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OUTLINE OF THE STRUCTURE AND HISTORY OF THE RUSSIAN PLATFORM

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I

The excursion of the Congress is confined in the main to the Western and Southern portions of that remarkable geologic unit which embraces almost the whole of Eastern Europe and since long has been known in geological literature as the Russian platform. The area under consideration is as a whole a uniform plain made up almost exclusively of the sedimentary rocks which have changed but very little since the time of their formation and have undergone as a rule no intense dislocations whatever. Their strata have retained upon vast areas that almost horizontal or slightly inclined attitude in which they were deposited; East of the meridian of Moscow they exhibit, however, some slight curvatures which become more intense toward the Southeast and ultimately pass into an intricate system of the brachyanticlinal uplifts.

On nearly all sides the platform is surrounded by mountain chains, which are either young, as in the South, or older, as in the East and especially in the North and North-west; it is only in the West, in Poland: that it has no sharp boundary. Such a frame made up of mountainous structures are to be met by the Congress excursions in the Crimea and the Caucasus.

The present paper is intended to convey in the most succinct manner an idea of the essential features of the geologic structure and history of the Russian platform, such features predetermining the main characteristics of its geomorphology and the nature of the soils inasmuch as the latter are dependent on the

parent rocks that underlie them. At the same time we will have to make some passing remarks on the structure of the mountain ranges, which in their origin are closely connected with the development of the platform.

The literature on the geology of the Russian platform is immense, but there are very few works dealing with the subject as a whole. As such we have to mention here, in the first place, a series of small but exceedingly important papers by A. P. Karpinsky, which have laid a foundation to all our knowledge of this problem and have entirely retained their significance up to the present day [1]). A summarizing paper by M. M. Tétiaeff [2]) is well known in the West of Europe, but his views are not adopted by Russian geologists. A series of summarizing papers have been published recently by the present writer [3]); the papers referred to have been used by S. Bubnoff for the compilation of an outline of the geology of the Russian platform, in German [4]). At last, mention should made of the brief articles by D. N. Sobolev [5]) in which the geologic structure of the Russian platform is considered from a quite particular point of view which is not adopted by other students of the problem.

We shall not dwell here on the works dealing with more special problems. As for the geologic maps of the European part of USSR, the map on the scale of 1:6.300.000 published by the Geological Committee in 1926, should be regarded as the best one.

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[1]) Earlier papers by A. P. Karpinsky (1883—1894) relating to the tectonics and the history of the Russian platform have been republished lately in a book entitled „Outlines of the geologic past of Russia in Europe" (Petrograd, 1919). His latest views are given in the paper „On the tectonics of Russia in Europe", published in 1920 (Bulletin de l'Académie des Sciences).

[2]) M. Tétiaeff. Des grandes lignes de la géologie et de la tectonique des terrains primaires de la Russie d'Europe. Annales de la Société géologique de Belgique. T. XXXIX. 1912.

[3]) A. D. Arkhanghelsky: a) An introduction to the geology of Russia in Europe. I. Tectonics and history of the Russian platform. Moscow. 1923; b) On the relations between the gravity anomalies, magnetic anomalies and the geology in East Europe. Mem. of the Committee for the study of the Kursk magnetic anomaly. V. Moscow. 1924; c) An outline of the geology of Russia in Europe. Vol. I and II, Leningrad. 1922 and 1926.

[4]) S. von Bubnoff. Geologie von Europa. Erster Band. Berlin. 1926.

[5]) D. H. Sobolev: a) On the tectonics of Europe. Bul. Polytechn. Inst. Warsaw. III. 1912; b) Glacial formation of the North Europe and a geomophological subdivision of the Russian plain. Bull. Russ. Geolog. Soc. N. 56; c) On the architecture of the crystalline basement of Scando-Russia. Bull. Soc. Natur. Moscou. Section géologique. IV. 1926.

II

The foundation under all the sedimentaries of the platform is composed of the strongly metamorphosed and dislocated Pre-Cambrian rocks which are everywhere separated from the overlying rocks by an unconformity. This Pre-Cambrian foundation of the platform is exposed but at few places. The largest areas are occupied by the exposures of the Pre-Cambrian on the North-west of the region here considered, where they form the huge Baltic or Fenno-Scandian crystalline shield which is usually considered as separate from the Russian platform, though, as a matter of fact, it presents but a part of the latter, being distinguished from the rest of the platform by the abnormally high position of the Pre-Cambrian rocks. The second vast area of the Pre-Cambrian exposures, known as the Asov-Podolian crystalline block is situated near the South-Western margin of the platform. The attitude of the Pre-Cambrian rocks is there materially different from that of Fenno-Scandian: within the latter the crystalline basement is raised for many hundreds of meters, locally even for more than 1000 m above sea level, while in the region of the Asov-Podolian mass the maximum height of exposed crystalline rocks does not exceed 260—280 m above sea level; in accordance with this the Pre-Cambrian rocks of the North-west are either directly exposed on the surface or separated from it only by the Quarternary deposits, while in the South-west they are mostly covered with the Tertiary rocks and do not crop out save in river valleys. The Asov-Podolian crystalline is thus largely hidden under the cover of the normal sedimentaries. The third large exposure of the Pre-Cambrian basement known as the Voronez block, is overlain by the younger sedimentaries for almost the whole of its extent, the outcrops of the Archean igneous rocks being accordingly confined to the deep valley of the Don river between the towns of Pavlovsk and Boguchar; they lie there at about 80 m above sea-level. The subsurface continuation of these exposures may be traced far toward the WNW, up to the towns of Schigri and Fatej by means of the magnetic anomalies which are associated with the magnetite quartzites. Within such a stripe the Pre-Cambrian rocks have been reached at many points by drill holes at the height of about 60 m above sea-level.

It is commonly believed that both the Baltic and Asov-Podolian crystalline blocks are cut on their margins by the faults

passing near the boundary of the area occupied by the exposures of the Pre-Cambrian rocks. Such belief is not, however, sufficiently corroborated by facts, and on the contrary, there are many reasons to think that the crystalline shields concerned have, under the burden of the sedimentaries, gentle subsurface slopes, a certain kind of shelves. Such slopes bind up the Baltic crystalline mass with the Azov-Podolian one as well as with the Voronej block at a relatively shallow depth.

Along the Southern boundary of the Fenno-Scandian shield the tectonic maps commonly show a zone of faults with which, *inter alias*, the formation of the Finland gulf is believed to be associated. The presence of such faults is scarcely substantiated by facts, but if they even existed, they should have been formed in a comparatively recent past and they could not essentially affect that original gentle slope of the surface of the Archean rocks southward, such a slope having been established as far back as the time of the Lower Cambrian transgression. The existence of such a slope is suggested by the drill holes which have reached the Pre-Cambrian rocks in Leningrad and at Reval, as well as by the general arrangement of the sedimentaries South of the Finland gulf, where they very gently dip toward the South and Southeast: the whole vast area occupied by the Devonian South of the Finland gulf lies on the Southern subsurface slope of the Baltic shield. The Eastern subsurface slope of the latter may occupy the whole space between the White Sea, Onega and Ladoga lakes on the one side and the Timan range on the other. This slope should be somewhat more isolated from the Baltic shield by subsequent ruptures than the Southern one. First, we have to acknowledge the existence of a zone of the recent graben-like subsidences within the area of the deep lacustrine basins just mentioned, for their origin can not be accounted for otherwise than by the tectonic factors; secondly, the subsidences suffered by the area here discussed in the Late Paleozoic and Mesozoic time induce us to presume the existence of earlier faulting. In fact the Late Paleozoic movements very materially changed the original nature of the Eastern slope of the Baltic shield: after them the region concerned became a wide and gently sloping synclinal downwarp, which presents a Northward prolongation of the Moscow and Eastern Russian depressions of the Pre-Cambrian foundation.

In the history of the Russian platform the Baltic shield with its two subsurface slopes acts very often as a unit, for which we have offered the name of the Baltic-White-Sea crystalline

mass; the Asov-Podolian and Voronej crystalline blocks are but offshoots of that huge Pre-Cambrian shield.

The junction of the Asov-Podolian block to the Southern slope of the Baltic shield takes place within Polessie, on the meridian of Sluck and Minsk. There, on the direct Northward prolongation of the Asov-Podolian mass the wells encounter the Devonian at a height of 20 to 140 m above sea-level, while the Paleozoic rocks lie at an indefinitely greater depth both West and East from there, in Poland and in the region of the South Russian depression respectively.

The uplifts of the Paleologic rocks in the structure of Polessie are commonly referred to as the subsurface bank of Polessie, but as we use the term of bank to designate quite different genetic units it would be more correct to use the term of the Polessie bridge, as proposed by Sobolev, to the underground continuation of the Asov-Podolian mass binding it up with the Southern slope of the Baltic shield.

The bridge linking up the Voronej block with the subterranean slope of the Baltic-White-Sea shield should lie underground somewhere within the region drained by the upper courses of the Desna, Oka, and Dniepr rivers, but its position can not be exactly fixed so far. The Voronej block is separated from the Azov-Podolian one by the deep South Russian depression. The boundaries of the Voronej uplift are not yet accurately known; as for the Asov-Podolian one it is shown by a number of facts that it likewise possesses gentle underground slopes of which the Southern one is especially well developed; in the region of the latter slope the wells reached the granito-gneissic foundation at a great distance from the Pre-Cambrian outcrops. The faults that outline the Azov-Podolian block should be therefore transferred for a considerable distance towards the adjacent depressions as compared with the position assigned to them on the tectonic maps prepared by Laskarev, Karpinsky and Archanghelsky.

Besides the above named three Pre-Cambrian masses which have been detected by direct observations we have to assume the presence, within the body of the Russian platform, of a series of other uplifts of the Pre-Cambrian foundation which are entirely hidden under the sedimentaries and are totally subterranean. The presence of such blocks may be suggested by their influence on the tectonics of the adjacent mountainous structures.

One of such horsts may be presumed to exist in the North-Eastern extremity of the area under consideration, in the region

of the Bolshezemelskaia tundra. Its existence is suggested by the abrupt arch-like bent of the arctic part of the Ural and of its branch the Tschernyschev range. The outcrops of the sericitic slates between the mouth of Pechora and Northern extremity of the Ural as well as at the so called Pytkov-Kamen are generally looked upon as the outer traces of the uplift referred to; this problem, however, requires a further thorough study. Should a Pre-Cambrian mass really exist within the Bolshezemelskaia tundra it may be considered as a part of the Baltic-White-Sea shield, separated from the latter by Timan that presents a Caledonian or possibly even more ancient branch of the Ural[1]). In the past few years the writer became inclined to accept the idea of the existence of the two underground uplifts of the Pre-Cambrian foundation which, as it will be explained below, has been once in connection with the Azov-Podolian block. One of such uplifts must be located in the region of the plateau of Stavropol, North of the middle part of the Caucasus range.

This Stavropol subsurface crystalline block to which the Caledonian folds of the Caucasus have been soldered from the South, is responsible for the absence of folding and thrusting disturbances of the Mesozoic and Tertiary rock in the middle parts of the Northern slope of the main Caucasus range. The other, by far the greater subsurface crystalline block, lies by all probability under the horizontal strata of Ustjurt and Northern Karakum, thus forming the extreme South-Eastern promontory of the platform. Its presence accounts for that peculiar cirumfluence of folds around different mountain systems of the Ustjurt-Karakum region which we shall discuss further.

The last subsurface crystalline block of the platform, lying in no open connection with the others is believed by K a r p i n s k y to lie under the, so called, Ufa plateau opposite to the boundary of the Southern and middle parts of the Ural. The abrupt bending of the range at that place, attended by considerable complications in its tectonics is believed to be due to the influence of that block.

The portions of the platform situated beyond the previously described Pre-Cambrian uplifts are characterized by much greater depth of the crystalline foundation and are therefore designated as depressions.

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[1]) The Timan range seemingly sustained byt comparatively insignificant posthumous movements in the Late Paleozoici, at the moment of the formation of the modern Ural.

Three main depressions may be distinguished: the Black Sea, the South Russian and the East Russian depressions; the last named depression may be inturn divided in to several portions. The East Russian depression, in the broad sense, designates the region bordered by the Baltic-White-Sea shield and the subsurface Voronej block in the North, North-West and West and by the Ural mountains and Ustjurt in the East; in the South the depression inperceptibly passes into the depression occupied by the Caspian Sea. The Northern boundary of the depression is not suggested by the modern geologic map, and is clearly disclosed only by the study of the Early Paleozoic and Early Carboniferous history of the platform. This is accounted for by the existence of that synclinal downfold in the Eastern slope of the Baltic shield which was formed in the Middle Carboniferous epoch. The North-Western portion of the depression projecting like a deep and wide bay between the Eastern slope of the Baltic shield and the Voronej block is known as the Moscow depression or basin The Moscow basin is separated from the rest of the depression (which may be called the East Russian depression in the strict sense) by a gently sloping anticlinal uplift of the Upper Palezoic known as the Oka-Tzna bank.

The Eastern portion of the East Russian depression may be in turn divided in a longitudinal direction into two areas, which differ from each other, first of all, in the altitude of the Paleozoic rocks which is dependent on the greater or lesser depth of the crystalline foundation. In the Northern, the Volga-Kama portion of the Paleozoic rocks, and particularly the Permian, are lying high above the sea level and are exposed over enormous spaces; the Pre-Cambrian foundation lies accordingly at a comparatively shallow depth. In the Southern, Caspian portion the Paleozoic outcrops rather rarely, it is found where more or less pronounced recent tectonic disturbances are present; normally the surface of the Paleozoic lies at a very great depth, much below the sea-level, under a thick cover of the Mesozoic, Tertiary and Post-Tertiary rocks. The surface of the granitogneissic foundation lies here deeper than in any other part of the platform. The other equally essential difference of the two portions just outlined consists in the different intensity and different nature of the dislocations observed in each of them, as it will be shown further.

The second of the main depressions of the Russian platform, the South Russian one, is located between the Azov-Podolian and Voronej crystalline mass and the Polessie bridge; on the

East it communicates with the Eastern Russian depression. It is asymmetrical in structure, for the axial line corresponding to the maximum depth of the old rocks passes very close to the Southern boundary. The Donetz range is included into the Southeastern part of the depression; it is plunging both Westward and Eastward under the cover of the Tertiary rocks receding to an unknown depth.

Finally, we designate as the Black-Sea depression an area of the recent subsidences bordered by the Azov-Podolian mass and the Donetz basin in the North, the Stavropol block in the East, the Carpathian mountains in the West and the West Caucasus, Crimean and Dobrudja ranges in the South.

The above mentioned main structural elements of the platform, the uplifts of the Pre-Cambrian rocks and the depression, differ from each other not only in the depth of the crystalline basement; the varying completeness of the sedimentary series is an almost equally characteristic feature of each of these elements. The sedimentaries either are completely absent on the positive, elevated features of the relief of the Pre-Cambrian rocks, or else they present a very incomplete series, with considerable breaks, not infrequently belonging to the continental facies. In the negative features, depressions, the series of sediments is much more complete, thicker, and consists predominantly of marine deposits. These peculiarities are easily seen on the accompanying diagrammatic sections: like the paleogeographic maps given below, they show that the relief of the Pre-Cambrian basement was formed very long ago, and its depressions have been long the low features, into which the sea penetrated sooner, than into the area of uplifts. Moreover, in some cases nothing but the slow subsidence of the bottom of depressions can account for the considerable thickness of sediments. The third peculiarity of the depression consists in the existence of more or less distinct Post-Eozoic folding which has not been authentically recorded on the areas of the Pre-Cambrian foundation. Before discussing these dislocations it should be emphasized that the investigations of the last few years induce us to change materially the views concerning the nature of the tectonic dislocations in the sedimentary rocks covering the slopes of the Baltic shield, though such views may seem to be securely established. It has been long since considered to be proved that the Paleozoic forms gently dipping folds at the town of Ravanici on the Polesie bridge as well as between the towns of Vysni-Volocek and Starica, and that consequently the Cambrian and Silurian rocks are exposed here,

which but for the presence of the dislocations should have been lying at great depth. These circumstances were being taken into account in all interpretations concerning the structure of the Russian platform. It has been recently demonstrated by drilling wells, that the outcrops of the older rocks between Visny Volocek and Starica present but morainal accumulations, while Prof. Mircink assumes that such is the origin of the Cambrian exposure at Ravanici too. In accordance with this it seems highly probable that the appearance of the Cambrian and Silurian on the Lovat river is likewise connected in some way or other by the glacial activity. If that be so there are no valid reasons for believing that the Paleozoic has undergone any folding in any part of the Southern slope of the Baltic shield. On the Eastern slope of the latter, folding of the Devonian and Carboniferous has been recorded on the shore of the lake Onega, Severnaia-Dvina rivers and on other rivers, but the observations of Tolstihin make it probable that most of such deformations are not of a tectonic nature; the only unquestionable folds seem to be those observed near the lake Onega, the origin of these folds may be associated with the faults that exist there. No Post-Eozoic folding is known to exist in the region of the Voronej and Stavropol blocks, while in the region of the Azov-Podolian shield they are present but on its periphery, at the boundaries separating it from the adjacent depressions (the region of Kaniov in the East and the region of Pelci in the West).

It is quite otherwise with the depressions where the sedimentary rocks have been subjected to complex and intense deformations at many places.

No dislocations are known to exist in the Moscow basin, but East of it, within the East Russian depression in a strict sense they occur very frequently. On the Northern, Volga-Kama area the deformations either present very long, but gently dipping and wide anticlinal and synclinal folds referred to in the Russian literature as banks and syneclises, or else are of the nature of very wide and gently dipping domes with minor and by far more sharp subsidiary domes, flexures and faults; the latter are in some cases of very great slip. We shall not dwell on the details and shall only mention the main uplifts.

Running along the Western boundary of the East Russian depression and separating it from the Moscow basin is the Oka-Tzna bank made up of the Carboniferous and Permian. On the North it is traced rather easily up the dip of the Permian rocks o the Volga between Kineshma and Kostroma, but its conti-

nuation in that direction is hitherto unknown. On the South the bank bends Eastward and being divided into separate uplifts is also traced up to the Volga in the district of Saratov. East of the Oka-Tzna bank there lies a considerable synclinal downwarp of the strata, of the Ulianovsk-Saratov syneclise which is traced from the latitude of Saratov in the South up to Vycegda in the North. North of the Volga the position of the syneclise is marked by the arenaceo-conglomeratic rocks which at present are usually looked upon as the Triassic continental deposits; toward the South these rocks are substituted, in the axial part, by the Jurassic, Cretaceous and finally Tertiary sediments up to and inclusive of the Oligocene. Both flanks of the synclise between the latitudes of Saratov and Kazan are complicated by minor deformations (faults, flexures, anticlines) little known thus far.

East of the Ulianovsk-Saratov syneclise there trends another stripe of the uplifts divided into several individual units. The Northern member of this stripe is the complex of uplifts of Viatka shown on the geologic map as a long longitudinal band of the rocks of the Kazan stage of the Permian, bordered on either side by younger continental sediments of the Tatar stage. The structure of the uplifts is rather intricate for the strata are here involved into several gently dipping minor anticlines and synclines. The second band of uplifts, the so called Permian axis of Zavolzie (region East of the Volga) begins Southeast of the Southern extremity of the Viatka uplifts near the mouth of the Iz river on the Kama; it is traced in a Southwestern direction up to the Bolshoi Irgiz river at the town of Pugachevsk. According Prof. Noinsky the Carboniferous limestones are raised at the mouth of the Iz, about as high as the level of the Kama river, while at a short distance West of the town of Elabuga the Permian rocks are involved into an anticline. A vast gently sloping dome-like uplift of the strata with some minor domes is situated in the region of upper courses of the Sok and Ceremsan rivers: the Carboniferous appears at many places in these domes; on the periphery the uplift is at places outlined by rather steep flexures and possibly, faults. The third uplift of the band under discussion is situated in the region of the arch of Samara (the Samara peninsula) and in the parts of Zavolzie adjacent to it from the South; the uplift is cut across by several faults and flexures of which the fault of Jeguli is the most important: it caused the abrupt curvature of the Volga at the arch of Samara. In the Southern flanc of the fault the Carboniferous is raised up to 200 m above the level of the Volga.

The last member of the uplifts of the Permian axis of Zavoljie is, according to the data of A. N. Rozanov, the uplift of the strata on the Bolshoi Irgiz where the Carboniferous is again exposed.

The study of the Southern portion of the East Russian depression is materially impeded by the fact that its middle port is an area of very recent subsidences and is consequently covered with flat lying sediments of the Quarternary transgressions of the Caspian Sea. The ancient rocks there outcrop at very few points, and it is therefore no easy task to decipher their tectonics; while on the peripheral parts of the portion the attitude of the strata is traced very distinctly. West of the Volga there is extending a band of the sharply marked uplifts in which the Lower Cretaceous, Jurassic and Carboniferous rocks are brought up to the surface amid the Paleogene rocks. Contrary to what is observed in the Northern portion, the flancs of anticlines show here at places steep dips, the angle of the dip amounting to tens of degrees. At isolated exposures of the ancient rocks in the inner portions of the Caspian depression the beds are always intricately and intensely deformed. The area to the East of the Ural river is characterized by numerous brachyanticlinal folds which are frequently diapiric and very strongly faulted. These anticlines are arranged in rows extending generally in a nearly longitudinal direction; the synclinal troughs, that separate them also show numerous faults. The peculiar nature of the deformations on the area here discussed is largely accounted for by the presence of the thick salt deposits in the Permian. The same type of short and sharp brachyanticlinal elevations is observed North of the Caspian plain, in the region of Obsci Syrt.

The most remarkable structural unit of the South Russian depression is the Donec range composed mainly of huge (up to 10.000 m thick) formations of the Carboniferous. The main element of the rather intricate geologic structure of the Donec basin is the so called „chief anticline" trending toward the West-North-West across the whole range. One long anticline trends to the South, the other one to the North of the chief anticline. The synclines separating these anticlinal uplifts are divided into two troughs each due to the bending of their axes. A multitude of brachyanticlinal elevations trending in the general direction of the Donec basin are situated along the Northern border of the basin. Furthermore, a very important rôle is played here by strike faults and partly dip faults and horizontal faults which at places may be traced to great distances. Toward the South

Russian depression the Cretaceous descends at places in form of steep flexures. Near the Southern boundary of the basin there is likewise a complex network of faults and horizontal faults; rather numerous outcrops of the igneous rocks seem to be associated with these deformations. Beside the Paleolozic, the Mesozoic rocks inclusive of the Upper Cretaceous have been affected by the diastrophism in the Donec basin. The first and main mountain-making phase seems to have taken place in the Permian period. Further the mountain-making movements between the Crataceous and Tertiary period are likewise marked quite distinctly; while the remaining moments of the diastrophism can not be spoken of with certainty thus far.

Besides, the Donec basin folding is not known out at the boundary of the South Russian depression and the Azov-Podolian mass on the right bank of the Dniepr river in the neighbourhoods of the town of Kaniov. The nature of these deformations is so far very obscure; some geologists believe their origin to be due to the activity of the glacier, which is hardly correct. The exposures of the igneous rocks (diabases) that exist in the inner past of the depression at the village of Isacki and at the North-Western angle of the Donec basin are very noteworthy. It may be believed that the existence of such rocks as well as of the igneous rocks on the Southern margin of the Donec basin is connected with the two main fracture lines that have been lately pointed out by Prof. Chervinsky in the region of the Azov-Podolian crystalline mass. Within the latter numerous outcrops of the eruptives of the Post-Eozoic age are likewise known between those lines. As for the Black Sea depression, two kinds of the deformations are known there. On its Northern margin there exist flexurelike subsidences stated by Laskarev at the village of Pelca on the Western border of the Azov-Podolian mass, as well as the faults which are indicated by the rapid descension of the Carboniferous to a great depth on the South-Eastern boundary of the Donec basin. The faults seem likewise to exist within the depression itself on the island of Berazan and in the steppe region of the Crimea. The diastrophism of a different nature is observed on the peninsula of Tarchankut, where the Tertiary rocks are involved into gently sloping folds trending in a latitudinal and West-South-West direction.

In completing this outline of the tectonics we have to consider the structure of the mountain ranges bordering the Russian platform. We shall not deal with the Ural and the Timan which are not to be crossed by the routes of the Congress excursion. In con-

nection with what has been said above we have to dwell but on the question concerning the Southward prolongation of the Ural for with this, the problem of the Southeastern boundary of the Russian platform is associated. The study of the tectonics of the area adjacent to the Northern and Southern shores of the Aral sea as well as of the remnants of the mountain chains in the desert of Kyzyl-Kum, has made it highly probable that the Ural extends in the longitudinal direction across the region of the modern Aral Sea and deltas of the Amu-Daria into Kyzyl-Kum where it joins the Northwestern branches of the Tian-Shan that are now buried under the Cretaceous rocks. The whole history of the mountainous Turkestan on the one hand, and of the areas adjacent to the Eastern coast of the Caspian, on the other, shows clearly that the Ural-Tian-Shan geosyncline and, subsequently, the Ural-Tian-Shan, mountain system was trending to the East of Ustjurt.

The investigations of recent years tend to show that the Main Caucasus range has a very peculiar and remarkable structure. In the middle part of the Northern slope, South of the Stavropol subsurface crystalline block, the Mesozoic and Tertiary rocks are very feebly disturbed. They are but raised as a whole in connection with the general rise of the range, and dip to the North at an angle of $5^\circ - 10^\circ$. There are here neither folds nor faults, and intense deformations are observed but on the margins of the laccolites which are very characteristic for the area. Underlying the Jurassic rocks are the thick series of the Silurian and Cambrian sediments which are very strongly and very intricately deformed and penetrated by different igneous rocks; the diastrophism suffered by such rocks refers to the Caledonian time. In the Eastern part of the Northern slope the attitude of the Mesozoic and Tertiary rocks changes abruptly, and they form there numerous folds; but the most peculiar and characteristic feature of the tectonics of the area consists in the presence of numerous fractures along which masses are chifled horizontally to considerable distances. The planes of such fractures gently slope Northward cutting the stratification planes of the rocks at comparatively small angles, thus producing a most curious system of thrusts in which the younger beds are shoved upon the older ones. The accompanying diagrammatic section gives a sufficiently clear idea of the phenomenon.

In the Western part of the range the Mesozoic and Tertiary rocks of the Northern slope are likewise thrown into folds; the geology of that portion has not yet been sufficiently studied for

the solution of the question whether or not there are any phenomena of the type of thrusts.

The structure of the Southern slope of the Main Caucasus range essentially differs from the structure described above. The displacements of the masses in a Southward direction led there to the formation of the folds overturned and thrusted Southward, in which the older rocks are driven upon the younger ones. Both in the East, near the Caspian sea and in the West, near the Black Sea the Main Range is dying out. A noteworthy feature of its Eastern extremity consists in the deflexion of the fold trends to the Southeast.

The low space along the valleys of the Rion and Kura river filled up mainly by the feebly deformed Tertiary strata separate the Main Range from the Little Caucasus and the Armenian plateau.

The tectonics of the last named area are characterized by an unusual abundance of the young igneous rocks and are little known so far; it is therefore difficult to determine there the direction of the movement of masses during the epoch of the last mountain-building movements. Fold soverturned and thrusted Northward have been cited for the Western portion of the area, while in the Eastern one they seem to be thrusted to the East, just as in the Main Caucasus range. In this brief outline we can not enter into any details as to the relations of the Caucasus to the mountain structures that are located East of the Caspian Sea (Kopet-Dag, Bolshoi Balchan, Malyi Balchan, Kara-Tau, etc). It should, however, be noted that in this respect, our views very essentially differ from the dominant ideas. Taking into consideration the arrangement and age of the mountain ranges just mentioned we believe that on the meridian of the Western extremity of Kopet-Dag there is a ramification of folds which in many respects resembles the branching of the mountain arcs farther Eastward, in Bukhara. The folds of Kopet-Dag at the Western extremity of the latter wind abruptly to SW and die out; this Southwestward direction of the folding continues in the Elbruz system, which, forming an enormous arc which embraces the Southern coast of the Caspian Sea, finds its prolongation in the system of Southeastward trending folds which are very characteristic for Eastern Transcaucasia. The Western extremity of Kopet-Dag and Elburz form the Southern branch of the ramified system. The Northern branch consists of the Tuar-Kyr range, situated on the Southeastern coast of the Karabugaz bay, and of the mountains of the Mangyslak peninsula, which are, no doubt,

associated with Tuar-Kyr. Al last, on the Asiatic side of the region under consideration there is outlined a middle branch represented by the mountains of Bolshoi Balhan and Kuba-Dag on the Krasnovodsk peninsula. The Eastern extremity of the Main Caucasus Range is a visible continuation of the last named branch to the West of the Caspian; this problem, however, needs a further thorough study for the folds of the Cretaceous and Tertiary beds have a sharply marked Nothwestward trend North of the Apseron peninsula on the Caspian Sea coast. We will still have to deal with the origin of the previously described phenomena at the end of the present paper.

As to the structure of the Taurida mountains that form the Southern part of the Crimean peninsula, it is so far hardly possible to give a quite definite plan of their architecture. The core of the mountains that is cut up in the South by the Black Sea is composed of very intensely deformed masses of the clay shales relating to the Triassic, Lias and Dogger and, in part, the Malm. These are often overlain, with a sharply marked tectonic unconformity, by the limestones of the Upper Jurassic and the Lower Cretaceous rocks that form a series of folds; the direction of the movement suffered by the latter folds has not been yet ascertained. The Northern slope of the mountains is made up of the Upper Cretaceous and Tertiary rocks which dip gently Northward. A characteristic trait of the architecture of the Crimean mountains consists in the existence of numerous dip faults and horizontal faults in which the rocks suffered considerable displacement both horizontally and vertically. As to the possible Western continuation of the Crimean mountains, we still hold, despite the reasoning promoted by W i l s e r, that the mountains of Dobrudja are associated with the Crimean range.

III

In the brief space of this outline we are not in a position to treat even in a most succinct manner the stratigraphy of the rocks composing the Russian platform and will only try to give a short sketch of its development in connection with the development of the surrounding mountain ranges.

There is a sufficient amount of facts to judge the history of this country in the Pre-Cambrian time. The attitude of the Iotnian sandstones and granites-rapakivi in the Baltic shield as well as of the simultaneously formed Ovrue sandstones and

rapakivi of the Azov-Podolian block show that the mountain-making movement, which produced complex architecture and metamorphism of our Pre-Cambrian, were completed as early as in the Eozoic era. The problem concerning the direction of the mountain chains formed in the last Pre-Cambrian period of folding presents much interest, and it has been possibly solved to a certain degree. A. Karpinsky, Member of the Academy, expressed once the assumption that the Pre-Cambrian folds had formed within the Russian platform a system of huge arcs with their convex sides turned to the East. Kuzinar has arrived lately at the conclusion that the Eozoic mountain-making movements resulted in the formation of the Scythian mountain system whose folds having made two „bends", were running conformably to the trend of the Kalevian and Iatulian rocks of the Baltic shield, Polessie subsurface bridge and Azov-Podolian block. The study of the trends of the youngest Pre-Cambrian sedimentaries of the Azov-Podolian and Voronej blocks and of the magnetic and gravity anomalies leads me to the conclusion that the Northwestern trend was predominant one for the Eozoic folding throughout the Russian platform. There are no data to support the views held by Karpinsky, and Kuzniar. In the Jotnian time all these folds were levelled by denudation and by the coming in of the Lower-Cambrian transgression the country had presented a peneplain.

There are so far but very few facts at our disposal concerning the history of the Cambrian period. The Lower Cambrian sediments have been long since known on the Southern coats of the gulf of Finland and the lake Ladoga, while the Upper Cambrian have been recently detected on the North Caucasus. according to A. P. Gerasimov. The Cambrian has not yet been found on the Ural mountains, but its existence within the Kirgiz folded area and in Tian-Shan makes it highly probable that the Cambrian will be discovered in the middle stripe of the Ural; there is at least, space enough for it in the thick series of crystalline schists. Anyhow, such facts make it impossible to believe, as Arldt does, that the major part of the Russian platform together with the Ural, the Caucasus, the Kirgiz folded area and Tian-Shan presented a land throughout the Cambrian period. It seems more probable to me that in the Lower-Cambrian the sea was covering not only the Southern slope of the Baltic shield, but likewise the middle stripe of the platform together with the Ural and the Caucasus. In the Middle Cambrian a regression, no doubt, took place, and the platform might have been raised, as a whole, above sea-level.

There are many more facts at our disposal for the Silurian period, than for the Cambrian. We have a very complete sequence of the Silurian deposits on the Southern slope of the Baltic shield. Moreover, the Lower Silurian is known in the Bolshezemelskaia tundra and in the Northern Ural, while the Upper Silurian exists in the Northern Timan, in almost all parts of the Ural, on the Caucasus and on the Southwestern margin of the Azov-Podolian block; the Lower Silurian may exist in all the cited

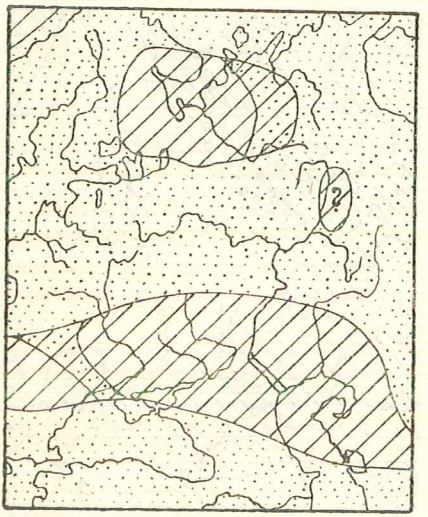

Fig. 1. The Silurian period. Dots and straight lines the Upper Silurian transgression.

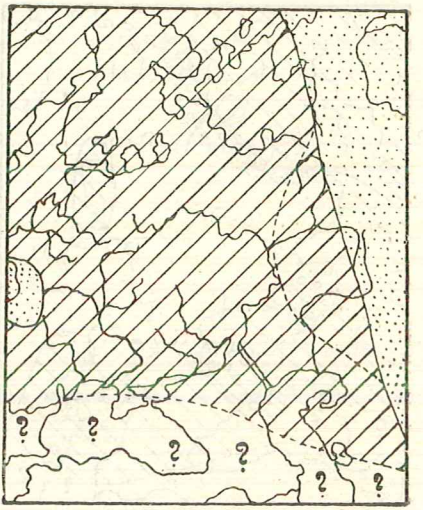

Fig. 2. The Early Devonian epoch. Dots the boundary of the sea during the second half of the Middle Devonian.

places save Timan. The Silurian is known to be absent on the Western slope of the Baltic shield; in the region of the Voronej block as well as on the Northern and Western margins of the Azov-Podolian block, According to such data the geography of the Lower Silurian may be reconstructed as is given in fig. 1. This map distinctly shows, besides the Caleodonian, Crimea-Caucasus and the Ural geosynclines, also the main structural elements of the Russian platform: the Baltic-White-Sea crystalline block in the North and the South Russian block in the South. This South Russian land of the Silurian period comprises all the exposed and subsurface crystalline blocks of the Southern part of

the platform, that are still constituing one mass not yet differentiated. Between these two masses there is a downwarp containing the Eastern Russian depression with the Moscow basin and the Southern slope of the Baltic shield. The South Russian depression has not yet come into existence. Judging from Timan, there was a small transgression in the Northeast early in the Upper Silurian, but at the close of the epoch the paleogeography abruptly changes in connection with Caledonian mountain-building pro-

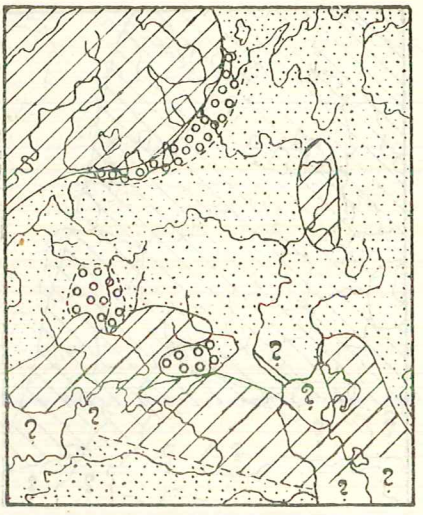

Fig. 3. The beginning of the Late Devonian. Small rings the area covered with the continental deposits.

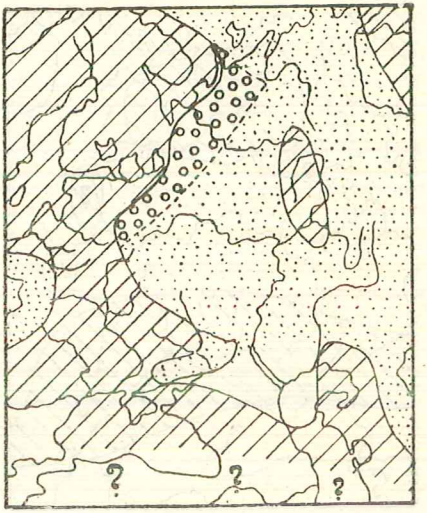

Fig. 4. The close of the Late Devonian.

cesses. Between the Silurian and Devonian have arisen mountain ranges along the North-Western margin of the Baltic shield and in the Crimea-Caucasus region. On the Ural the movements are seemingly less intense and do not embrace the whole geosynaline; but upliifting should have taken place on that area. This is demonstrated by the fact that the marine Middle Devonian uncomfirmably overlie at places the older crystalline schists and at other places the continental sediments of the Devonian age in combination with the extensive development of the vulcanic activity on the Eastern slope. The most intense mountain-building movements took place, to all probability, in the Eastern part of

the geosyncline which is now lying under the West Siberian plain. These movements affected also the platform and were responsible for the uprisings which led to the total retreat of the sea from the platform. On the area of the platform only a part is of red clays and sandstones of the continental type on the slopes of the Baltic shield which may belong to the Lower Devonian.

The transgression of the sea starts again in the Middle Devonian. All the paleogeographical maps of the Middle Devonian

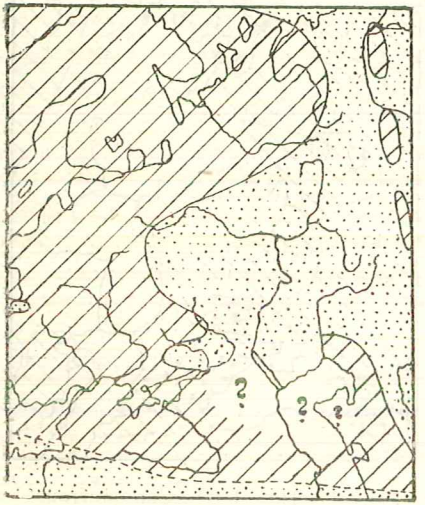

Fig. 5. The beginning of the Carboniferous period.

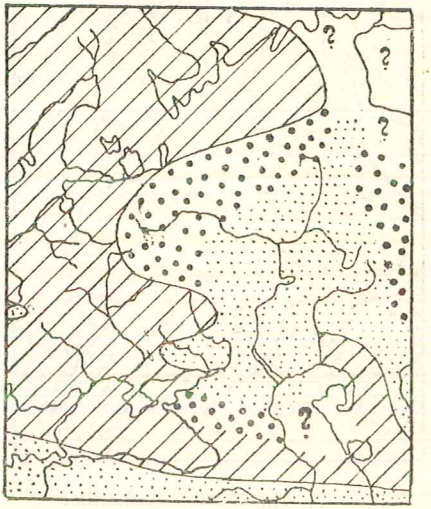

Fig. 6. The Early Carboniferous epoch (the Late Touronean age). Black rings mark the area of the distribution of the coal-bearing sediments.

in existence show a wide extension of the sea within the platform, the only matter in dispute being the position of the Uralian geosyncline early in the Middle Devonian epoch, in the age of Pentamerus baschkiricus. The last few years investigations induce us to materially change this view. During the first half of the Middle Devonian time the sea was confined to the territory of the Ural, and even there the South-Western part of the modern range was land. In the second part of the epoch the sea transgression had come in, which covered the whole of the Ural and extended undoubtedly some way into the East Russian depression; the transgressional sea did not reach, however, the Moscow basin

and Timan where the Devonian is exposed. This phase of the life of the Middle Devonian basin is given, for convenience sake, on the same map which shows the Lower Devonian phase. On the periphery of the Baltic shield as well as on the Northern margin of the Azov-Podolian and Voronej blocks there were being deposited, in the Middle Devonian, the red arenaceo-argillaceous rocks of the type of the old red sandstone, now absolu-

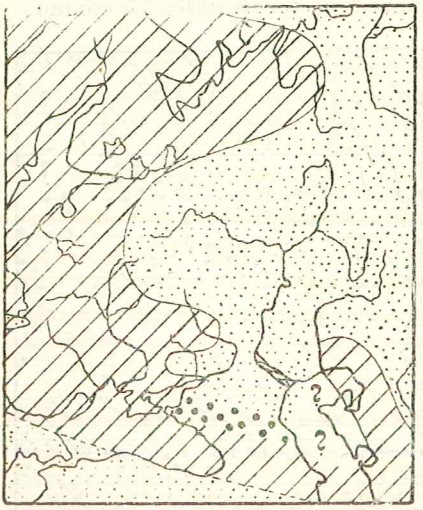

Fig. 7. The Early Carboniferous epoch (the second half of the Visean age).

Fig. 8. The Late Carboniferous epoch.

tely unfossiliferous, and containing an abundance of remains of armoured fishes.

The paleontological study of D. V. Nalivkin are showing that the culminating point of the Devonian transgression was reached early in the Upper Devonian. In that epoch the sea is covering not only Timan and the Moscow basin, but also the Southern slope of the Baltic shield. The red lagoonal and continental deposits continue to settle but in the closest vicinity to the modern outcrops of the crystalline rocks in Finland and Karelia. The sea transgression did not extend into the Caucasus where not the least traces of the Upper Devonian have been found as yet; a still young, high mountain range existed there in that epoch.

The process of the dismembering of the South Russian crystalline shield and of the formation of the South Russian depression sets in along with the Upper Devonian transgression. Fractures arise on the place now occupied by the Donec basin, attended by the outpourings of the magma, and the portion of the crystalline block between such factures sinks down, thus giving rise to a rudiment of the future Donec geosyncline.

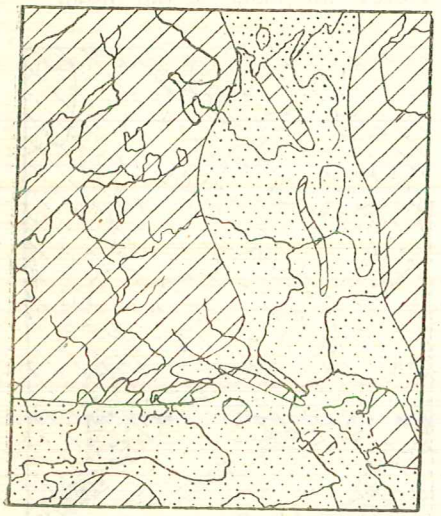

Fig. 9. The Early Permian epoch (the Artinskian age).

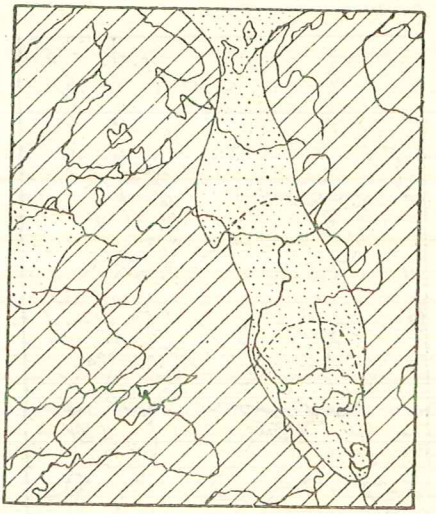

Fig. 10. The Late Permian epoch (the Kazanian age). Dots indicate the successive stages of the contraction of the basin.

The Upper Devonian transgression was of a by far lesser duration, than the Silurian one, and in the second half of the Upper Devonian the sea considerably shrinks in the North-West. The Baltic-White-Sea block rises up, driving the sea to the South-east; this process goes on in the Tournean age, in the beginning of which the sea is already entirely driven out from the Baltic shield slopes; at the close of this age even the Moscow basin becomes a swampy lowland, where the vegetable materials are being accumulated which give rise to the formation of the coal of the Moscow region. The processes of coal formation take also place on the territory of the Main Caucasus Range which by this time changes from a higth mountainous region into a swampy lowland.

In the Visean age the uprise of the platform is interrupted for a short interval and even gives way to very slight subsidences due to which the sea again invades, in the second half of the age, the Moscow basin and the whole Ural, depositing everywhere the limestone beds with Productus giganteus.

Between the close of the Visean and the beginning of the Moscow age there take place, in the Eastern parts of the Ural geosyncline, the first uprises of the Hercynian phase of the moun-

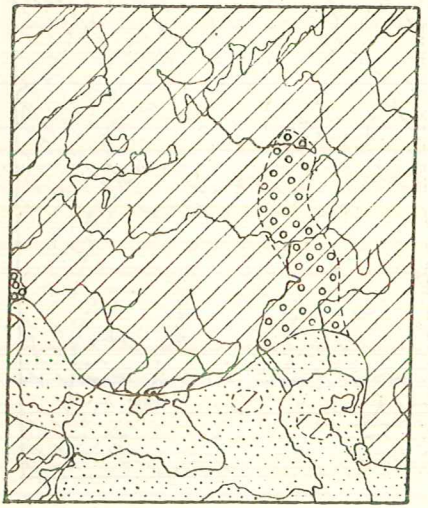

Fig. 11. The Early Triassic epoch. The rings mark the area of the distribution of the continental sediments.

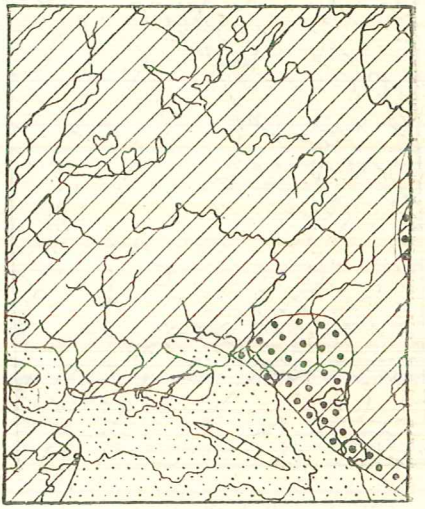

Fig. 12. The Lower Yurassic epoch. The black rings indicate the area of the distribution of the continental mostly coal-bearing deposits.

tain-building movements. These movements give rise to the intrusion of the large masses of granite into the deeply buried portions of the geosyncline and to the intrusions of the breccias and conglemerates at the surface, on the Eastern slope of the range; the last named materials being derived from the fragments of the Lower Carboniferous limestones. The traces of such uplifting may also be seen on the platform, where red clay and sands appear between the formations of the Upper and Lower Carboniferous limestones. Such movements, however, do not prevent the subsidence of the Eastern parts of the platform, and in the Moscow age the transgressional sea extended into Timan and

the Eastern slope of the Baltic shield. Thus the idea suggests itself that simultaneously with the incipient upliftings on the Trans-Ural region downfolding is taking place on the platform, parallel with the Ural. Such downfolding involves not only the East Russian depression, but also the Eastern slope of the Baltic shield which at that time acquires a synclinal downfold. Such situation is preserved during the Upper Carboniferous when the Eastern slope of the Ural is rising as a whole above sea level,

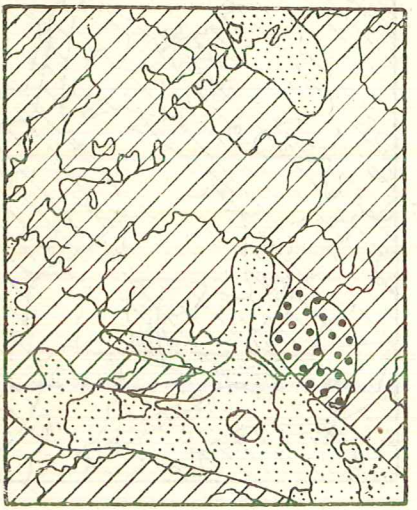

Fig. 13. The Middle Jurassic epoch.

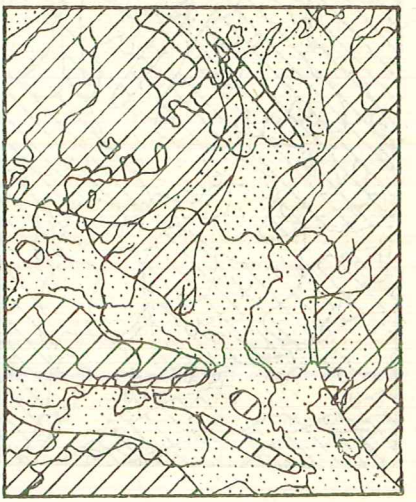

Fig. 14. The Late Jurassic epoch. The dots indicate the distribution of the sea at the Early Callovian age, the dots and straight lines the area invaded by the sea at the Middle Callovian and Oxfordian age.

while on the Western one conglomerates appear at some places pointing to the intense uprises of the middle parts of the range.

Throughout the whole of the Middle and Upper Carboniferous the Donec basin is subjected to subsidences accompanied with accumulation of enormous thicknesses (to 10.000 m) of sandstones and slates. The Caucasus still presents a land area on which the red clays, sandstones and conglomerates begin to accumulate instead of the coal-bearing sediments.

At the beginning of the Early Permian time there takes place the definite formation of the Ural which becomes a young high range

subjected to intense erosion. The products of such erosion form at the foot of the Ural Western slope huge accumulations of conglomerates, sandstones and shales of the Artinskian stage. The mountain-making movements occur somewhat later in the region of the Donec geosynclinal downwarp, and that region is not turned into land until the second half of the Early Permian time. In the body on the platform the orogenetic processes give rise

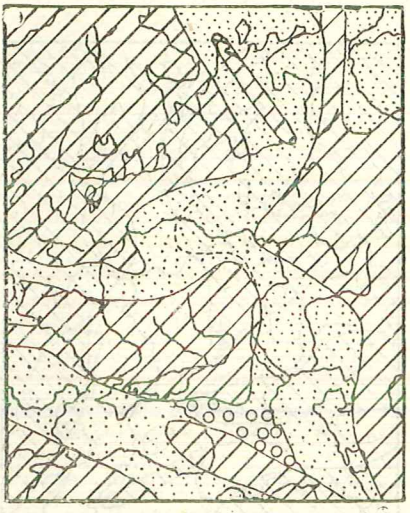

Fig. 15. The upper Jurassic epoch. The first half of the Early Volgian epoch. Rings indicate the distribution of the lagoonal sediments on the Caucasus.

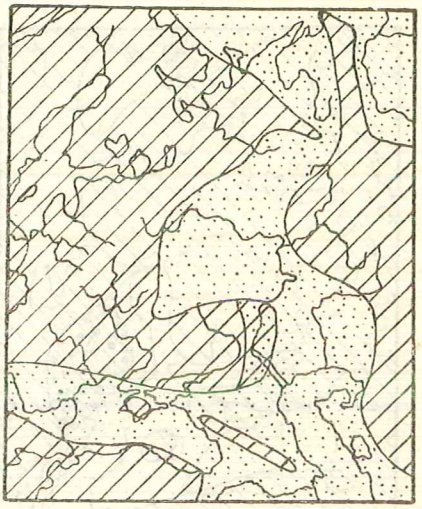

Fig. 16. The Early Cretaceous epoch (the Valanginian and Barremian age).

to an intricate complex of the movements which ultimately lead to the general uprise of the whole its mass and to the total driving out of the sea. Here we see a complete reiteration of the process that took place after the Caledonian folding, and it may be believed that this may be a certain general law governing the movements of the earth's crust: the mountain-building movements within the geosynclines that border a platform are attended by the rising up of the latter, while the deepening of the synclinal downfolds goes on parallel with the sinking of the platform.

The first reaction of the platform to the definite formation of the Ural folds seems to have been the production, in the axial part of the East Russian depression, of a bank parallel to the Ural or of a longitudinal system of uparched structures, which served as the embryos to the subsequent uplifts within the territory of the Viatka uplifts; the upper course of the Sok and Ceremsan rivers, the Samara are probably of a more Southern, now submerged links of this chain. The existense of such uplifts is

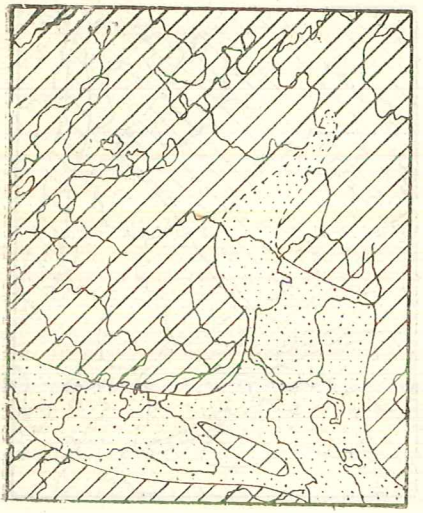

Fig. 17. The Early Cretaceous epoch (the Aptian age).

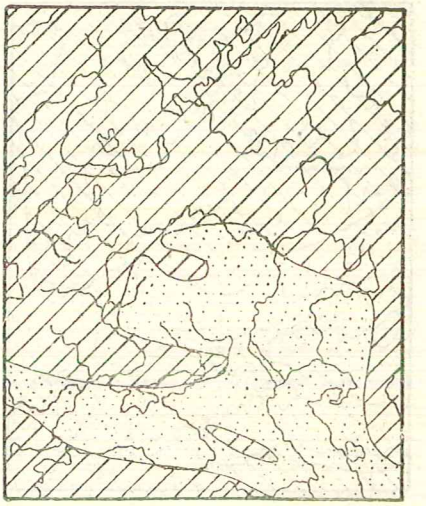

Fig. 18. The Early Cretaceous epoch (the Albian age).

suggested by the following facts: first, the position of the Upper Permian directly overlying the Carboniferous with an unconformity on the area of the upper course of the Sok river; secondly the pronounced faunal difference of the Lower Permian present along the Western slope of the Ural on the one hand and in the Western portions of the East Russian depression on the other. Such differences can not be accounted for otherwise than by a formation of a certain barrier that separated in a measure the eastern band of the depression from the Western one. This was followed by a dismembering of the Lower Permian sea into a number of isolated basins which gradually were losing water by evaporation in conditions of an arid continental climate, and fi-

nally became enormous saline basins in which large quantities of angydrite, gypsum rock, salt and different potassium salts have accumulated. The process of rising culminated in the complete retreat of the sea from the platform; early in the Upper Permian enormous thicknesses of red clays, sandstones and conglomerates of the continental type began to accumulate on the platform.

In the middle of the Late Permian time the Cis-Uralian downwarp, formed in the Middle Carbonaceous epoch, is resto-

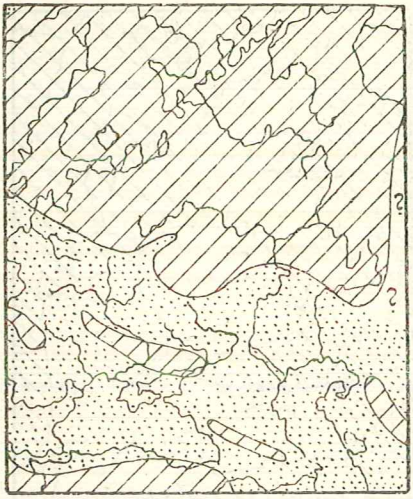

Fig. 19. The Late Cretaceous epoch (the Cenomanian age).

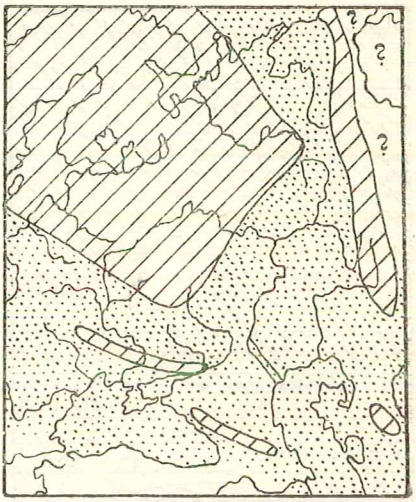

Fig. 20. The Late Cretaceous epoch (the Santomian age).

red for a short time and into it penetrates the sea that deposited the limestones, clays and sandstones of the Kazan stage. This transgression, however, was a short-lived one and in the second half of the Kazan age the sea retreats gradually Southward, into the area of the modern Caspian depression where a vast saline basin arises in which gypsum and salt are depositing. North of this area there are situated lakes in which red and banded clays and marls with fresh water and land fauna are deposited. Thus the process of the Post-Hercynian risings is closed.

The Permian history of the Crimea-Caucasus region exhibits very essential peculiarities. As we have arleady seen, the last named region presented a land area from the time of the Caledonian

mountain-building movements. After the Silurian it was not until the Early Permian that the sea penetrated into that region for a short interval of time; such transgression comes not from the North, from the platform, but from the South, out of the region of Thetys, owing to which the Lower Permian fauna of the Crimea and the Caucasus is sharply distinguished from the Permian fauna of the platform and even of the Ural region. This event inconspicuous as it may seem at the first glance, inaugurates the

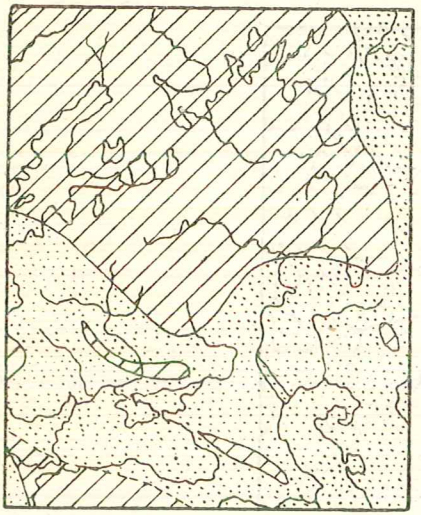

Fig. 21. The Late Cretaceous epoch (the Maestrichtian age).

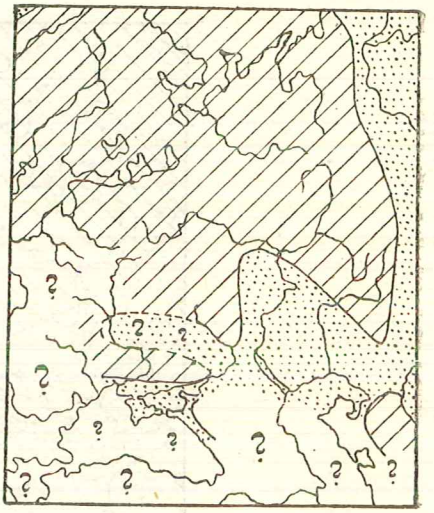

Fig. 22. The Early Tertiary epoch (the Paleocene).

Mesozoic history of the Caucasus and Crimea; the Crimea-Caucasus region is then turned again into an active geosynclinal trough. No Upper Permian is known in the Crimea-Caucasus region; it seems probable that the echo of the Hercynian movements reached then the region, and the sea was driven out. From the Triassic on, the Caucasus and Ural change their roles with each other. The former becomes a geosynclinal trough, and its sinking down is being interrupted many a times by the paroxysms of the mountain-building movements; while the latter goes through a period of senility which is observed on the Caucasus in the Carboniferous.

During the Early Triassic time the Crimea and Caucasus together with Mongyslak are covered with the sea which extends also into the Caspian depression. North of the latter, red clays, sandstones and conglomerates with verterbrate remains are being deposited in the river and lacustrine basins within the Paleozoic Cis-Uralian downfold. At the close of the Triassic the sea abandons the Caspian depression and at the same time intense orogenetic movements take place in the Caucasus, Mangyslak and probably in the Crimea. This Old Cimmerian phase of folding

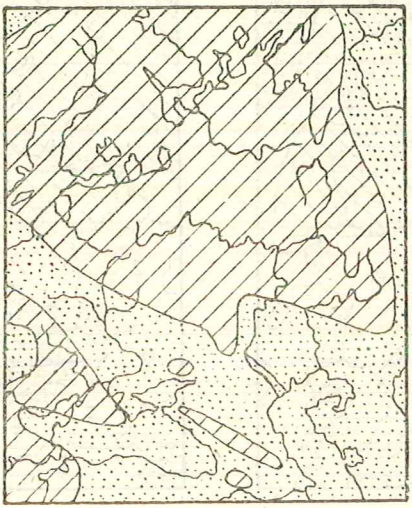

Fig. 23. The Early Tertiary epoch (the Late Eocene, the Early Oligocene).

is of great importance for the explanation of the structural relationships, first of the Crimea-Caucasus region, secondly of Mangyslak and, thirdly, of the East Russian depression.

The contemporaneity as well as the intenseness of the Post-Triassic tectonic movements on the Caucasus and Mangyslak induces us to think that these regions do not present independent tectonic units but are merely parts of one unit, separated from each other by a block, situated within the bottom of the modern Caspian, such block presenting, as it seems, together with the Stavropol block a fragment of the South Russian crystalline shield which existed in the Early Paleozoic. The present arrangement of the folded mountainous structures adjacent to the Southern

part of the Caspian sea, combined with the known facts relating to the tectonic movements of the Old Cimmerian folding phase, lead me to the following hypothesis concerning the structure of the orogen in that region. East of the Caspian, the geosynclinal downfold which was situated on the place now accupied by the present Kopet-Dag was one unit, not subdivided into any portions. Within the modern Caspian there were two rigid blocks, one North of the line connecting the Apseron and Krasnovodsk peninsulas, the other South of it. Such blocks were responsible for the dismembering of the geosynclinal downfold into three branches referred to above. The Northern branch, passing between the North-Caspian mass and Ustjurt through Tuar-Kyr toward Mangyslak, deserves an especial attention. The mountains of Mangyslak are usually believed to be associated with the Donec range; but the lack of the marine Triassic and of a distinctly pronounced unconformity between the continental Triassic and the Liassic in the last named range does not allow us to think that there really existed such a connection in the epoch under piscussion. Considering that the distinct traces of the rising up during the interval, that separated the Upper Permian from the Middle Jurassic are to be found in the banks (anticlines) and domes of the East Russian depression, it may be thought that the Northern branch was extending into that region, gradually dying out and losing the properties of a true geosyncline.

In the Lower Jurassic the sea once more penetrates into the Crimea-Caucasus region and the latter is again turned into a downfolding geosynclinal trench. Quite similarly to what took place in the Paleozoic evolutional epochs, the platform is likewise involved into such downward movements, and within it a great Jurassic transgression is starting; different phases of that transgression are shown on the fig. 12, 13, 14.

The idea of the cyclic alternation of the longitudintal and latitudinal downfolding movements within the Russian platform, dependent on the sinking of the Ural or Caucasus geosyncline is firmly adopted in the geological literature. On the basis of such an idea a latitudinal trend of the Jurassis transgressional sea might be expected. But in reality merely a general sinking of the platform is observed which took place many times before the Jurassic; while the longitudinal downfold of the East Russian depression is again outlined in an especially distinct manner. Similarly to what took place on the Caucasus in the Late Paleozoic, the Eastern slope of the Ural is first transformed, in the Jurassic period, into swampy lowlands, in which brown

coals are being formed, and then it is invaded by the sea in the North. We should note here still another analogy. As we have previously seen, the dismembering of the ancient Southern Russian crystalline mass was associated with the Post-Caledonian transgression. A considerable extension of the area of sinkings between the Azov-Podolian and Voronej blocks leading to the formation of the modern South Russian depression is associated with the Jurassic trangression that followed in time the Old Cimmerain folding.

The area occupied by the sea on the platform is considerably shrinking toward the close of the Jurassic period, in the Early Volgian and especially in the Late Volgian age. The analysis of the material has shown that this retreat is also connected with the mountain-building precesses that occured in the Caucasus and Crimea in the Tithonian time (the Old Cimmerian phase). It is remarkable that such movements likewise caused the uparching of the anticlines (banks) of the Volgian region. With the coming in of the Early Cretaceous the sea covering the platform takes again possession of a part of the area that was abandoned by it incident to the New Cimmerian uplifting; while at the close of the Lower Cretaceous considerable rearrangements of the land and sea areas take place, the sea being concentrated in the Southern half of the platform and adopting a pronounced latitudinal trend. This process is completed in the Cenomanian. In that epoch the longitudinal downfold which has been traced by us on the platform throughout nearly the whole of the geologic history of the latter seems to be completely smoothed. This, however, can not be stated with absolute certainty. For, on the one hand, we know but very little of the Post-Permian history of that part of the East Russian depression that is adjacent to the Ural; the patches of the Santonian found in the extreme North-east, on the Ussa river and near the city of Ufa, make it possible that once older horizons of the Upper Cretaceous had existed there and were subsequently washed away. On the other hand, we have reasons to believe that the Canomanian and Touronian beds exist within the Western Siberian plain into which the East Russian downfold might have been displaced at the close of the Mesozoic. In the Santonian age the longitudinal Cis-Uralian downfold is again outlined with absolute distinctness owing to the patches, previonsly mentioned; its existence in the Maestrichtian is not proved, but it is quite certain that East of Ural the sea extends in that epoch from the Turgai bay up to the Arctic Ocean.

At the transition between the Cretaceous and Tertiary and in the Paleocene age there comes in a new orogenic phase which is manifested with especial distinctness in the Donec basin; its traces exist also in the Crimea and, seemingly, in the Caucasus. At last, the Paleocene movements are outlined with an absolute distinctness in the uplifts of the right bank of the Volga South of Saratov. This time again the platform as a whole reacts upon the mountain-building movements within the geosynclines surrounding it by a general rise which totally drives the sea out of it at the limit between the Cretaceous and

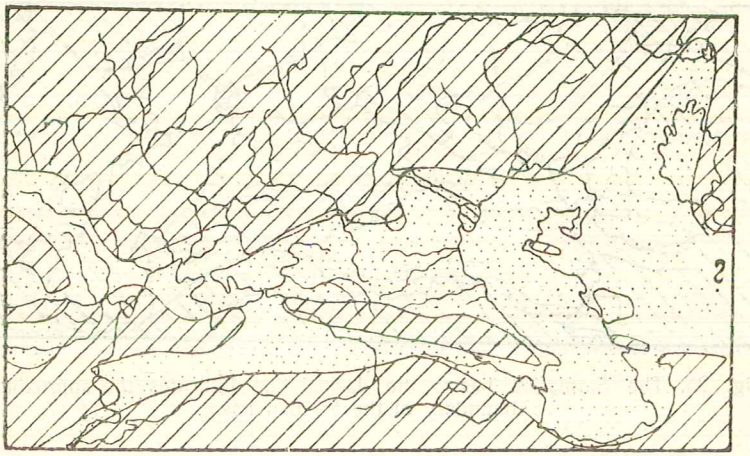

Fig. 24. The Middle Miocene basins.

Paleocene. Such rising up is of particular interest inasmuch as before it the depth of the East Russian and South Russian depressions reached 1000 m.

These risings are followed in the Early Tertiary by a new transgression that covers the Crimea and Caucasus, the Southern part of the platform, the West Siberian plain and the Eastern slope of the Ural. Judging from the situation of the longitudinal downfolds, the Ural finally enters into the composition of the platform, and the rôle of the East Russian depression passes to the Western Siberian plain.

With the Neogene epoch there begin the last orogenic movements in the Southern geosynclinal zone. In view of the lack of space we can not trace such a process in detail, and shall

dwell but on a few, most characteristic traits of the process. The folding was completed, first of all in the Taurida mountains which respond to the Post-Paleogene tectonic stresses merely by the dip faulting and horizontal faulting and by a bodily uprise of the mass. The middle part of the Northern slope of the Caucasus range soldered to the Stavropol crystalline block is submitted, together with the latter, simply to a general upward movement without folding; here likewise fractures are formed and with them the intrusion of the laccolites of the Mineralnie Vody region is associated. In the Eastern and Western parts

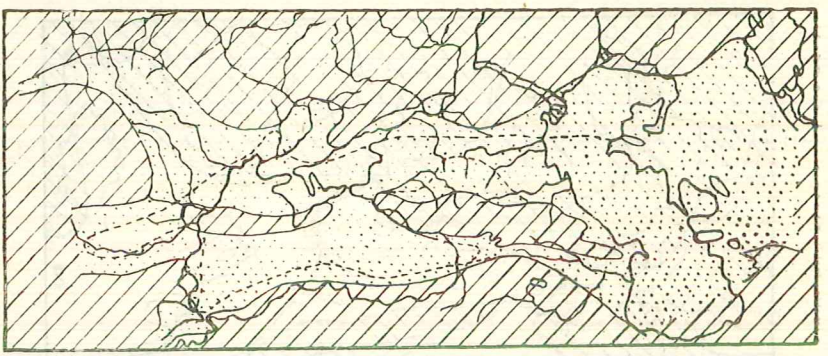

Fig. 25. The Sarmatian basin; the dashed line indicates the approximate boundary of the Pontian basin.

of the Northern slope there are formed not only folds but also numerous scalelike bedding-plane thrusts which displace the rock masses Southward. On the Southern slope of the range numerous folded thrusts are formed incident to the general movement of the masses in a Southward direction. On Mangyslak the Neogene mountain-building movements are manifested merely in the formation of a gentle arch-like uplift of the range, while in the Donec basin we do not succeed in finding their traces. In the Caspian depression the gentle folding of the Pliocene refers to the close of the Neogene.

North of the Crimea-Caucasus geosynclinal region the sea does not extend in the Neogene, beyond the Southern border of the platform; the sea simultaneously covers both the depressions of this region and the subsurface crystalline blocks, and invades even the Southern portions of the Azov-Podolian block. As the orogenic process advances, the sea covered area dimini-

shes more and, more and moreover in connection with the rising up of the Stavropol block, the basin is being gradually divided into two independent portions. The East Russian depression is outlined only at the close of the Pliocene when it is invaded by the transgressional waters of the Akcagylian basin. From that moment on, the Caspian portion of the depression is preserved without any changes of importance up to the present day.

During the Quarternary period the platform is subjected to glaciation together with the neighbouring parts of West Europe; vast glaciers are formed also on the Caucasus. The details of the Quarternary history of our region are far from being cleared up, for a systematic study of the continental Quarternary was started but quite recently.

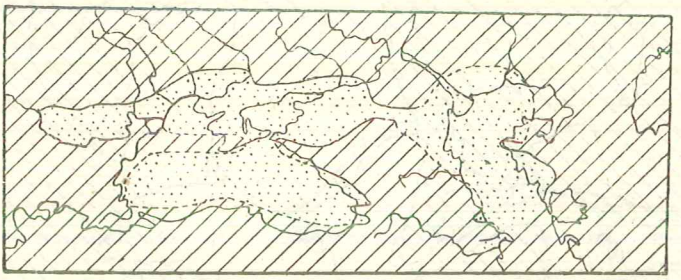

Fig. 26. The Pontian basin.

Most of the students of the glacial deposits on the Russian plain acknowledge the existence of three glacial stages on it: the Minuel, Riss and Würm stage. But the question concerning the boundaries of the distribution of the glaciers pertaining to the epochs just named is now far from being definitely solved, and regarging it the views of different investigators disagree considerably. The most obscure appears to be the question relating to the dimensions of the Mindel glaciation. Some hold that it extended to White Russia and the Moscow region, whilte others (A. P. Pavlov) believe that it occupied even somewhat larger areas than the Riss glaciation, and reached, in the Southeast, the Volga at Stalingrad; but there are also the geologists who consider it of quite limited extent. The Southern boundary of the distribution of morains as shown on the existing geologic maps and on the diagrammatic map appended to this paper, is believed to be the boundary of the Riss glaciation. Further, as

to the Würm glaciations, all agree that it occupied by far lesser areas than the Riss glaciation; but the position of its boundaries also is not exactly established: some think that the morains of this epoch do not extend South of Tver, while others believe

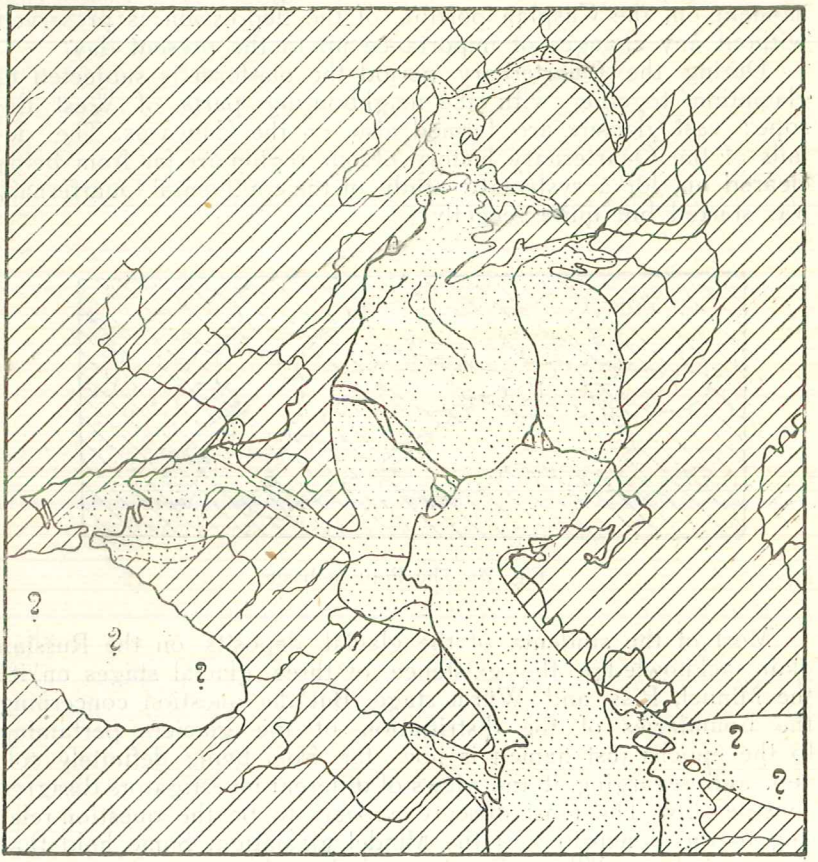

Fig. 27. The Akchagylian basin.

that they reach Moscow. Terminal morains of White Russia, as well as of the Smolensk and Tver governements are believed to be associated with the Würm glaciation.

A particularly complex problem is certainly that of the relations of the glacial deposits to the different genetic types of the

Quarternary sediments existing in the extra-glacial, Southern portion of the platform. Within that portion, the geologists refer to the glacial epochs, first of all, the formation ot the eolian loess, which is present, in its typical shape, but in the South-western parts of the platform, within the basins of the Dniepr and Dniestr rivers, where it is distinctly subdivided into several stages: moreover, the accumulation of sands and loams composing the high terraces of river valleys is likewise believed to be associated with the development of the glaciers. The geologists long since use to ascribe the periodical Quarternary transgressions of the Caspian to the augmented supply of waters dirived from the melting of the glaciers. Quite recently attempts have been made to ascribe to the same causes the periodical changes of the salinity of the Black Sea. Such assumptions, however probable, can not be considered to be proved for, on the one hand, the transgressions are more easily and more properly ascribed to the sinking of the region of the Caspian depression, while on the other hand the periodic fluctuations of the salinity in the Black Sea basin occured throughout the whole Neogene, even long before the first glaciation.

Moreover, some geologists connect the formation of fossil soils, which are frequently observed in the loess and Quarternary loams of the Southern part of the platform, with the increase of the humidity and of quantities of waters in the river systems during the interglacial epochs; and with the same events is believed to be associated the formation of cliffs that divide the high terraces of the river valleys.

As many problems associated with the history of the Quarternary are not yet sufficiently studied we obstain from giving a paleogeographical map for that period.

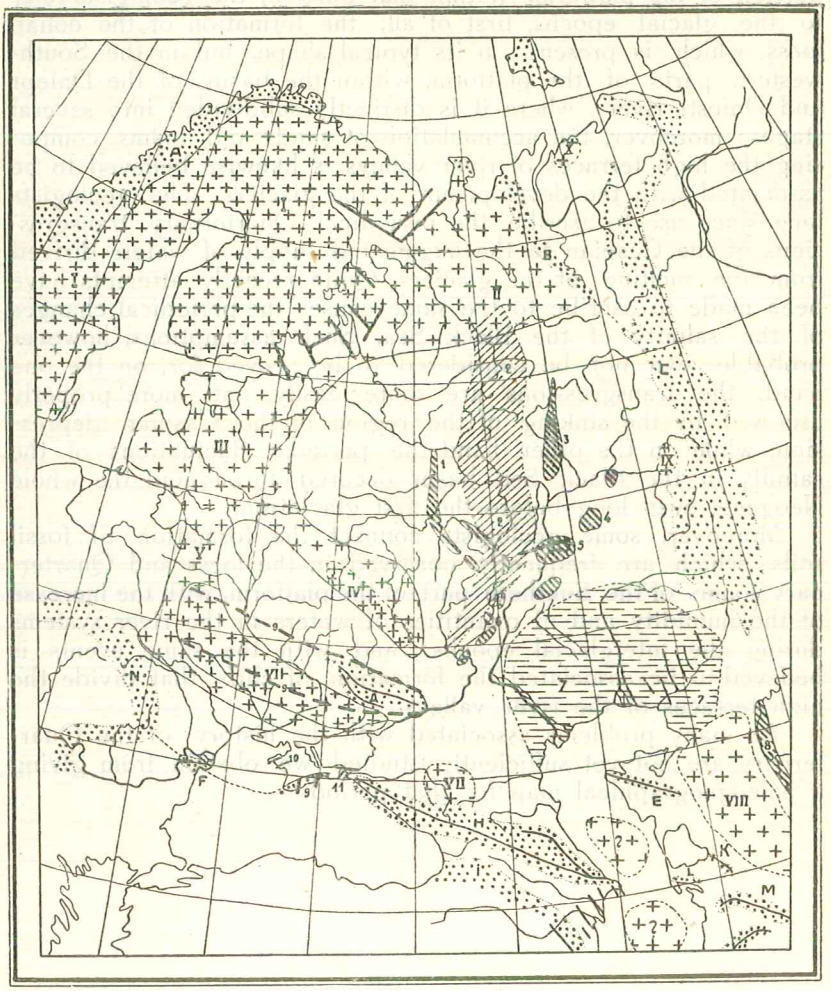

Plate I

Plate I

A diagrammatic map showing the geologic structure of the Russian platform.

Explanation of signs:

1) mountain ranges, 2) exposures of the Pre-Cambrian and the Pre-Cambrian reached by borings in the Voronej crystalline block, 3) areas within which the Pre-Cambrian foundation is lying at shallow depths, 4) bank-like anticlines, gently sloping anticlines and great dome-like uplifts, 5) the Ulianovsk-Saratov syneclise, 6) the Caspian depression, 7) other depressions, 8) directions of the axes of the folds, 9) faults.

Explanation of numbers and letters:

I) the Baltic shield, II) its Eastern subsurface slope, III) its Southern subsurface slope, IV) the Voronej uplift of the Pre-Cambrian rocks, V) the Polessie bridge, VI) the Azov-Podolian shield, VII) the Stavropol subsurface block, VIII) the subsurface block of Ustjurt, IX) the Ufa subsurface block, X) the exposures of the crystalline schists at the Pytkov-Kamen.

1) the Oka-Tzna bank, 2) the Ulianovsk-Saratov syneclise, 3) the Viatka uplifts, 4) the uplifts on the area crossed by the upper courses of the Sok and Cheremsan rivers, 5) the uplifts and fault of the Samara arc, 6) the anticlines between the Volga and Medveditza rivers, 7) the area occupied by brachyanticlinal folds associated with salt, 8) uplifts on the shores and isles of the Aral sea and the delta of Amu-Daria, 9) Prof. Chirvinsky's line of factures, 10) folds on the peninsula of Tarkhankut, 11) folds of the peninsulas of Kerch and Taman.

A) the Caledonian mountain chain, B) Timan, C) Ural, D) Donetz range, E) the mountains on the peninsula of Mangyshlak, F) Dobrudja, G) the Taurida mountains, H) the Main Caucasus Range, I) the Little Caucasus and Armenian plateau, K) the upilfts of Tuar-Kyr, L) Bolshoi Balchan and Kuba-Dag, M) Kopet-Dag.

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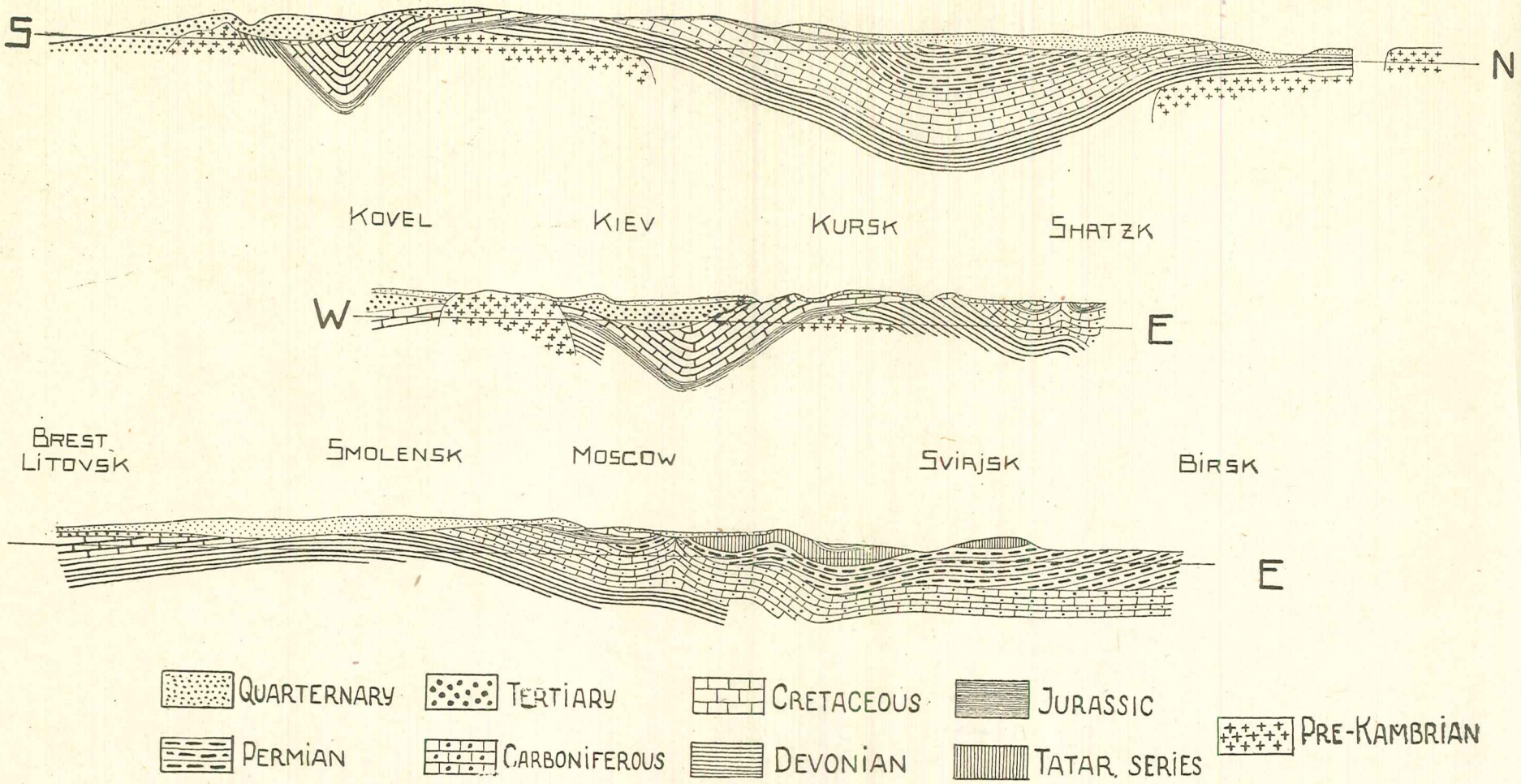

PLATE II

Geological profiles through the russian platform from North to South and West to East.