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**A brief report on the geological journey across Russia in 1841. Letter from R. Murchison to His Excellency the Minister of Finance.**

In the letter with which Your Excellency honoured me in February of this year, you were pleased to notify me that the STATE EMPEROR was honouring with his high patronage G. Verneuil and me for a geological journey. What we wanted to do in Russia is to disseminate the research that we have begun in the past year. This commission was not only completely fulfilled, but His Majesty the STATE EMPEROR rendered us such a gracious welcome, the

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entire [Ural] Mountain administration rendered us so many benefits, and the Russians, with whom we had intercourse during our journey, rendered us such hospitality, being devoted to the benefits of your great people and using all efforts for the success of the natural history of Russia.

Inspired by these feelings, I dare to present from myself and from my co-workers an outline of the results of our main research. Most of all, it is a pleasure to confirm that the active and wise help of the Mining Administration, and the means provided by it for our journey, were the first reasons for its success, while the sincere and scholarly assistance of Count Keyserling and Lieutenant Koksharov which the Mining Administration communicated to our expedition, contributed just as much to our success. With such comrades and with all the funds delivered to us, the work we assumed was very much easier. For the five months of uninterrupted work, each member of the expedition had only one goal and used all their efforts to attain the truth. Inspired by the same thought and sharing the same opinion, each tried to fulfil his duty and my one service to others was the fact that I

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drew up a plan for our expedition and from time to time communicated new methods of practical geology to better achieve the goals. Proceeding along the excellent route that was prepared for us and, changing it only according to unexpected circumstances and discoveries, we were able to achieve our objectives because if we met anything dubious, we immediately took new measures to eliminate it. We multiplied our strengths, doubled our observations and collected, in such a way, such a number of facts that would require a two-year journey from another expedition if we had not been able to split into parties like ours.

The subjects of our journey were, as your Excellency knows, to:

1) Classify and determine the relative antiquity and relationships of the various rocks that make up the Ural Mountains.

2) Pay special attention to the Donetsk coal basin and determine its exact correlation with the equivalent Formation in England.

3) Inspect as many localities in the south and in the centre of Russia as possible in order to

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collect new materials for compiling a geological map of European Russia.

**I. Ural Mountain Range**

The first of the above-named items took up most of our time. For a better study of the true composition of the Ural Range, so apparently complex, we drove across in different directions from the outskirts of Bogoslovsk in the north, to its southern end. Travelling almost always in two teams, we could study the Asian and European slopes at the same time, going sometimes to the centre of the ridge, to Siberia, then to the provinces of Perm and Orenburg. As for the north of this ridge, that is, from Bogoslovsk to Zlatoust, our work was greatly facilitated by the prudent measures of the Mining Administration. Geological, mineralogical and technical maps were presented by each state-owned plant, and excellent officers helped us with diligence and taking much time. Completely familiar with the nature of the surrounding rocks, they greatly reduced our work. It only remained to deduce from this set of rocks so different in their mineralogical composition, some kind of symmetry, which,

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once determined, could serve as a guide for practical engineers in the search for mineral wealth.

In the Urals, as in the other mountain ranges that we studied, the sedimentary rocks that make up the main mass have undergone so many changes in their primitive character, from the eruptions of igneous (ignée) materials, which appear differently as in a changed state, and very rarely retain those signs by which one can judge the scale of their relative antiquity. And therefore, instead of repeating everything that was already reported by our predecessors in the study of this chain, that is, that it consists of quartz-rich, micaceous, chloritic, shaly and calcareous rocks (most of which were classified as Primary rocks), let us say that in spite of all the changes that these rocks have undergone, we have found enough organic remains to be certain of their sedimentary origin and to determine their relative antiquity. We will add that apart from some granite ridges of various eruptions of serpentine, porphyry and dioritic rocks, which broke through the ridge in lines parallel to its major axis, and which do not constitute its main mass, the Urals, from Bogoslovsk to its most southern extremity, are

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related to the systems: Silurian, Devonian (Old Red Sandstone) and Carboniferous. Most of the mines are located in one or other of the mentioned systems of this great Palaeozoic era.

The geological map of this chain, which will be compiled to explain our observations, will show the constant presence of these masses in narrow ridges in the north of the Urals, where they are more often interrupted by igneous rocks and where, in accordance with what we can call a much richer geological law, than in the southern Urals, where they are located in the form of a fan and present to the geologist in beautiful spurs a complete explanation of what could have been hidden in the north. We then see how the following rocks are black dolomites, crystalline limestones and quartz-rich and micaceous rocks, that retain their original character and even their former fossils, as they become more distant from the large axes of eruption, we attribute to the Silurian period the metamorphic rocks, on which lie some of the gold-bearing placers and in which are the famous deposits of iron ore, malachite,

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of the eastern slope; and to the Devonian and Carboniferous period, the different, but very rich ores of the western slope.

No fact in natural history has proved to explain the origin of metal-bearing masses, better than the appearance of various volcanic rocks, especially at their points of contact with sedimentary strata, through which they pass to reach the Earth's surface and no region provides better evidence of this than the Urals. This connection of some plutonic and sedimentary rocks with precious metals is so important that the engineer who studies it in detail may achieve unimaginable wealth in this mountain range.

Our research led us to survey, on the western slope of the ridge, a large number of strata, which we attribute to the Carboniferous period, but we must present our opinion that it is very unlikely we would find there abundant coal formations, but instead of explaining what we need to understand coal, but subordinated to sandstones passing into quartzites, lying directly above the coal limestone, which were discovered in the name of Prince Lazarev and

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Princess Butera, may eventually be useful for the region. Various geological facts also make us think that research in the Artinsk basin and its surroundings would not be useless.

**II. Southern Carboniferous [Coal-bearing] Region**

To study the region between the Dniepr and Don, known under the name of the Donetsk coal region, we first examined its eastern parts, then cutting across it from the south to the north along the rivers Mius, Krinka and Kalmius without leaving a single one where coal is being developed, we visited districts distant from the Don on one side and the Dniepr on the other. To the north and to the east, this sediment (occupying a surface of about 25,000 square versts) is covered by Secondary and Tertiary sediments, in which over time it will be possible to open it; but to the west it becomes gradually thinner and, according to our observations, the Volga River, covered with Primary rocks, can be treated as its eastern margin.

In a technical and geological sense, this sediment is not equivalent to the Coal Formation (terrain houillier) of England, Belgium and France. Resting on the Old Red Sandstone (karakuba), which is identical with the sandstone of Scotland and northern England, it consists of a well-developed lower and limestone part of the Carboniferous system. In this, it

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can be compared with some sediments of the same relative antiquity in Northumberland and the western parts of Yorkshire and Durham, counties where, as in the south of Russia, it bears very abundant coal seams. Perhaps it would be inappropriate to remove the sides and hide the fact that, excluding the management work, which is being done well, most of the mines of the Donetz region are nothing more than open mines or galleries set in the slopes of mountains. Apart from Lisichya Balka, nothing has been done anywhere to drain any mine, and therefore, as soon as the development reaches a certain level, it is immediately abandoned. If England developed only five layers, which can be reached without pumping out water, then it would not have extracted a hundredth of what is needed for its own use, where the seams are very slightly inclined and appear to be folded in a wave-like manner, it would not be difficult to mine coal, using open-pit cuts of the valleys to enable canals to drain away the waste water.

In this, there are several striking fold axes, directed almost always from WNW to ESE; of

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which the slightest traces are visible in the southern part, and which acted with such force towards the north that coal was often pushed to the surface. Coal mines are known only where nature has made almost all of these folds, and therefore it is easy to imagine how much benefit you could get in this region if you look in the neighbourhood of the abundant layers, where they have an insignificant slope and often slightly deepen.

Many developments in the south of Bakhmut, and especially in Lisichya Balka, have completely shown both the quality and multiple layers of coal. Skilfully performed drilling will show the same wealth, more or less developed in other parts of this region.

As for the two types of coal, anthracite and ordinary coal, it seemed clear to us that both of them are modern; in one word, that in the Novorossiysk region, like in Vallis, the same coal seam, resinous in one area, when moving to another, becomes anthracite. Some of these Donetz strata show a real transition from anthracite to resinous coal, and make up hard coal

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very useful for steamships, while pure anthracite (Popovka and Grushevka) is equal to the best anthracite in England.

Without setting out the details of this sediment, I shall present in the third part of this report, some significant differences between its composition and the composition of sediments of the same era that occupy part of northern Russia; now I allow myself to say only that no land, even England, can represent such a rich development of the lower part of the Carboniferous system as the Donetsk region.

Finally, after a careful study of all parts of the Empire where it was possible to hope to meet the coal beds, we are strongly convinced that the Donetsk region is the only one (and we will present strong reasons for this in the third part of this report) showing numerous layers of combustible material useful for metallurgy, and we can say clearly that from the minute the STATE EMPEROR turns his attention to it and deigns to encourage establishments run by experienced people, this region will become a great centre of regional industry.

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**III. General table sediments of Russia, geological map and others**

I communicate the table of sediments of Russia, a section from Taganrog to St. Petersburg and a sketch of our map even though they are imperfect in their construction (\*[[1]](#footnote-1)\*), making up the graphic results of our works. Asking Your Excellency to look at the table of soils, I will not enter the explanation of the phenomena presented to us by the upper sedimentary soils [= rocks], which gave us the opportunity to make curious comparisons with the sediments of the same era in our countries. I will pay attention to the new points in the lower sediments. In the provinces of Vyatka, Perm and Orenburg, there is an extensive system of sandstone, limestone, marl, gypsum and salt. In terms of its stratigraphic position, this sediment can be compared with Rothe-todte-Liegende and the Zechstein of Germany. But it cannot be positively attributed to one or the other of the German divisions, either by fossils or by the

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nature of rocks. Its extensive development in Russia compels us to regard it as the best or true example of the deposition of this era, scattered here and there separately in Europe. That is why we propose the name of the Permian system, a name that, we hope, will be accepted by geologists of other countries, because it is better than the old names

This Formation, in which there are numerous mining locations known to you, is distinguished by a large number of organic bodies, which are almost all unknown, but which, by their main features, indicate the proximity of coal-bearing sediments. The most abundant and most distinctive is the one that we have called *Productus Cancrini*.

As for the coal-bearing sediments of northern Russia, our present research has confirmed strikingly the validity of our opinion in the past year. Differing in their complete composition from the beautiful southern coal-bearing sediments, the only representative of coal. As for the coal soil of northern Russia, our present research has confirmed strikingly the validity of our opinion in the past year. Differing in its entire composition from the excellent southern coal sediments, the only representative of coal occurs in a strip lying in the lower layers and having the position of the Carboniferous Valdai strip, so well described by Lieutenant Colonel Helmersen. It lies, here and there (see section from Taganrog to St. Petersburg) on the most ancient formations, called (Old Red Sandstone) or Devonian, which rises to the

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south of the Tula and Kaluga, and which, according to the physical geography of the country occupies a wide belt more than 150 versts from the south to the north from the sources of the Oka to Likhvin. The section of the Don through Voronezh, made by Count Keyserling, gave the same results and proved the development of this Devonian axis to the east. His observations, like ours, confirm this important fact, that everything that is coal to the north lies in a great depression, which we call the “Moscow Basin”. In a scholarly sense, this discovery presented us with a lot of answers, explaining to us the reason for the large differences that exist between the Moscow and Donetsk basins. These two basins, separated from each other since ancient times, were filled up with seas, which had different shores and different tributaries, which, being subject to different conditions, provided the necessary space for different sediments. But I want to draw the special attention of Your Excellency to the public benefit of this discovery, because it will give us a means to determine the exact limits of the northern coal strip, but approving of the recent efforts made to determine the local area of ~~​​~~combustible material in Tula and Kaluga, where coal is conveniently developed

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for the benefit of the known needs of the region, we cannot hide that the fossils are almost the same as exist in Valdai, and that beyond the limit that we noted, any effort to find coal would be fruitless.

Here you can see the practical side of our science and I can dare to hope that the use of the classification principles in Russia, which I presented in the work presented to His Majesty, is useful.

Studying the differences that exist between the Carboniferous deposits of northern and southern Russia, we can say that Russia represents the same phenomenon as Great Britain and Ireland and in many parts of England: Carboniferous limestone or the lower layers of the system, contain combustible substances at Valdai and Kaluga, that are useful only for home use and some factories, while in other districts of my homeland, the same formations, changing their lithological character, becomes a large and rich supply of coal, as in the Donetsk.

In conclusion, I ask Your Excellency to allow me to tell you that it will take us quite a long time to compile the proposed work, after examining, comparing and describing the rocks we have collected, and but preparing the sections and maps. We will devote all our

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attention to this, and with the help of our Russian colleagues, we hope to present to His Majesty a work that will testify to our desire to benefit Russia. Between letters, I ask Your Excellency to present to His Majesty our first sketches, as proof of the success of the expedition, which His Majesty was pleased to encourage, and as a surety that His High Patronage, removing for us any obstacle, within the limits of His vast empire, enabled us to reach general conclusions that are essential for the success of science.

2.

**Geological observations in Russia.**

Letter from G. Murchison to G. Fischer von Waldheim.

Translated by Lieutenant Koksharov.

So how did we take the most active part in the success of the geological expedition carried out by me now together with my friends G. de Verneuil, Graf Keyserling and Lieutenant Koksharov; then I will try to tell you some of the main results of our journey. Asking you to

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advise the honorable Society of Moscow Naturalists who have honoured me as one of their foreign members, I am fulfilling my intention with great pleasure.

The existence of the Silurian, Devonian and Carboniferous systems in northern Russia is already known to you from the extracts from our notes and published in the publications of the London and Paris Geological Societies. The purpose of our journey this year was as follows:

1) To study the order of bedding, relations and geographical distribution of upper sedimentary rocks.

2) Explore the Ural ridge so as to be able to clearly see in what order the horizontal Formations of the flat space of Russia are arranged.

3) Explore the formation of the Donetsk Basin, abounding in coal seams, and adjacent rocks of southern Russia.

We have already determined, if possible, the past year, the boundaries of the huge basin of the Carboniferous system of central Russia. This year we have added to this only the evidence of an uplifted stratum, forming at Samara an almost large island of the Volga, the

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rocks of which are full of fusulines and are exposed by very deep erosion. These rocks belong to the upper levels of the Carboniferous limestone, which is very distinctive in the geology of Russia.

The Carboniferous strata are generally covered by a suite of marly, clayey, limestone and sandy strata, which we propose to give you the name "Permian system." Although this system, by its general features, is equivalent to formations of the Rotliegend, Zechstein and others, it is impossible to positively identify one or other of the German divisions, whether by the fossils or by the nature of the rocks. The English classification, in the context of which we could attribute the mentioned group to the lower tiers of the of the New Red Sandstone (Nouveau Grès Rouge) is no longer serviceable. The name New Red Sandstone is purely mineralogical, and therefore it is also inconsistent with the huge thickness of marls, white and yellow limestones and brown sandstones, as the name Old Red Sandstone for rocks of black colour and shales of the Devonian. In the Permian system, we rank the main sediments of gypsum in Arzamas, the river Piana, Kazan, and Kama and Sylva rivers, Ufa and the

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surrounding area of Orenburg; salt springs of Sergievsk and other parts of Orenburg province, and equally all copper mines, huge fragments of trees and petrified plants, to which you have already submitted the list to the *Bulletin* of your society (1840).

In the red sediments occupying the vast basin of the provinces of Vologda and Nizhny Novgorod, we did not find other organic remains, except for poorly preserved small *Cypris* and bivalves, but judging by the thickness of the sediments, their distribution and mineralogical features will sometimes be compared to the Trias. We are more convinced in this assumption by the case where Count Keyserling discovered in the Bogdo mountain, lying in the middle of the Kirghiz steppe, some fossils otherwise completely unknown in other parts of Russia, and which are already encountered in the already mentioned *Ammonites bogdoanus* of Von Buch. This famous scientist attributed *Ammonites bogdoanus* to the Muschelkalk Formation.

The Lias, it seems, does not exist in Russia, but as G. Buch published very recently, the Jurassic rocks in Russia are composed of two parts, of which the upper one is in many parts

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of the Donetsk region ([[2]](#footnote-2)\*). This part is almost always in the form of oolitic limestone and contains many fossils, such as: Nerineas, Trigonias and others, which you have already described, and which allow you to compare it with the Upper Jurassic sediments of Germany and the Portlandian coral-bearing limestone of my homeland.

The lower part of the Jurassic, much more developed, does not cover, however, uninterruptedly very large spaces, but is scattered here and there in scraps, and in some places, it is covered by the younger formations. Starting from the eastern slope of the Urals, from 64° to the Caspian Sea, it retains almost the same mineralogical character and the same fossils. The sediments occupying the space are the middle and lower layers of the Jurassic strata. This is where your Moscow iron sands, your sandstones and black clays, to which we have already seen a similar one last year on the Volga, between Kostroma and Kineshma, at Makariev on Unzha, and which we have met again this year in many places, mainly between Arzamas and Simbirsk, between Syzran and Saratov, at Sarapul and on the Ilek river in the vicinity of Orenburg.

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The Cretaceous sediments, however, are composed of heterogeneous horizons. Although the Cretaceous comprises marls and sandstones, it does not contain other fossils than those located in the bulk of the Cretaceous of western Europe. *Catillus*, *Belemnites mucronatus*, *Ostrea vesicularis*, and *Terebratula carnea* it seems, can be encountered at all levels.

Above the white Cretaceous, we did not find nummulitic limestone (calcaire nummulitique), which begins in the Crimea and which becomes very remarkable stretching into Georgia, Egypt and southern Europe ([[3]](#footnote-3)\*\*). Also, the members corresponding to the lower strata of the Tertiary (Eocene period) do not seem to exist in Russia, but instead of that, the middle and lower tertiary tiers (Miocene and Pliocene) occupy a very wide surface around the Volga (Antipovka), Podolia and Volyn, and equally in the areas surrounding the Azov and Black seas, where they are the youngest deposits. Time does not allow me to talk to you

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about the numerous and interesting phenomena of the Urals, for the study of which we spent about 3 months. We made observations about the amazing gold-bearing placers, about the position of your huge animals and comprehended the secret of metamorphism (change) of sedimentary rock, in which the Ural represents wonderful examples, for a better study of which we must always refer to the excellent works of Von Humboldt and Gustav Rose.

I will only tell you that this ridge is very far from being considered one of the most ancient. It consists, in addition to the igneous rocks, of sediments of the Silurian, Devonian and Carboniferous, more or less altered, which, incidentally, did not prevent us from finding (and in many places) our *Pentamerus knighti* that provides rather positive evidence about its antiquity. The mentioned rocks of the Urals are located in parallel strips and almost symmetrically along both its slopes, and in its southern part they appear to be deployed in the form of a fan, being mixed with porphyries, the action of which partly turned them into jasper.

It is still less important for you to be informed about the formation of the Donetsk region,

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which is replete with coal seams, for without going into details about the vastness, thickness (so important for the future good of Russia) and other circumstances, I will not give it due justice. Geologically speaking, we can say briefly that all the numerous coal seams of this system are subordinate to Carboniferous limestone (Mountain limestone and grit) and that the Formations known in England under the name of coal (terrain houiller) in the Donetsk region do not exist in the full meaning of this word (as G. Eichwald).

It remains for me to talk to you about one very interesting discovery that we made with Count Keyserling, who returned to Moscow along two different roads through Voronezh and Orel (Don and Oka). In general, until now, it was thought that Russia from the north to the south represents a system of deposition, which, as it approaches the south, gradually becomes younger, that is, that the ancient formations of northern Russia, approaching the south, are covered with younger and younger rocks, ending with the Carboniferous sediments of the Donetz region are pushed out from the bottom by granite and plutonic rocks of the southern steppe. But this is not so - the huge axis of the Devonian outcrop, which is about 150 versts in

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width, crosses central Russia at the latitude of the Voronezh and Orel provinces, heading to the ENE, to unite, probably, with the rocks of the same antiquity in Lithuania and Courland. It is more precious for us that the strip of Silurian soil that we have found today (under Chablis in Lithuania) is located on the same uplift line. The importance of this is not hidden from your discernment, and of course you are already guessing the consequences. The described axis of the Devonian system clearly indicates the reason for such a great difference between the sediments of the Carboniferous basin of the Donetsk region and the basin of your vast Moscow space; for the two seas, in which these sediments were formed, were separated from each other by land even in very distant times, and thus having different coasts from each other, also had different tributaries and different sources, on which the nature of the marine sediments mainly depends, so the deposition could and should have been different.

Our discovery on the other hand explains the perfect similarity between the two shores of the Moscow basin. In the provinces of Kaluga and Tula, as well as in Valday, Devonian

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rocks, characterized by the remains of the fish *Holoptychius nobilissimus*, pass under the Carboniferous system, serving as the basis of coal seams (accompanied by *Productus gigas*), which now constitute the subject of research and government exploration.

You will be surprised by the vast area we have explored, if I don’t have time to tell you that the expedition was provided with the patronage of Count Kankrin, and that the necessary orders of very enlightened people were provided in advance, moreover, the hospitality and hospitality inherent in the Russians and in the Russian people contributed a great deal to the success. Thus, all obstacles were eliminated and all possible conveniences for travel were delivered.

We will have the honour to deliver to you promptly, together with our description, a general table of the order of bedding of geological units in Russia, which we are already preparing, as well as sections and maps ([[4]](#footnote-4)\*).

Accept, gracious sir and dear comrade, confidence in our sincere feelings are completely devoted to you.

1. \* The table and the section were taken back by R. Murchison, who said that, according to their proper completion and accurate verification, they will be published by him in a short time and in a new and improved form. [↑](#footnote-ref-1)
2. \* See description by G. Bled. [↑](#footnote-ref-2)
3. \*\* I received samples of nummulites from Elizavetgrad, which is why it can be assumed that the Crimean system continues to the southern slope of the granite steppe. [↑](#footnote-ref-3)
4. \* I saw this table, compiled according to completely new principles, some maps, cuts, and so on. All this is prepared with such a knowledge of the soul that there is nothing left to wish for. Fischer von Waldheim. [↑](#footnote-ref-4)