the Potomac deposits of Maryland, and has been found also in the *Atlantosaurus* beds of Wyoming, thus offering, with the associated fossils, strong testimony that the American and European localities are in the same general horizon of the Upper Jurassic.

Havre.—The last day at my disposal before sailing for America, I spent in Havre, in the Muséum d'Histoire Naturelle, where the director, M. Lennier, showed me many vertebrate fossils of interest, from the well-known localities near the city. Here, again, among the fragmentary specimens not yet investigated, I found the bones of another Dinosaur, also one of the Sauropoda, but considerably larger than the *Pleurocalus* at Caen. The remains were very similar to those of *Morosaurus*, and the horizon was in the Kimmeridge, which is here well defined.

From Havre, I crossed the Channel to Southampton, and with a parting look at the Wealden cliffs of the Isle of Wight, which have furnished the remains of so many interesting Dinosaurs, I sailed for home.

III.—NARRATIVE OF A GEOLOGICAL JOURNEY THROUGH RUSSIA.

1. FINLAND.

By GEO. F. HARRIS, F.G.S., M.S.G.F., etc.

THE meeting of the International Geological Congress at St. Petersburg towards the end of August last year was about as successful in promoting the main objects the Congress has in view as any of its predecessors. There was a marked absence of anything like a serious radical programme, and in that sense the meeting may be said to have been progressive. The majority of the papers read were commonplace, the few exceptions being mostly in the domain of petrology. Every geologist who attended the meeting was grateful to the Organizing Committee for getting together such a nice little exhibition of specimens, maps, and models for the occasion. It was full of interest.

The official Russian geologists did everything in their power to assist their visitors. They caused certain scientific institutions in St. Petersburg to remain open longer than usual, and were never tired of explaining the rich collections stored in the geological and mineralogical museums in the Imperial University, and in kindred museums. During the week of meeting they organized a day's excursion to the Czar's palace at Peterhof, and another to the renowned falls of Imatra—a long distance off, in Finland, but distance counts as nothing in the Russian Empire. Then there were the inevitable receptions, though, fortunately, these were not carried out to the same extent as at the Washington Meeting.

But it was not of the actual Congress meetings, nor of the papers read or mumbled before them, nor of the wonderfully preserved mammalian remains in the temporary museum, nor of the unvarying courtesy of the Russian officials, that I desire to write in these articles. Neither may I say anything in the GEOLOGICAL MAGAZINE concerning the social aspects of our visit to the other side of Europe

—of the many banquets held in our honour, of the terrible number of speeches, mostly by self-elected “representative” spokesmen, which frequently commenced shortly after the soup was placed upon the table (so keen was the competition to do justice to our hosts!): these and many minor incidents, some of a distinctly sensational character, would more fittingly be recorded in the pages of a three-volume novel.

The Committee of Organization had arranged that four excursions should take place in connection with the Congress meeting. Of these, three were to be held before the meeting, viz.:—(1) to the Urals, (2) to Esthonia, (3) to Finland; and one after, namely (4) to South Russia, by the Volga or alternative routes, over the Caucasus through Tiflis to Baku (variations), thence to Batoum and across the Black Sea, through part of the Crimea to Sebastopol, and on to Odessa. I had the good fortune to be included amongst the participants of journeys 3 and 4—to Finland and Transcaucasia; and the aim of these articles is to give some account of the geology along the lines of route pursued by those two parties. To begin with the Finland journey; and I prefer to write in narrative style.

Starting from St. Petersburg at night-time for Helsingfors, we had no opportunity, then, of learning the character of the scenery through which we passed. The next morning broke dull and grey, and through the rain we could see that although the country was flat it was extremely well wooded, and that the fields adjacent to the railway track were strewn with enormous boulders. The country was saturated with water, and the bracken fern and undergrowth generally were doing their best to hand plenty of peat down to posterity. Here and there was evidence of disastrous forest fires, whilst numerous blackened stumps stood out of the peaty soil and could be counted by hundreds in the clearings. Vegetation was not only abundant, but luxuriant, and this in what is usually called cold, icy Finland! And so we continued to Helsingfors, meeting with but little else by the way except an occasional outcrop of granite.

At Helsingfors, Wilhelm Ramsay, of the University of that city, met us. This indefatigable geologist has done much for the geology of the country adopted by his ancestors. His work in the Isle of Hogland¹ and on the Quaternary deposits of Finland² may be cited as examples, whilst he has written joint memoirs with H. Berghell³ and E. T. Nyholm⁴ on the petrography and stratigraphy of the older rocks of Finland.

Helsingfors stands at the extremity of a small promontory, which is composed of a heterogeneous mass of what, for want of a better

¹ “Om Hoglands geologiska byggnad”: Geol. Fören. Förh. Stockholm, Bd. xii, 1890. “Beskrifning till kartbladen, No. 19 och 20, Hogland och Tytärsaari”: Finl. Geol. Und. 1891.

² “Ueber den Salpausselkä im östlichen Finnland,” Fennia 4, No. 2; Helsingfors, 1891.

³ “Das Gestein von Iiwaara in Finnland”: Geol. Fören. Förh. Stockholm, Bd. xiii, 1891, p. 300.

⁴ “Cancrimitsyenit und einige verwandte Gesteine aus Kuolajärvi”: Bull. Comm. Géol. de la Finlande, No. 1, 1895.

name, is called gneiss or "granitic schist," and the same class of rock extends for many a square mile around, relieved only by considerable extensions of overlying Glacial and Post-Glacial clays, and sands. The gneiss is believed to be of Archæan age. It is an indescribable mixture, the so-called foliations resembling flow-structure, leading one to the belief that the whole was due to contact metamorphism. In certain cases, where schistose fragments appear to have been more or less absorbed, such an explanation is highly probable; but, except the "Rapakivi," practically all the granite of South Finland, for at least 200 square miles, is foliated or "gneissose," or "schistose." Over large tracts appearances are certainly in favour of differential movements in the magma. But I will not say much about the rock, for our opportunities of examining it in the field were very small. The islets which add so much to the beauty of the environs of the Finnish capital are constituted either of this gneiss or the "gneissose granite."

The courteous Director of the Geological Commission of Finland, Mr. J. J. Sederholm, invited us all to the offices of the Survey, where he had prepared a representative collection of rocks and minerals, and examples of such fossils (all Quaternary) as have been found in the country. Sederholm's contributions to geology are already important. Amongst other things he has prepared a small geological map of Finland in two editions—solid and drift. He has especially studied the "Rapakivi"¹ and Archæan² rocks of South Finland. During the past year or two he has been engaged on the detailed mapping of the extremely interesting country in the neighbourhood of Tammerfors.³ In conjunction with W. Ramsay, he prepared the useful guide⁴ for the use of members attending the Finland excursion.

The collection of specimens at the office of the Geological Commission proved very interesting, and, in a measure, served as an illustrated guide to the class of rocks which we were to study in the field during the following week. Many types, however, did not lie along our track; amongst these latter were marvellous examples of "rapakivi" and some "globular" granites, and a word or two respecting them may not be out of place.

The peculiar kind of "granite" known as rapakivi has, typically, a number of large phenocrysts, commonly rounded or ovoid, composed of a kernel of orthoclase enclosed within an envelope of oligoclase (Fig. 1). The rock between these phenocrysts is fine-grained and frequently micropegmatitic. The formation of the acid

¹ "Ueber die finnländischen Rapakiwigesteine": *Tscherm. Min. und Petrogr. Mitth.* Wien, Bd. xii, 1891.

² "Archaische Eruptivgesteine a. d. südwestlichen Finnland": *id.*, Bd. xii, 1891. "Ueber einen metamorph. präcamb. Quarzporphyr von Karvia, Provinz Åbo": *Bull. Comm. Géol. Finlande*, No. 2, 1896; etc.

³ "Archaische Sedimentformation im südwest. Finnland": *Bull. Comm. Géol. Finlande*, No. 6, 1897.

⁴ "Guide des excursions VII Congrès Géol. Internat. : XIII, Les Excursions en Finlande"; St. Pétersbourg, 1897.

before the more basic felspar in the phenocrysts, and the detailed structure accompanying that phenomenon, form a very instructive study.

At the same time, the term rapakivi is largely applied by the geologists of Finland to holocrystalline rocks of granitic type

FIG. 1.—“Rapakivi granite” ($\frac{1}{3}$ nat. size). a = orthoclase ; b = plagioclase.

which contain large, rounded, and even irregularly-shaped phenocrysts of orthoclase, and which may not have the triclinic felspar wrapping round them, except in very rare instances in any one *massif*. It is used, in fact, as a general field term for granites of that description of Pre-Cambrian age. As thus defined, “rapakivi granite” extends over enormous areas in Southern Finland, on the north-eastern shore of Lake Ladoga, in the little island of Hogland in the Gulf of Finland, and in the Åland archipelago. It is one of the youngest of the Pre-Cambrian eruptives in the country, and has been classified by Sederholm¹ in his Jotnian formation—the younger subdivision of the Algonkian (or Archæozoic) group.

The “globular granites” exhibited at the offices of the Geological Commission (some of which were subsequently shown in the temporary museum formed in connection with the Congress meeting at St. Petersburg) have been described in some detail by Benjamin Frosterus.² The accompanying diagram (Fig. 2) represents one of these rounded or ovoid bodies. Mr. Frosterus tells me that the kernel is frequently formed of a fragment of biotite schist. Following his observations in the work just quoted, it will be seen that, normally, there is a kernel or nucleus, outside of which are four successive zones. In the diagram (Fig. 2) a represents the nucleus, which, in the specimen analyzed by Frosterus, contained 63·64 per cent. plagioclase ($Ab_2 An_1$) with 18·92 of biotite and 19·60 of quartz. Then followed the first coating or andesine zone (b), in which the plagioclase ($Ab_4 An_3$) amounted to 73·22, biotite 8·00, and quartz 16·50. The next coating, the oligoclase-andesine zone (c), yielded plagioclase ($Ab_1 An_1$) 56·07, biotite 5·60, and quartz 39·72. This is succeeded by a microcline zone (d), in which we have plagioclase ($Ab_3 An_2$) 16·52, alkali-felspar 57·44, and

¹ “Guide des Excursions,” etc. (op. cit.), p. 18.

² “Kugelgranit von Kangasniemi in Finland”: Bull. Comm. Géol. Finlande, No. 4, 1896.

quartz 26·74. The outermost zone (*e*) has plagioclase ($Ab_2 An_1$) 44·28, alkali-felspar 6·79, biotite 4·00, quartz 42·82. The mineral composition of the stone between the globular bodies is plagioclase ($Ab_2 An_1$) 35·49, alkali-felspar 16·88, biotite 12·27, quartz 32·53. From this and from the chemical composition of the different zones and the "muttergestein," it is evident that the general tendency of the ordinary separation of the crystals from the original magma was normal—that the zones, on the whole, become more acid as they recede from the nucleus. The proportion of $Si O_2$, for example, in zone *b* is 61·64, *c* 72·92, *d* 74·80, and *e* 75·67, whilst the rock between the globular bodies has 70·46. Not the least interesting feature in these remarkable bodies is the mechanical deformation to which they have occasionally been subjected, and which has had the effect of breaking through the zones and squeezing out some of the substance of the interior. In certain of these Finnish "globular granites" shown at Helsingfors the spheroidal and ovoid bodies have been partially absorbed by the matrix in which they occur. The concentric zoning is clearly marked, and in most cases the minute crystals are so arranged as to produce a radiating effect.

FIG. 2.—"Globular granite." Diagram showing disposition of zones in one of the typical ovoid bodies (about $\frac{1}{4}$ nat. size). The distinguishing italics are explained in the text.

The structure of these bodies differs somewhat from that of the well-known spheroids in the granite of Mullaghderg, County Donegal, described by Dr. Hatch,¹ though the Finnish rock agrees better with the Irish than with certain Continental rocks adverted to by the last-mentioned author.

At length, after a stay of three days, it was time to leave Helsingfors, and Mr. Sederholm took charge of the party. A long railway ride north, to Tammerfors, and an enthusiastic welcome from

¹ Quart. Journ. Geol. Soc., vol. xlv, 1888, p. 548 et seq.

the inhabitants of that manufacturing town were the first items on the programme. The country seen on the way was flat or but slightly undulating, with low hills occasionally; the whole well wooded and watered. The Glacial clays passed through shortly after starting were here and there covered by Post-Glacial clays and littoral deposits containing *Litorina*, *Cardium*, *Mytilus*, *Tellina*, etc. A ridge of considerable size was traversed by the railway at Hyvinkää, which proves to be a large terminal moraine. To the north of that place moraine gravels predominate, and there are several åsar, a phenomenon which I intend to describe more particularly at another stage of our journey. Then several lakes come into view, and Tammerfors with its hilly scenery is reached.

Tammerfors is situated on a narrow neck of land formed by an "ås," which separates the lakes of Näsijärvi and Pyhäjärvi. The former lake is about 58 feet above the latter, and the two are connected by rapids, which in parts are very beautiful. The journeys for the next two or three days were from that place as a centre, a special train being always at our disposal.

The neighbourhood of Tammerfors is excellent for studying the Archæan rocks of Finland. The following divisions are recognized by Mr. Sederholm¹:—

1. Post-Bothnian granite.
2. Bothnian schists.
3. Pre-Bothnian gneiss.

In the last division, granites (essentially metamorphic), porphyroides, and closely foliated gneiss predominate. These latter, according to Sederholm, are granitized mica-schists. All these rocks crop out to the south of the town.

We examined the foliated granite and mica-schist (on the afternoon of our arrival) in a railway cutting at Siuro, about twenty miles west of Tammerfors; and in a railway cutting to the west of Suoniemi we had an opportunity of examining the mica-schist highly plicated. The micro-structure of these and some other Finnish rocks will presently be described.

We will turn now to the second division—the Bothnian schists, which, as will be seen as this narrative proceeds, we examined at many points. The local development of these is known as the Tammerfors schists. They crop out in bands running east and west, the whole being highly inclined and limited by the Pre-Bothnian gneiss on the one hand and the enormous outcrops of the Post-Bothnian granite on the other. These schists are often represented by phyllades,² which occasionally approach true argillites and sometimes pass gradually into fine-grained mica-schists. The foliated arkose, which Mr. Sederholm calls "leptite" (to be more particularly referred to hereafter), occurs in this subdivision. So also do certain hornblende (mostly uralite) schists (called porphyritoides), which were originally volcanic tuffs, and sometimes have altered lavas intercalated between them.

¹ "Excursions en Finlande" (op. cit. supra), p. 2.

² This term is here used in its broad sense.

But one of the most remarkable features of the "Bothnian schists" in the neighbourhood of Tammerfors is the presence of conglomerates on several horizons. These, in many instances, are so fresh that one finds some difficulty at first in believing that they are really Archæan. The waves of Lake Näsijärvi, in the lovely bay of Hormistonlahti, where these conglomerates are well exposed, have assisted the atmosphere in picking out the more or less crystalline cement between the pebbles. In other situations these Finnish rocks reminded me strongly of certain Cambrian conglomerates in North Wales; but I do not desire to draw the comparison any closer, for the Cambrian of the neighbouring parts of Russia, as everyone knows, is peculiar as being so little affected by the ravages of time.

Mr. Sederholm places¹ the thickness of the Tammerfors schists at from 4,000 to 5,000 mètres—2,000 mètres for the phyllades, 1,500 for the lower tuffs and conglomerates, and the remainder for the upper tuffs with their intercalations of phyllade and conglomerate.

The Post-Bothnian granite, which crops out to the north of the schists in the Tammerfors area, is shown by Sederholm to traverse the latter, veins being thrown out at certain places, and large pieces of the schists being caught up at frequent points along the junction between the two rocks. And these pieces of included rock, in addition to possessing the structure and mineral composition of the Tammerfors schists, have occasionally been discovered to contain typical pebbles as found in the last-mentioned formation.

As I proceed with the narrative, I propose to give field notes and some account of the micro-structure of examples of these Archæan rocks which I collected, and to deal with the Glacial deposits, in the next article.

(To be continued.)

IV.—NOTES ON SOME SMALL LAKE-BASINS IN THE LEPONTINE ALPS.

By Prof. T. G. BONNEY, D.Sc., LL.D., F.R.S., V.P.G.S.

ROCK-BASINS have been getting out of favour of late. The "heckling" which they have suffered from my friend Mr. Marr tempts one to echo Betsy Prig's classic remark about Mrs. Harris. Mr. Brend, however, though "dealing faithfully" with them in the September number of the *GEOLOGICAL MAGAZINE*, does permit one or two to exist on sufferance, so that I feel minded, were it only as an act of charity to these depreciated securities, to describe two or three examples in the Alps which I think must be true rock-basins.

The first is called the Lago Tremorgio.² It lies, at a height of 5,997 feet above the sea, on the southern flank of the Val Bedretto, at the top of a long and steep ascent from Fiesso. It is slightly irregular in outline, but circular in form, with a diameter between

¹ Op. cit. supra, p. 4.

² I examined it in 1893.