beds of limestone as regular as stairs: near this place the river's bed rises to the level of the limestone, and the sand is no more seen.

I have before mentioned a stone resembling a hard white species of tufa, which is found in large masses in the bed of the river, and which I have not been able to detect *in situ*. This is one object which I would beg to point out to the attention of any future traveller.

\* Or, to speak more correctly, from that part of the limestone strata through which the river Tosna now flows.

I have given views in Plate 31, of this interesting and romantic glen, taken from the grounds of an old deserted country house on the right bank of the Tosna, the situation of which, placed on the summit of the rocky bank of the river, and surrounded with hanging woods of deciduous trees, abounding in rare and beautiful plants, which feather down to the water's edge in every vacant space between the stony precipices, affords the wildest and most picturesque scenery to be met with in all the country round Petersburg; and would not be misplaced in Wales or Austria.

These, with the Pulcovca outlier, are the only places worth visiting on the Ingrian side of the Neva.\* The Carelian side is still less fertile in interesting localities. The principal, however, are

The hills and lakes of Toxova, which, though it does not offer much to the lover of geology, is yet worth visiting, as the most favourable specimen of the scenery of this side of the country. I may add Riabova and the banks of the river Okhta from the gorge of Copsala to its mouth.

I flatter myself that this enumeration of the principal geological points, may be of use in saving many tedious hours of useless research to those who may hereafter visit the environs of Petersburg. In a country, the features of which, scarcely in any instance direct

\* It must be remembered that, however interesting some of the spots described may be in themselves, they are scattered over a very considerable tract of country. As places of minor interest, I may particularize Caporié, Lapoukhina, Gastilitzi, Ropsha, and the whole bank and gullies which intersect it between Strelna and Oranienbaum: also Pargola, and Coultoushy beyond the Neva, and the falls, as they are ridiculously termed, of the Neva itself.

Among the manufactories, the iron works of Caterinhof, at four versts from Petersburg, those of Cesterbeck and Colpina, the former at twenty, the latter at twenty-four versts, distance: the paper works at Peterhof, and the cotton works of Alexandrovsky, deserve to be inspected.



an observer to the spots best calculated to instruct him, and which after all, are but few in number, much time must necessarily be lost in traversing the country at hazard, and much disappointment experienced in seeking sections, rocks, &c. where they are not to be found, though sometimes balanced by the good fortune of finding them in inconsiderable ravines or banks where their existence was hardly to be suspected. Not the least evil is the enormous accumulation of diluvium so generally spread over the whole face of the land. Though not so thick as in many other countries, yet it blocks up by far the greatest number of the banks and escarpments, where it would be natural to expect the strata to shew themselves at the surface. Add to this, bogs and impenetrable forests, the distance from Petersburg to any interesting ground, bad roads and other inconveniencies: the absence of quarries, in a country where building with stone is hardly known; of gravel pits, where the roads are not *made* roads, (except with logs,) but tracks of earth, left to be beaten and formed by carriages as paths are by men; and the Russian language known to few, and its only alternative among the peasantry, the Finnish, being known to still fewer of the foreigners who visit this country.

I must observe also that the sections on the banks of the rivers alter their appearance considerably from year to year: the severe frosts of the winter and the sudden melting of the snows in spring contributing to throw down and carry away large portions both of rock and soil. This accounts for the frequent landslips and fresh broken appearance of the banks of the most inconsiderable streams. Nature offers every season some new opportunities of investigation to the practical geologist in a northern climate.

It may not be amiss to add to the foregoing observations, some account of the relations which the strata of the district I have

been describing bear to those of other parts of Europe, as well within the limits of Russia as beyond them.

To the north, the blue clay disappears under the overwhelming mass of granitic boulders and sand, no precise boundary being assignable to it, or to the granite of Finland, the first rock *in situ* which appears beyond it. The intermediate bed, consisting entirely of loose sand, becomes so mixed with that derived from the same origin with the primitive boulders, increasing greatly in size and number as they approach their original rock in Finland, that they are no longer distinguishable, and all trace of a decided outcrop is lost. The limestone has not yet been discovered north of the Neva. Thus, the district described in the preceding pages may be considered as comprising the most northerly border of the formation which consists of the three most marked strata of secondary rocks which occur in this part of the north of Europe; the blue clay, the intermediate bed, and the Pleta limestone.

Their progress, however, is traced very satisfactorily towards the east, beginning at Nicolskoy on the Tosna, the last point on this side to which I have followed the escarpment in the detailed survey. Although the blue clay is seen in great strength on that river, yet the general rise of the bed and valley of the Neva towards the Ladoga lake, and consequently of the valley of its tributary streams, soon cause the sand of the intermediate bed to become the lowest visible stratum. It probably crosses under the Neva a little above Pella on the left bank and below Astrafki on the right, forming, as is supposed, together with an accumulation of primitive boulders which appear to have been collected on a bar of the harder sandstone beds, those rapids commonly called the falls of Pella. The increased rapidity of the stream is occasioned also by its being suddenly raised, as it were, on a step of this sand, independently of

its being impeded by the fortuitous presence of the primitive boulders which have rolled into this principal valley or lowest trough of the district, and have been stopped by the more solid ledge of sand on which they have now settled. The same circumstance is of frequent occurrence in many of the smaller rivers round Petersburg, which consequently appear in many places like mountain torrents, whilst in others they are sluggish and muddy streams, perfectly suitable to the tame character of the country through which they flow. A sort of bar probably of a similar nature, exists opposite Schlüsselburg; the Neva flows over it as it quits the Lake Ladoga. This forms a kind of lip or edge to the basin which contains the lake, behind which is deposited the greatest part of the earthy particles which the water may have collected; hence the great purity of the waters of the Neva, and in general of all rivers at their exit from lakes. What the Neva deposits therefore lower down, must be chiefly if not entirely taken up in its own course, properly so called and not drawn off from the lake. The lake itself, at least the southern part of it, is so extremely shallow,\* as to be scarcely navigable; it probably rests upon the sand, without penetrating in any part to the clay. The limestone I have not traced myself thus far, but it is visible at Poutyelova, where I have examined it, and I have little doubt of its extending uninterruptedly along the hills which skirt the valley of the Neva on this side and of its joining the Tosna with Poutyelova, as I have found it to connect the Ishora with the Tosna.

The great quarries of Poutyelova, which principally supply the capital with limestone for flags, are situated on the top of a high

\* The northern parts are very deep; but there the coasts consist of harder and older rocks and are much indented by deep bays.

*Geology of the Environs of Petersburg.*

451

ridge of hills south of the Ladoga Lake, twenty-five versts south east of Schlüsselburg. The strata are remarkably regular and horizontal; and the stone differs in no respect from that found nearer Petersburg. These quarries enrich the inhabitants of the thriving crown village of Poutyelova, which is placed on the very brow of the hill in the body of which the stone is worked. The escarpment is in some places nearly perpendicular, and commands an extensive view of the lake Ladoga. Standing on this cliff, and looking to the north, it is impossible not to admit that there is at least a plausibility in the opinion, that the lake once washed its feet, and that it has since retreated, leaving the boggy plain now below it, which is yearly encreasing by a continuation of the same cause. The general traditionary idea that all the waters in this part of Russia are gradually sinking in level, (an idea which I shall not stop to examine,) tends to corroborate it. In the woods of Nazya are seen long barren ridges of loose sand, parallel both to the cliff and to the present shore of the lake, which might well be the ancient strands of the lake, left one behind the other, as it retired. This sand is very different in appearance from the true intermediate sand as it is seen in the neighbourhood. If not a sandstone, it is at least coherent, and shews the same colours, red, white, and yellow, so common on the Ishora and Tosna: in addition to which it forms several small hills and knolls of a decided character near Sheldikha, and may be seen cropping out from under the limestone on the eastern ascent to Poutyelova. The latter locality is at a considerable elevation. The celebrated canal of Ladoga, cut by Peter the Great, but now much neglected, runs through the plain below; by means of which the stone is transported to Petersburg.

The broad valley through which the river Volkhof flows to New Ladoga, here interrupts the escarpment: the limestone may perhaps

appear on the banks of this river higher up, but I have had no opportunity myself of ascertaining whether it does so or not.\*

The limestone hills reappear east of the Volkhof and stretch in the same direction, varying a little to the north east, towards the south of the lake Onega. The river Sas cuts through them, and its picturesque banks claim the particular attention of the geologist. The cliffs between Poulnitza and Lzy are a sandy variety of the Pleta lime, abounding in organic remains, usually well preserved. I found there, during a very cursory examination, a fungite exactly resembling those of the Tzarscoe Celo, and Esthonia; blocks full of broken encrinites, &c. resembling those of Sweden, Esthonia, the Valday hills, and central Russia; also one remarkable fossil, the nature of which I have not been able satisfactorily to determine. It resembles a fish's skin, and is coloured red and white.

South of the Lake Onega, extends a plain which is described as exactly similar to that south of the lake Ladoga. The tract between the two lakes is represented as entirely occupied by the sand, till towards the north the older rocks appear. On the river Megra, occurs a limestone containing madreporas of great beauty, which I conceive to be a continuation of the Pleta lime. It is said to occur (with trilobites, and accompanied by the black intermediate clays) near Vitegra, at the mouth of the river of that name. It probably stretches as far as the sides of the Oural chain in the governments of Archangel or Vologda; but these as yet are parts unknown.

Of the southern boundary of the limestone tract I have no very certain accounts, nor have I been able to investigate it myself. On the river Sas it is of no great breadth, and is succeeded on the

\* I have since heard that the limestone is seen in cliffs on the banks of the Volkhof.

*Geology of the Environs of Petersburg.*

453

south by a red sandy country resembling that on the north west of the Volkhof; it appears to pass by Chudovo, and to bound the plain of Novgorod and Ilmen. I have seen specimens of it from Seltza Posad on the Shelon, in the government of Pscov: but I cannot state with certainty whether that forms a detached body from the great mass of the formation to the north, or whether it is connected with it. In character it resembles that of Esthonia.

Westward, the limestone stretches along the boundary of Esthonia and Livonia, occupying the greatest part of the former country. Near Fellin in Livonia, it is said to have been worked formerly by the Swedes, for the sake of lead and copper, no longer to be found there. It is continued to the western extremity of Esthonia, and passes into the group of islands of which Oesel and Dago are the principal, and in which some of its beds are sufficiently fine to be used as marble. This Esthonian portion of the limestone is famous for the superior beauty of its organic remains, especially at Lachsberg, near Reval. They agree with those found near Petersburg, but the fungites and corallines are larger and in a much better state of preservation. Boulders of it are found scattered over the central parts of Livonia, and more sparingly in the vale of Novgorod. It is connected with the Ingrian limestone by passing between the Lake Peipus and the gulf, and under the stream of the Narova, being the rock over whose strata that river falls a little above Narva.

I have above only followed this formation as far as it is known with tolerable certainty to extend in one uniform direction, and in a mass probably but little interrupted, within the confines of Russia; an investigation which at the same time will serve to give an idea of what must be its boundaries along a part of the northern and eastern borders of the Great Basin of the north. Before I am led to speak

of its prolongations in other directions beyond the frontier of the empire, it may be as well to notice a few instances of similarity which exist between some of its members and certain rocks in other parts of Russia.

The red marly clay of the central governments sometimes resembles much the variegated portions of the blue clay. I will only mention Uryevetz Pavolskoy or Uryetz on the Volga, where the marl is streaked with grey, white and blue beds. This variety is common along the banks of the Volga, and of the Msta.

The black slaty clay of Simbirsk and Moscow, containing green sand and pyrites in abundance, much resembles that of the copper strata of the intermediate bed, but contains numerous organic remains and septaria, both unknown in that of the environs of Petersburg. From near Simbrisk I have seen specimens of a slaty bed, containing fragments of what resemble the broken shells of some of the chamite beds, but which are too indistinct for me to venture to pronounce them identical. I only mention them, therefore, to induce those who may have it in their power to make repeated comparisons, without which nothing in geology can even approach certainty. In the eastern part of the town of Kineshma on the Volga is a sand-pit, the sand of which is a bright yellow or white, and of a glassy appearance, like that on the Ishora. A globular sandstone, perfectly resembling that described on the Tosna, is found on the Msta, a few versts above Borovichy, accompanied by a coaly clay, in which there is much pyrites. In the neighbourhood of Nishny Novgorod, is found also a globular sandstone nearly resembling those of the Msta and Tosna except in colour, which in the former is greenish grey, in the two latter, yellow.

That variety of the limestone which is filled with broken entrochites, small terebratulites, &c. and is most common in Esthonia and on the Sas, is almost identical with the white limestone of the hills south of Moscow and of the central parts of Russia. In the limestone used at Cazan, quarried I believe on the right bank of the Volga, are small terebratulites having some likeness to those of Gatchina in the yellow Pleta. The limestone at the falls of the Msta above Borovichy, bears also some resemblance to it: more perhaps in geological situation than in outward appearance, as it lies above a series of sandy bituminous and pyritical beds which are again supported by the clay.

Before attempting to trace this formation out of the Russian territory, it must be remarked that its general line of bearing is from north-east to south-west. Proceeding therefore from the Livonian isles in a south westerly direction, we meet first with the Isle of Gothland, whose structure and fossils, especially the trilobites and orthoceratites found in its limestone, are merely a continuation of those of Esthonia. The same may be said of Oeland, and of the opposite coast of Sweden, behind which rise the primitive rocks, which thus form a western boundary of the formation. But it is remarkable that Sweden contains a great many detached districts\* or outlying masses or basins, of these strata, separated by ridges of

\* There are those of Jetland, Dalecarlia, Nerimke, east and west Gothland, Scania, and the isles. The latter indeed is not properly speaking, a detached district, being in fact the western extremity of that which is the subject of this memoir.

The sections given in Thomson's Travels in Sweden, seem to render it probable that this formation rests immediately on the primitive rock; supposing, as I do, that the blue clay of Petersburg answers to the lower bed of the Swedish secondary strata. The apparent absence of all intermediate rocks, between the most southern known termination of the Finnish granite and the most northerly point of appearance of the Russian secondary strata, concurs with the general resemblance they bear to those of Sweden, to support this idea.



primitive country. They all agree in consisting of a limestone resembling the Pleta, lying on strata of sand and bituminous or aluminous clay, slightly differing from those of Russia. The red Pleta with ortho-ceratites, may be identified with that of Osmundsberg in Dalecarlia: the yellow containing trilobites, with that of the Isle of Gothland; the entrochites, &c. of Esthonia, with those of Scania. In many parts it is covered by floetz trap and floetz porphyry. I confess myself unable to trace these formations any further. I suspect their existence in the south of Norway, and their western boundary must be sought in Scotland and England; in the latter country, the transition limestone, with trilobites and orthoceratites, and its accompanying sandy and argillaceous beds are the only rocks I know that bear the least resemblance to them.\* Their southern edges must be looked for along the north of Germany, the south of Poland, and Russia. The intermediate country of Denmark does not seem to present any trace of them.

\* On comparing a very complete series which I was able to collect of this limestone, with the transition limestone of Longhope, and the environs of May Hill on the north west of Gloucester, Professor Buckland has ascertained an agreement in so many minute circumstances of the rock itself, as well as of its organic remains, as to feel the most confident assurance of their identity, the resemblance is particularly striking in those varieties of the limestone which are charged with magnesia, and the chief difference appears to consist in the accidental presence of grains of chloritic earth disseminated through some of the strata near Petersburg, such grains not being usual in the transition limestone of England.

This identity being admitted, we may expect to find in the limestone shale and slaty sandstones of the English transition series, analogous depositions to the beds of slaty clay and siliceous sand that lie beneath the limestone in Russia.

In several varieties of these latter, this analogy is faithfully maintained, but in the greater part of them a want of compactness, either original or resulting from gradual decomposition, reduces much of the sandstone to the condition of mere loose sand, whilst the argillaceous slates present an appearance of unstratified clay.

For a detailed account of these transition rocks in England, on which Professor Buckland has founded his comparison with those of Russia, see his paper on the districts adjoining to the Severn in South Gloucestershire.

*Geology of the Environs of Petersburg.*

457

I shall conclude with stating, for the information of the future geological traveller in the north, what I consider the principal desiderata in the history of the formations in the neighbourhood of Petersburg. It would be necessary to commence by visiting those localities I have before enumerated, in order to acquire the requisite acquaintance with the characters of the strata: a work of no great length of time, and which I have been the more particular in pointing out, because, were they to be blindly hunted after throughout a tract of country so generally uninteresting as the greater part of the environs of Petersburg, and which gives so seldom the least clue to its hidden treasures, not only would more time be uselessly consumed than is usually at the disposal of those who are not residents in the capital, but many would be turned back by an early disappointment from researches of the highest importance to the geological history of Russia.

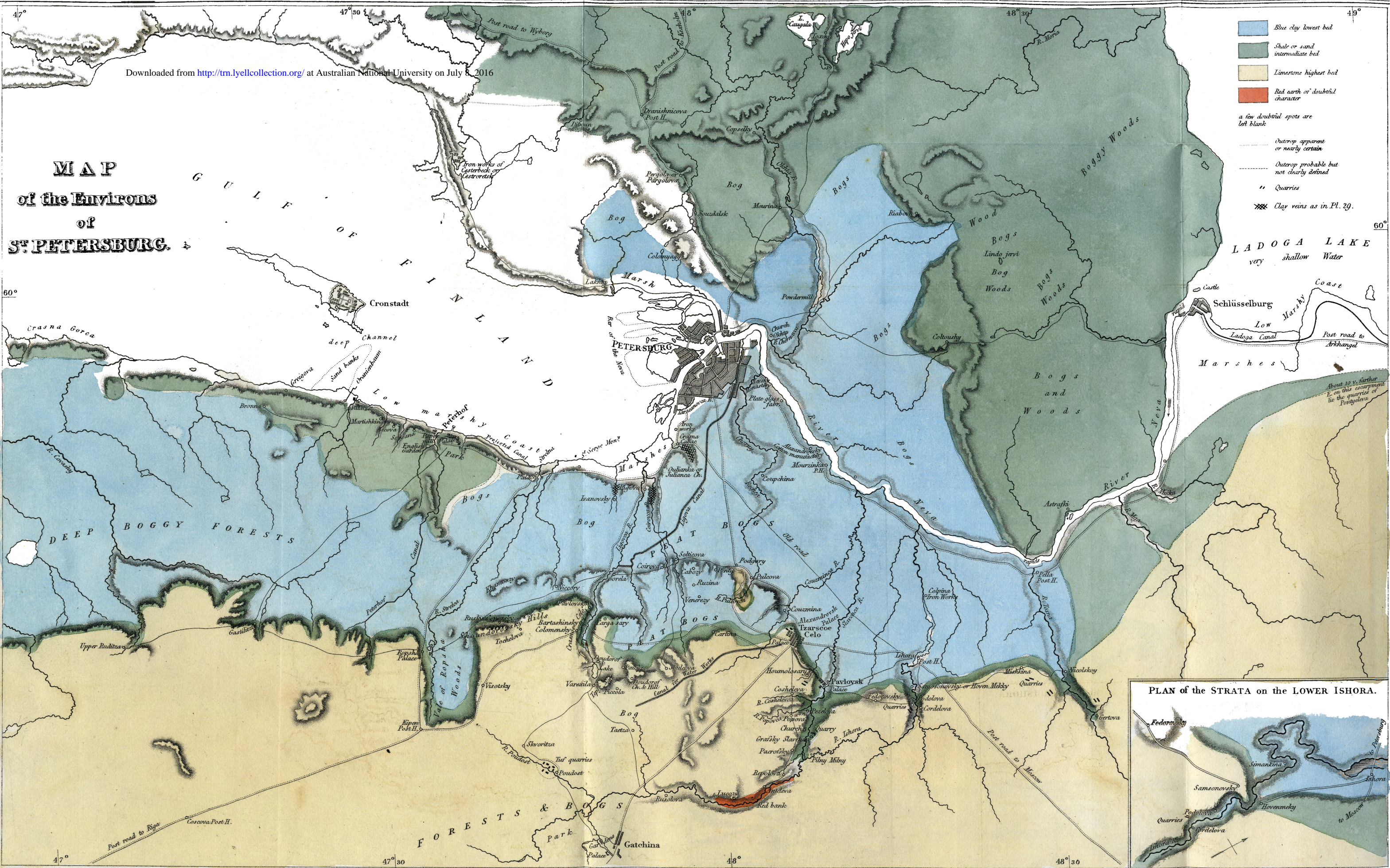
One of the first objects is to trace accurately the outcrop of the limestone from Nicolskoy on the Tosna, eastward behind Schlüsselburg to Poutyelova, the nearest known point in that direction. In so doing, the rivers Mga, Moika, &c. will be the places most likely to exhibit natural sections, and their banks, I doubt not, will be found equally interesting, if not equally beautiful, with those of the Ishora and Tosna. Of course, if such researches can be prolonged beyond Poutyelova and the Sas, much information cannot fail to be collected. The southern outline of the limestone along the vale of Novgorod; its prolongation westward through a part of the *goot* of Pscov, and the north of Livonia and Esthonia will also afford ample space for the labours of a geological investigator. It will also be useful to follow the northern escarpment from the vale of Ropsha by Gastilitzi and Caporié towards the falls of Narva; in doing which, an opportunity will offer of proving whether outliers

458      The Hon. Mr. STRANGWAYS *on the Geology, &c.*

of limestone exist or not at Soikina, or in the cape between the Luga and Narová. Every point of resemblance of it with the formations of other parts of Russia will of course be valuable: and in Esthonia, it is probable that the coast near Reval, from its indented shores and isles, and the marked character of its organic remains, will be ground amply calculated to repay the trouble of examination. This should include an excursion to the Islands of Æsel and Dago.

Each of the secondary districts of Sweden, would, if compared with that described in this memoir, present interesting features of similarity\* to it, and be peculiarly useful in affording points of contact with the primitive rocks, to which the northern districts add the important circumstance of being overlaid by *pseudo-volcanic* beds. Though this is wanting in Scania, yet that province would perhaps be the most useful in its results, as it shews the connexions of a greater variety of rocks; gneiss, white entrochal limestone, coal and sandstone, chalk and flint, &c. and several remarkable fossils. It would perhaps give a compendium of the strata of north and central Russia, at the same time shewing their relation both to the primitive and to some of the most important of the secondary rocks, and also allowing something like proof to be made of their connexions with those of the opposite coasts of Denmark, and through their means with those of the western parts of Europe.

\* An examination of the national cabinet of the Mint at Stockholm, and that of the University of Abo, Hermelin's maps, Thomson's travels, and the cursory view of the country which I have been able to make myself, enable me to make these assertions without hesitation.

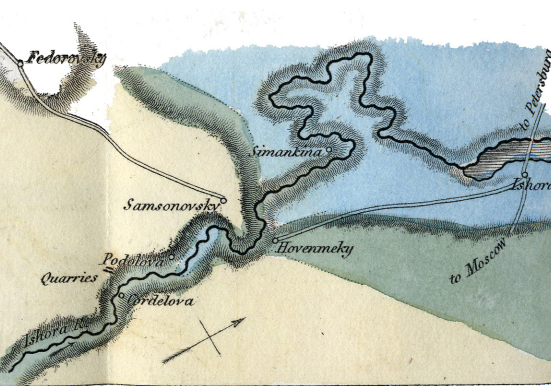


# MAP of the Environs of ST. PETERSBURG.

Downloaded from <http://tm.lyellcollection.org/> at Australian National University on July 8, 2016

- Blue clay lowest bed
  - Shale or sand intermediate bed
  - Limestone highest bed
  - Red earth or doubtful character
- a few doubtful spots are left blank
- Outcrop apparent or nearly certain
  - Outcrop probable but not clearly defined
  - Quarries
  - Clay veins as in Pl. 29.

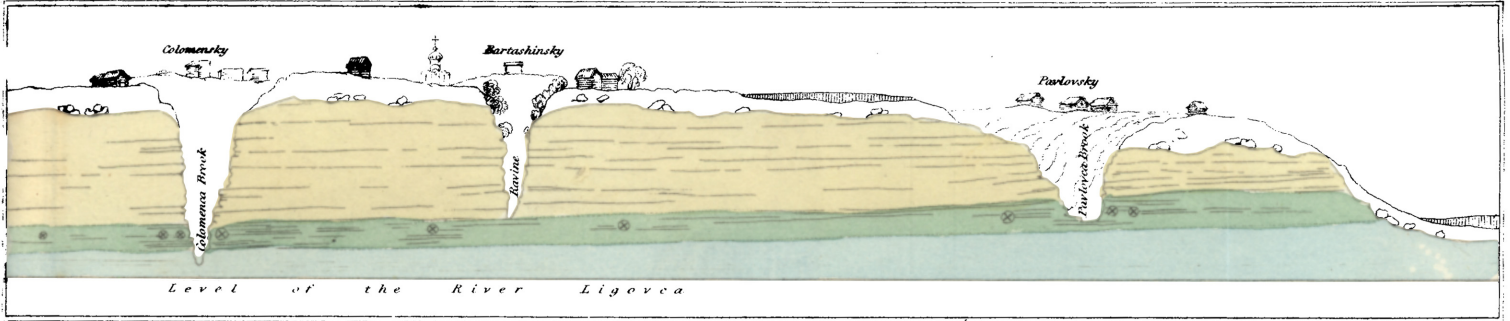
PLAN of the STRATA on the LOWER ISHORA.



Drawn by The Hon<sup>ble</sup> W. F. Fox Savignowsky.

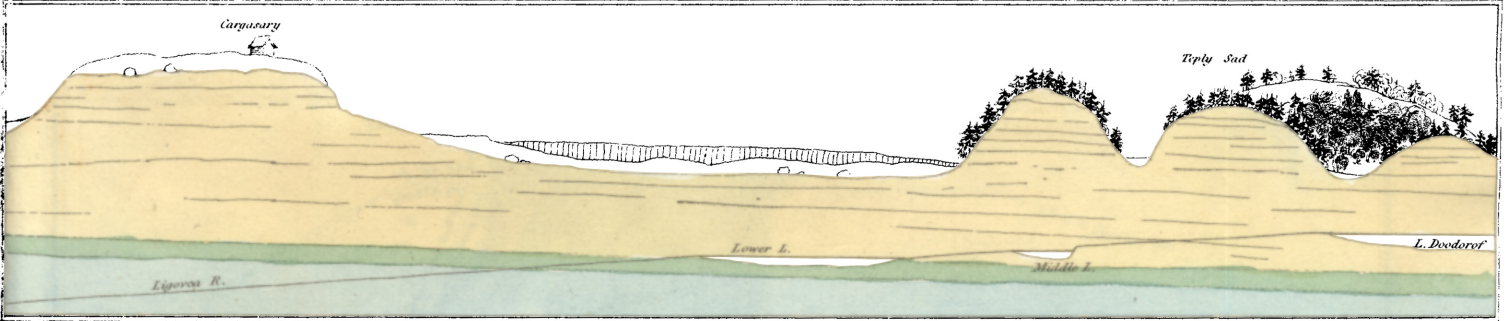
Engraved by J. Cross, Currier Street.

Fig. 1.



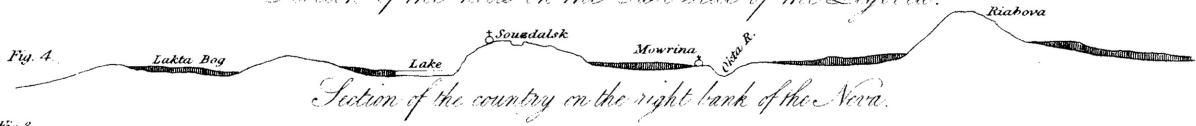
- 1 [Hatched pattern] Bog.
- 2 [Pattern with circles] Diluvian Gravel with Primitive Boulders.
- 3 [Yellow box] Limestone.
- 4 [Green box with circles] Bituminous Shale with Concretions of Tank Stone and Pyrites.
- 5 [Light green box] Clay.

Fig. 2.



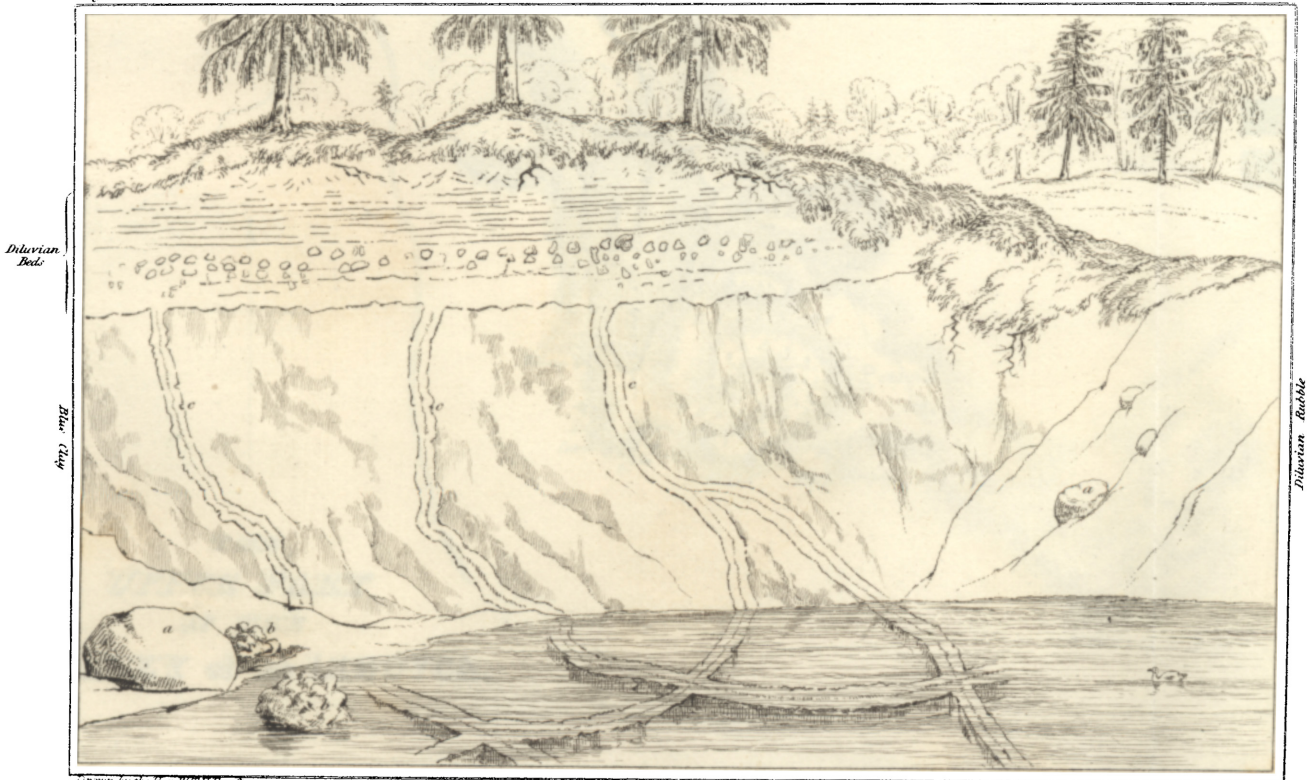
Section of the hills on the East side of the Ligovca.

Fig. 4.



Section of the country on the right bank of the Neva.

Fig. 3.

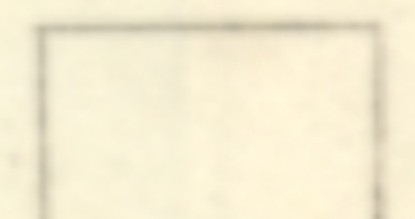
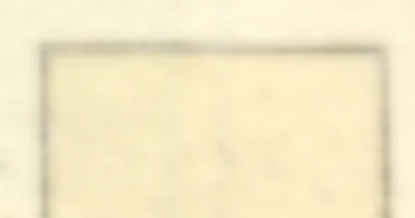
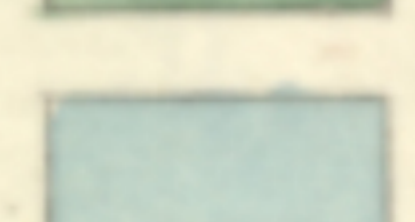


- a. Granite Boulders.
- b. Fragments of Diluvian conglomerate.
- c. Veins of Yellow clay.

Clay veins in the Coerova.



THE  
 UPPER PART  
 OF THE  
 VALLEY of the LIGOVCA.

- Marsh 
- Peat 
- Diluvium 
- Limestone 
- Green Schist 
- Blue Clay 

Drawn by The Hon<sup>ble</sup> W. H. Fox Strangways.

Engraved by J. Cross, Gursitor Street.

Illustration  
continued with  
Caption



*View near Gortova on the right bank of the Tasma.*



Standard

The Cliff below the Church is Blue Clay

Drawn by the Hon. W. T. H. Fox, Esq., F.R.S., &c.

*View of Nicolscoy on the right bank of the Tasma.*