REVIEW ON BOOK OF R.B. KRAPIVNER "CRISIS OF GLACIAL THEORY: ARGUMENTS AND FACTS"

V.G. Chuvardinsky, P.K. Skuf'in, S.P. Evdokimov

Key words: *glacial theory, tectonic, glaciology, glaciotectonic, diamicton, moraine, roche moutonnée, sheep-like rock, glacial grooves, tectonic grooves, slickensides, glacio-dislocation, glacial large erratic masses (glacial mass overthrust block), fiords.*

1. Introduction and general aspects of the glacial doctrine.

In 2018, GEOS publishing house published a major monograph by Rudolf Krapivner, The Crisis of Glacial Theory: Evidence and Facts [1]. The book is based on a huge factual material collected by Rudolf Krapivner during his numerous expeditions to the Russian Plain, the north of Western Siberia, Primorye, Kamchatka, the Kola Peninsula, the Caucasus, as well as to the shelves of the Sea of Okhotsk, the Kara Sea and, especially, the Barents Sea. The author comprehensively examines the signs and criteria underlying the powerful and indisputable glacier theory and comes to a conclusion that the ice age doctrine may be erroneous. According to Krapivner's analysis, the main geological, geomorphological and paleogeographic criteria, on which the glacier theory is based, are in fact not of glacial, but mainly of geological and tectonic origin. At the same time, the author makes a number of fundamental discoveries that could bring glory to more than a few academic institutions with esteemed scientists. But they were too arrogant to notice them, leaving the palm of victory to a field practicing geologist. Krapivner's most impressive discovery is that he identified the fault-tectonic origin of glacial erratic masses and the fault-folded origin of "glacial dislocations" that are very common in the platform cover of the East European plain and Western Siberia. Those giant tectonic formations have, for almost two centuries, been the foundation of deeply-rooted views about the incredible dynamic power of the cover glaciers ostensibly deeply embedded in the upper layers of the Earth's crust and uprooting glacial erratic masses from its depths that are many hundreds of meters thick and tens of kilometres long. Moreover, the cover glacier (according to other scientists) moved those erratic masses many hundreds of kilometres away from the place of their origin. By analysing drilling data, however, Krapivner convincingly showed that the rocks composing the bodies of the glacial erratic masses become part of the sedimentary cover of the adjacent sites not disturbed by tectonics, and their movement range (vertical and subvertical) amounts to hundreds of meters or several kilometres — being squeezed by tectonics from the depths of the cover section. Glacial dislocations, which are very common in the fault-line areas of the platform cover, are equally important to confirm the "correctness" of the ice-age doctrine. Krapivner offers a tectonophysical model of their formationased on the data obtained by drilling out the formations, their geophysical study and geological and structural analysis. However, supporters of the ice-age theory conceal the results of drilling and tectonophysical analysis as they are convinced that the cover glacier "bit" into the rocks of the platform cover, sometimes even up to 2.6–2.8 km deep (the Yugan erratic mass) and "dragged" giant blocks of loose rocks at a distance of more than 600 to 650 km. It is very important that Krapivner came to that conclusion in his first monograph of 1986 [2], long before the drilling of the cover glaciers of Antarctica and Greenland. The results of that drilling are as follows: cover ice is not able to detach or dislocate anything as bottom layers of ice are immobilized; they reliably protect the subglacial bed from plowing. The ice does not capture boulders and contains only dust-like particles, mainly volcanic ash. The results are so astonishingly clear that the proponents of the glacial theory had to see the light and renounce the apparently erroneous theory. But no, they did not see the light, did not repent, did not backtrack, so erratic masses and glacial dislocations are still the most reliable foundations of the cover glaciations theory. With that in mind, Krapivner has a special chapter in his monograph we are about to review, considering the issues of theoretical glaciology and analysing in detail the results of through drilling of cover ice in Greenland and Antarctica as well

as ice domes in the Arctic islands. His conclusions are unambiguous: cover and dome glaciers preserve their bed, they are not able to plow it nor are they able to capture and move boulders. Glacier bodies contain minor inclusions of dust-like matter, mainly volcanic ash, which fundamentally undermines the foundations of the glacier theory. Now even the boulders that make up the Quaternary moraine argue against the glacial origin of both the boulders and the moraine itself. Sizeable chapters 3, 4, and 5 of the monograph touch upon the issues of non-glacial formation of boulder deposits, non-glacial origin of the moraine on the European lands and on the shelf of the Arctic seas. The 6th chapter stands apart as it considers some of the main hypotheses concerning the causes of marine transgressions (glacial eustasy) and ice forcing through the Earth's crust (glacial isostasy). Krapivner shows the fallacy of the glacier theory and provides justification for the neotectonic nature of those global phenomena. The chapter provides evidence of the fault-tectonic origin of the fiords and the "ice-exaration" types of relief on the Baltic shield. The conclusion chapter summarises the main results and provides recommendations for replacing the obviously outdated glacial paradigm with a new non-glacial theory based on the recent developments of modern Earth sciences. Rudolf Krapivner specifically emphasizes that academic community needs to abandon the method of complete concealment of recent publications by anti-glacialists as well as the common practice of preventing the fundamental developments from being published in academic journals.

The monograph by Rudolf Krapivner starts with a quote from the E. Hallam's book, Great Geological Controversies [3]: "It is impossible to imagine a geologist who did not perceive as a firmly established fact that, in the very recent past, the cover glaciers with a thickness of 3.5–4.5 km spread over vast areas of Europe and North America several times, erasing all the life in those areas."

Hallam is right that the Western and Soviet / post-Soviet academia support the glacial theory fully and unconditionally; they believe it to be a fundamental scientific achievement, an epoch-making doctrine that is firmly established in all Earth sciences, from general geology and geography to geobotany and zoology, from paleogeography to geomorphology and Quaternary geology.

Unlike Western science, where the glacial doctrine is unshakable, things are more complicated in Russia. Academic science and research university glacial schools keep up with the Western science: they zealously follow the European and Canadian American glacial theories and developments, and introduce them at home with servility. They deem it inappropriate to tag behind the advanced Western science, even more so that the glacier theory was derived from Western sources a century and a half ago.

However, even with the complete domination of the glacier theory in our country, there still were researchers — geologists and zoologists — who argued a lack of evidence concerning glacial hypotheses. Although there were not many of them, sometimes they managed to publish their works, but the official science was usually quick to restrict the publication of critical anti-glacial manuscripts, which was easy because all academic journals were under the full control of academic institutions. In our country, there were successful practical geological expeditions carrying out geological surveys, geological prospecting, and exploration. They were conducting extensive field research, and contributing to the production of new, unique evidence that was clearly contrary to the principles of the glacier theory. Publications by field geologists in departmental collections of academic research papers could not cover the whole problem but they contributed to the understanding that, in order to undermine, and better still, to debunk the glacier theory, deeper knowledge and as much evidence as possible was required.

Rudolf Krapivner, the author of the monograph, is a person who, undoubtedly, has an incredibly wide range of knowledge as well as many years of experience in field geology. Here is some information on his geological and research practice: he graduated from the Moscow Geological Prospecting Institute (Ordzhonikidze-Institute back then), got a degree of Candidate of Geological and Mineralogical Sciences (1967), then a degree of Doctor of Geological and

Mineralogical Sciences (1990), and worked as Chief Researcher at ZAO GIDEK, hydrogeological and geoecological company.

The scope of his extraordinarily fruitful scientific and practical activities includes late Cenozoic geology, structural geology, neotectonics, hydrogeology, tectonophysics, glaciology, and ecology. The spectrum of his field research is even more impressive, covering central regions of European Russia, Pechora and West Siberian plains, Primorye, Kamchatka, Caucasus, the islands of the Arctic ocean, and the Kola Peninsula. Especially amazing are his marine expeditions aimed at studying the shelves of the Barents Sea and Kara Sea, the Sea of Okhotsk, and the coastal zone of the Sea of Japan.

He is the only Russian geologist we know with such a wide range of field studies.

Back in 1960, Rudolf Krapivner set himself the task to understand the actual origin and formation mechanism of the moraine on Russian Northern plains as well as to understand the origin of the "glacial" types of relief. Since then, he has continued this demanding work. As far back as 1986, Nedra publishing house published Krapivner's first monograph, «Rootless Neotectonic Structures» [2], where he thoroughly shook the foundations of the glacier theory, proving the fault-tectonic origin of glacial large erratic masses and establishing the plicative-tectonic genesis of glacio-dislocations in the platform cover of the Russian Plain and Western Siberia. It would seem that supporters of the glacier theory must begin to reconsider the glacier theory, but instead, under the pretext that the book was published in Nedra that is not an academic but departmental publishing house, the glacialists declared it "unreadable" and something to be "concealed".

In 1990, Krapivner defended his doctoral thesis, «Structure and Conditions of Formation of Near-Surface Neotectonic Dislocations», before the academic board at the Academic Institute of Earth Physics, where he proved the fault-tectonic nature of glacial erratic masses and folded the origin of glacio-dislocations on the basis of his geological studies, geophysical data, and drilling works, as well as the materials presented in his monograph of 1986.

The researcher’s conclusions were met by the academic board at the Institute of Earth Physics with extreme disbelief and even aggression, and it was only a stroke of luck that he did not fail the thesis defence. That crucial moment will be covered more fully in the section "On the origin of erratic masses and glacio-dislocations".

At the beginning of the 21st century, the Earth sciences, where the glacier theory reigned unconditionally, took an unexpected turn. As part of international projects, the most powerful glacial covers of Greenland and Antarctica were through drilled in a number of sites with full selection of a glacial core. At the same time, it suddenly became clear that the sections of the glacial covers are absolutely free from boulders. Instead, they contain micron-size dust-like particles in minute quantities, mainly volcanic ash. It has been found that the bottom parts of the cover ice are immobilized and do not perform any exaration work. For almost two centuries, there was a good deal of discussion about the huge plowing role of glacial covers, but, in fact, they only contribute to conservation of the topographic surface. Krapivner considers this question in the most voluminous, full of evidence, second chapter, "Glacier theory and glaciology". A separate part of it is devoted to the pieces of evidence of the fault-tectonic origin of the "exaration-glacial" types of relief which are the most striking and commonly accepted signs of the cover glaciation. Roche moutonnées and sheep-like rocks with striation and grooves on pre-Cambrian rocks are considered to be an especially reliable criterion of cover glaciation. The advocates of the glacier theory are right about one thing: exaration forms of relief, from fiords and skerries to roche moutonnée and grooved polished rock surfaces, are indeed the brightest, most vivid and accessible forms for a route study. And this is what ruined the glacial conception of their origin: in fact, all types of glacial exaration relief have a fault-neotectonic origin. At the same time, such types of relief as roche moutonnée with their striation and grooves also continued to form in the "post-glacial" (Holocene) time. These questions are considered by Krapivner in the 6th chapter. They are also mentioned in the first chapter and other chapters of the book.

2. Principles of the glacial theory and results of drilling of modern glacial covers

Along with the consideration of theoretical foundations of dynamic glaciology, the author provides unique materials on through drilling of the ice sheets of Greenland, Antarctica, and ice domes of the Arctic islands, obtained as part of international projects.

University and academic scientists, members of scientific glacial schools, constantly refer to the ice sheets of Antarctica and Greenland, which, in their opinion, contributed greatly to transforming the ancient surface of the platforms and crystalline shields. It is believed that the very existence of the thick glaciers testifies to the inviolability and accuracy of the glacial doctrine and that in the Quaternary period, such glaciers plowed and swept from the Baltic shield up to 200 m thick crystalline rocks, carried blocks and boulders of bedrock for thousands of kilometres as well as dragged huge glacial erratic masses hundreds of kilometres away.

For clarification, we have to turn to the glaciological activity of these glacial covers, having successfully performed their glacial functions for many millions of years.

To date, glaciologists, geologists, drilling technicians, and geophysicists have studied the dynamics and patterns of movement of the cover glaciers throughout their thickness and their section. Of particular and unique importance are the results of the through (to the underlying bedrock) drilling of the ice of Antarctica and Greenland, obtained during the work on international projects. A thorough study of many kilometres of ice columns, as well as the study of vertical ice cliffs as well as of ice in tunnels made in the base of glaciers, yielded some surprising results. It turned out that the continental ice is not a mass of debris-laden ice stuffed with huge boulders and blocks (which is a usual picture shown in the diagrams and figures in textbooks on general and Quaternary geology and geomorphology), but rather contains only inclusions of sandy loam-clay and fine-grained soil.¬ Even the basal layers of glaciers, which scientists usually believe to be a powerful basal moraine stuffed with huge blocks and flat-iron boulders (for example, in the schemes by V. M. Kotlyakov and N. V. Koronovsky), were only found to contain small lenses, clumps of clay and sandy-loam matter and rare sand grains. These mineral inclusions only make several hundredths per cent and are mainly represented by volcanic ash, microcosmic particles, aeolian dust of remote deserts, ¬rare inclusions of fine terrigenous matter, as well as spores and pollen. Glaciologists also found that the bottom layers of the ice of cover glaciers¬ (which, according to the main principles of glacier theory, are the ones to perform all geological work) do not participate in the general movement of ice masses; they are dead weight, staying put for hundreds of thousands of years and protecting the underlying rocks from wearing away and denudation. Moreover, the cover ice preserves large palaeotectonic lakes with their relict, very ancient water, from the notorious glacial plowing.

Well, contrary to the canons of glacial theory, the mantle ice does not cut or plow or rip the underlying rocks, it does not form exaration types of relief nor does it create any sorts of glaciotectonic structures. The mantle ice does not have inclusions of blocks or boulders and, after melting, it can leave only a thin, patchy cover of sandy loam-clay sediments. This is the real, main, or basal moraine of the cover glacier, but without any boulders.

Below is a brief description of the results of drilling of Arctic ice domes and ice sheets of Greenland and Antarctica.

The Svalbard archipelago.

The glaciers of Svalbard are divided into two types. Western Svalbard is dominated by ridge-and-valley glaciers. They have blocks and boulders on their surface that have toppled from the mountain slopes. Eastern Svalbard has the glaciation, so the surface moraine, of course, cannot be found here. The glaciers are drilled through by several wells.

Amundsen plateau glacier.

The well with a depth of 586.7 m reached the bedrock, near which there are alternating layers of transparent and opaque ice. Micron-size mineral inclusions are found in opaque layers. These microinclusions are most noticeable at depths of 511.6 and 566.7 m. According to

laboratory analyses, mineral microinclusions are represented by mica scales, quartz microparticles, volcanic ash and slag, spores and pollen.

Lomonosov Plateau.

Although the Lomonosov plateau is located in Western Svalbard, its glaciation is of cover type. The well that drilled the Fridtjof glacier reached the bed at a depth of 220 m. In the core of the lower layers of ice, micron-size dust-like inclusions were found, and the bottom hole was made in the bedrock. In the well drilled in the Grenfjord glacier that reached the bedrock at a depth of 211 m in the ice, micron-size mineral inclusions were also noted.

Ice dome of Devon Island (Canadian Arctic). Two wells with 298.9 and 299.4 m deep were drilled through this glacier. At a height of 2.6 to 4 m from the bed, some concentration of microparticles was recorded in the ice. Then, from a height of 1.2 m and to the bottom of the well, the concentration of microparticles was found again. The authors provide no information about the mineral composition and percentage of microparticles in the ice.

Greenland.

Greenland ice sheet is the most powerful in the Northern hemisphere, with the maximum thickness of ice being 3,416 m. Its size is comparable to the hypothetical Scandinavian ice sheet. In different parts of the Greenland ice sheet, the ice was drilled through by five deep wells with full ice core sampling.

The north-western part of the ice sheet. At Camp Century station, the ice sheet was drilled through by American drillers in 1968. The well reached the bedrock at a depth of 1,391 m. Throughout the section, the ice is clean, but at the base of the glacier, a mass of ice 15.7 m thick was drilled, containing dust-like, fine-grained substances. This ice sheet consists of frequently alternating thin layers of pure ice and contaminated ice rich with fine ground. The size of morainic material particles in that debris-laden ice (as the authors call it) vary from less than 2 microns to millimetre-sized particles and small clumps of those.

By weight, the average concentration of pulverized material is 0.24%, and by volume, it is 0.10% to 0.12%. There are no fragments of boulder size in this debris-laden ice (or bottom moraine, according To V. M. Kotlyakov's terminology).

In another paper by these authors, the same core section is described as a 17-metre thick debris-laden ice with a high content (0.24% by weight) of morainic material with a slight increase in particle size closer to its upper parts. The authors again write about the micron size of the particles. But apparently it is extremely necessary to find a basal moraine in the section of the cover glacier, so microparticles and clumps of microparticles are readily believed to be found in it. When such a basal moraine melts, a thin cover of dust-like clay substance with about 1.5 cm to 2 cm thick is formed.

The southern part of the ice sheet. In 1981, drilling operations at Dye-3 station (a joint US and European program) were completed. According to drilling data, the ice thickness at the station was 2,037 m. Ice core at different depths was 500 m, 901 m and 2,030 m to 2,035 m and contained mineral inclusions represented by volcanic ash of different concentrations, from insignificant to noticeable and strong. The age of the ice near the bed is estimated at 125 to 150 thousand years.

The Central part of the ice sheet. In the centre of Greenland, the ice sheet was drilled by two wells, i.e. GRIP-1 (European project) and GISP-2 (US project). The first well reached the subglacial bedrock at a depth of 3,029 m in 1992. The GISP-2 well is located 30 km southwest of the first well; its drilling was completed in 1993. The well has a total depth of 3,053 m, of which 1.55 m was drilled in the rocks of the bed (the thickness of the ice, therefore, is a little more than 3,051 m). So, two well were drilled in the mysterious central part of the ice sheet. Maybe the ice forms a powerful debris-laden mass, i.e. a basal moraine in the centre of the glaciation? No, this is not the case. In the lower part of the ice, there are only minor inclusions of dust-like matter that look like individual patches.

The Northern part of the Greenland glacier. This important glaciological sub-region has a well drilled by the North Greenland glacial project. The well is located in the centre of Northern

Greenland at an altitude of 2,921 m above sea level. Drilling began in 1996 and was completed in 2004. As a result, a 3,091 m thick ice sheet was drilled.

In 2003, at a depth of 3,085 m, brown subglacial fresh water gushed into the well and rose by 43 m. After a pause in drilling in 2004, the drill string reached the bedrock at a depth of 3,091 m and partially drilled through the underlying bedrock represented by red sandstones. Judging by the description of the core, the ice thickness throughout the section was represented by ice that did not contain any noticeable mineral particles.

The ice opened in the bottom part of the glacier has an unusual brown colour (the same as the water that subsequently froze). But there was a sensation awaiting drillers and glaciologists: a small piece of wood of relict origin was found in the core of lake ice. Apparently, during drilling, the water of the ancient lake was stirred up, and the lightest bottom fraction — a piece of wood — froze into the newly formed lake ice.

TUTO ice tunnel. In the north-western part of Greenland, a special TUTO ice tunnel was constructed at the place of the contact of the cover glacier and the bedrock bed. Mineral particles were detected in the ice, and the ice was called debris-laden. Nothing is reported about the number of mineral inclusions, but it is indicated that those are micron-size inclusions and that they became part of the basal part of the glacier by freezing and sticking processes. Studies using an electron microscope have shown that the revealed tiny grains and scales of minerals belong to quartz, feldspar and silica illinitions, and they do not show signs of any processing as all grains are weathered.

So, all 5 wells that were drilled through the Greenland ice sheet and the TUTO ice tunnel provide unique materials for the so-called basal moraine and debris-laden ice. Cover ice and even outlet glaciers do not contain any blocks or boulders, but only dust-like, fine-grained inclusions. This will also be the real nature of the basal (main) moraine — it will be a thin veneer of clay-sandy loam substance which is dust-like in a dry state.

Antarctica.

In different parts of the Antarctic ice sheet, six deep wells were drilled that reached the bedrock. In addition, the shelf glaciers of Ross, Filchner—Ronne, Amery, Lazarev, and Shackleton have been drilled through.

Baird station (USA). It is located in West Antarctica. In 1968, the drilling of a well was completed there, which drilled through the ice cover and reached the bedrock at a depth of 2,164 m. The study of the ice core showed that in the near-bottom part of the glacier there is a mass of debris-containing ice (according to V. M. Kotlyakov, a basal moraine) with a thickness of 4.83 m. The mass is represented by alternation of pure ice and ice containing mineral inclusions of sand-clay size. As for the fine-grained soil, it is assumed that it fell into the ice in the process of freezing and adhesion of sediments of the bed to the lower part of the glacier.

Vostok station (Russia), central part of East Antarctica. Drilling of the 5G-1 well began in 1990; in February 2011, the ice was drilled to a depth of 3,720.4 m. The well entered the lake ice of a very large subglacial lake Vostok and most of that ice has been already drilled. According to media reports, at the end of January 2012, the well drilled through the entire lake ice and entered the fresh water of lake Vostok. The total thickness of the drilled ice is 3,769.3 m.

Lake Vostok is larger in area than Lake Onega and much deeper as well: according to geophysical data, the depth of the lake (i.e. the thickness of the lake water) is 700 m, and in some areas of the lake up to 1,200 m and even up to 1,500 m.

The glacial ice drilled by the 5G-1 well contains mineral and organic inclusions at depths of 3,311 m, 3,538 m, and 3,608 m. The article by Kotlyakov (2004) reports that these morainic inclusions (that is how they are called in the publication) are represented by volcanic ash, microparticles of meteorites (cosmic dust), as well as spores and plant pollen. The percentage of the dust-like particles is not given, no boulders or at least break stone was found throughout the section of the ice thickness.

Kohnen Station (Germany). It is located on Queen Maud Land; the ice thickness according to drilling is 2,774 m. In 2006, water appeared in the well at this depth and rose to a

height of 80 km. According to available data, there are no inclusions of any mineral substance in the near-bottom parts of the glacier [5]. The age of ice at the bottom hole of the well is 900 thousand years.

Dome F Station (Japan). It is located in East Antarctica (on the side of the Indian ocean) on the so-called glacier dome F. The well was drilled in 2003–2007 and reached the glacier bed at a depth of 3,044 m. Dust-like inclusions were observed near the bottom hole of the well, and the age of ice near the bedrock is estimated at 1 million years. This means that the ice lay dead-weight without movement in place the entire Quaternary period. Also, the entire Quaternary period, i.e. 900 thousand years, bottom ice lay in place at the Kohnen station, completely preserving the pre-glacial surface.

Station dome C (European program). It is located in East Antarctica (on the side of the Pacific Ocean) on the glacier dome C. Having passed a powerful mass of ice, the well (it was drilled in 2000–2005) reached the bedrock at a depth of 3,270 m. There are no mineral inclusions in the ice section, and there are no noticeable mineral or other inclusions in the bottom parts of the ice. The age of ice at the bottom hole of the well near the glacier bed is estimated at 800 thousand years.

Law Station (Australia). It is located near a coast in Eastern Antarctica. The well reached the bedrock at a depth of 1,196 m in 1993. There are no morainic inclusions in the ice section, if they do not consider dust-like inclusions as such.

So, the evidence is that there are absolutely no blocks or boulders in the debris-laden ice of Antarctica (instead, rare inclusions of dust-like substance called debris are found). Scientists use as a last resort the hypothesis of glaciers grinding into the flour the large material that never existed. What are the arguments against this theory? Firstly, the "glacial flour" is contained in the ice in minuscule quantities, and secondly, the bulk of this "flour" is volcanic ash, and some of it is microscopic terrigenous and cosmic matter. Maybe the glacier grounded meteorites into flour as well? But such a glacier theory is refuted by the presence of very tender plant spores in the debris-laden ice that are preserved in their original form. Could the glacier's grinding possibly be selective?

At the meeting on the Quaternary period in 2011, during the discussion on the report of one of the authors of this review, some scientists began to argue that, when drilling through glaciers, the wells "bypassed" or "went round" blocks and boulders, so that large fragments were not recorded. It turns out that, if necessary, the drill string can wriggle like a snake under a pitchfork! But for how long will such excuses prolong the dominance of the glacier theory?

We wonder what glacialists will say to the fact that the boreholes of core drilling of glacial strata in Antarctica and Greenland are not displaced by moving ice, although it takes several years to drill each of the three-kilometre wells. This means that moving continental ice is not able to displace the steel core pipes. Neither can it move boulders, as the moving ice just flows around both steel pipes and boulders (if they are any on the subglacial topographic surface).

3. Dynamics of glacial covers. John Nye's formula. [4].

John Nye is a professor of Physics at the University of Bristol, Fellow of the Royal Society of Great Britain. Nye's model is based on the theory of plasticity of the glacier flow; it is expressed by Nye's famous mathematical formula:

$\tau = \rho g h \cdot \sin\alpha$,

where τ is the shear stress,

ρ is the density of ice,

g is the gravity acceleration,

h is the thickness of ice,

α is the glacier surface slope, and

pgh is the weight of the ice pillar.

Krapivner considers a number of glaciological hypotheses, but he pays the most attention to the theory of John Nye, further confirming its thoroughness. This is Krapivner's analytical derivation is that, in contrast to the principles of the glacier theory, cover glaciers are not able to form a boulder-block moraine, since they are not able to carry boulders. Needless to say, they cannot reject blocks of rocks (small or super large) or dislocate the rocks of the platform cover either.

Glaciologists and academia scientists believe the Nye formula and the discovered mechanism of cover ice movement to be the established model of movement of glacial covers and ice sheets. Here is the conclusion of the scientists of the All-Russian Geological Institute (VSEGEI) F. A. Kaplyanskaya and V. D. Tarnogradsky made in their book, Glacial Geology (1993): "An important and universally confirmed by practice, the Nye's formula conclusion is that glaciers move in accordance with the slope of their surface, not the shape of the bed". This is the process of flowing and sliding of accumulated surface masses of ice on the surface slope of the ice sheet itself. If the ice cover is thick, the roughness of the post-glacial relief is irrelevant: the glacier flows unhampered through the buffering bottom layer of ice that smoothens the uneven terrain.

This viscoelastic spreading of ice on ice is the physical essence of glacial cover dynamics: the lower part of the glacier remains geologically inert, motionless and does not perform the geological and tectonic work at all which the glacial theory obligatorily prescribes to them.

Who needs such "incompetent" ice sheets? Maybe John Nye does not deserve the Seligman Crystal he has been awarded with? This very Nye's famous formula destroys the glacier theory and ruins the usual understanding of the glacial cover tectonic activity. The results of through drilling of Greenland and Antarctica ice confirm the Nye's model completely.

It seems even some advocates of the glacier doctrine are starting to understand it. No, they have not yet banned the Nye's formula, they simply drive home to the "little ones" that the glacier, despite the insinuations out there, must do its work of plucking and squeezing. Kaplyanskaya and Tarnogradsky do exactly that — whatever the formula, the glacier has to carry out its geological and tectonic work of destroying subglacial crystalline rocks and transferring blocks and boulders hundreds and thousands of kilometres away.

P. S. Voronov and M. G. Groswald did not mince their words when talking about the Nye's model: "Viscoelastic flow of ice in accordance with the slope of the glacier surface, as well as the movement of ice on the surfaces of internal shears is the only way to explain ice sliding on ice". Here, the supporters of the glacial doctrine are right. Scientists are trying to find a way out of the impasse, and return to the old theories about the vigorous plowing of the bedrock by the bottom parts of the ice, but they overlook the profiles of ice velocities in the vertical sections of cover glaciers that were empirically established when drilling glaciers. Glacial charts show that, in the bottom part of the ice, the speed of ice movement amounts to zero, and then it gradually increases when going up the section of the cover glacier. The glacier cannot plow the bed; it is confirmed by the fact that its section, including the bottom parts of the glacier, contains neither boulders, nor even a single sample of the break stone size. There is a dust-like substance, although in scanty quantities, but nobody wants to tout that, according to its mineral composition, it is mainly volcanic ash and dust of remote deserts. There are aeolian processes in work, but glacial processes have been and are extremely passive. But, apparently, these arguments do not count for glacier theory advocates: V. I. Astakhov et al. zealously repeat both the Nye's formula and the conclusion drawn by F. A. Kaplyanskaya and V. D. Tarnogradsky: "In ice sheets lying on a flat base, the movement of ice is determined by the slope (shape) of the surface of the glacial shell... In glacial covers and domes, there is a slow spreading of ice according to the law of flow of viscoelastic bodies". But these scientists also ascribe plowing and large tectonic activity to the glacier.

Just a while ago, supporters of the glacial doctrine argued that the strongest glacial exaration and glacial plucking took place in the central glacial zone and cited the Baltic shield as

an example. And now it's quite the opposite and the thin ice on the glacier's periphery allegedly are the main zones of the glacier's energetic work!

The glacier theory has consistently demonstrated extraordinary disingenuousness. Krapivner highlights that "the glacial theory is hopelessly outdated, but it is extraordinarily resilient since it has no boundary conditions and constantly changes and confuses its own principles and "rock-solid" scientific ideas". Nevertheless, such "addled" publications of glacioscientists receive grants from the Russian Foundation for Basic Research!

Special long-term studies of glaciologists, both Russian and foreign ones, have shown that in the bottom part of cover glaciers, be it the central or peripheral glacial zone, tangential stresses remain very low. According to the materials of P. A. Shumsky and M. S. Crass, in different parts of the Greenland and Antarctic ice sheets, they range from 0.02–0.05 bar up to 0.06–0.01 bar. According to the studies of the noted specialist in tectonics, A. V. Lukyanov, shear stresses at the site of contact between the ice of glacial covers and bedrock are within 0.01–0.05–0.015 bar, i.e. also extremely low. Low values of shearing stress in the bottom part of glacial covers are stated in the monographs by famous glaciologists W. F. Budd and W. Paterson. Such minute stresses result in the immobility of the lower horizons of the cover glaciers since they are unable to overcome even the force of friction. Only the overlying layers of ice are moving and spreading and here John Nye is right.

Wrapping up this section, it is necessary to cite the conclusions of D. Y. Bolshiyanov, a modern explorer of glaciers of Arctica and Antarctica and prominent glaciologist: "one more conclusion in terms of glacial geology theory can be drawn from John Nye's formula: the movement of the cover glaciers depends not on the slope of the bed but on the slope of the glacier surface". Another conclusion of D. Y. Bolshiyanov is quite justified: "The main provisions of glacial geology are not confirmed by observations over modern glaciers. This, in turn, means that the theoretical construction of glacial geology is based on a wrong understanding of the mechanism of glacier movement". [5]

Proponents of the glacier doctrine, contrary to logic and common sense, saddled the cover glaciers with functions and processes that are not intrinsic to them, i.e. fault and plicative tectonics, glacial-bulldozing dislocation and squeezing of bedrock, formation of numerous types of "glacial-exaration" relief, which actually has a fault-tectonic origin. The glacier theory also has big trouble with capture and transportation of boulder-block material. It's time to understand that it is not the work of cover glaciers to carry blocks and boulders. Anyway, the results of through drilling of the ice sheets of Greenland and Antarctica are embarrassing for the glacier theory. If they allowed the ice drilling, they should have completely hushed up the results or not let them be published in scientific journals, for that matter.

4. Origin and mechanism of formation of the proverbial exaration relief

Krapivner considers the issues of genesis of the "glacial exaration" relief in three chapters of his book, i. e. in chapters 1, 2, and 6. In the first chapter, he dwells in some detail upon this problem in his unpublished review of the monograph of V. G. Chuvardinsky On the glacial theory. Origin of glacial formations (1998). Here is an excerpt from the review. "The work of V. G. Chuvardinsky is particularly interesting because it is largely devoted to the results of his research of the Kola Peninsula and Karelia over several decades, where, as it is believed, there are clear classical signs of glacial exaration: roches moutonnées, sheep-like rocks, glacial striation and polishing of rocks, skerry and fiord relief, etc., which have never been disputed earlier. The author provides convincing data in favour of the tectonic nature of those phenomena, including photographs showing that the surfaces grooved and polished by the supposed exaration continue under allochthonous tectonic plates of bedrock. Most often, such facts are established in the exposures illustrating the structure of groups of roches moutonnées, drumlins, fiords, and skerry coasts. The conclusion about the tectonic origin of these phenomena is confirmed by the information about the wide development of neotectonic faults of different kinematic types on the Baltic shield, perfectly seen on the included aerial and space images, as well as photographs of

roches moutonnées that are well known on the shields and ancient platforms in the extraglacial regions.

The monograph in a well-argued manner criticizes the glacier-theory hypotheses of the origin of peculiar ridge landforms and geological bodies forming them: the so-called eskers and drumlins that are widespread in Karelia and on the Kola Peninsula. The author focuses on the connection of the formations with faults established by many researchers and proposes models of their tectonic origin. Analysing the "fans" of boulder scattering within Finland, Karelia and the Kola Peninsula, Chuvardinsky substantiates the original concept of tectonic transport of coarsely fragmented material updip and along the shear-type fault zones, resulting in the fact that the orientation of those fans is subparallel to the directions of tectonic striation, usually mistaken for glacial striation. The distance of tectonic transportation of coarsely-fragmented material from the root sources, which is measured for guiding boulders, usually amounts to hundreds of meters or several kilometres."

As Krapivner reports in his book, the review was submitted for publication in the Stratigraphy. Geological correlation journal but was rejected by the editorial staff based on a note by Yu. A. Lavrushin, the internal reviewer of the editorial staff, vocal supporter of the Great Ice Age theory, where he wrote: "R. B. Krapivner's review of Chuvardinsky's book is a promotional article and to publish this promotional clip is to lower the scientific rating of the journal".

Krapivner tried to do publish his review and sent a reasoned letter to B. S. Sokolov, member of the Academy of Sciences, editor-in-chief of the journal. Here are the last lines of this letter: "I urge you to reconsider the possibility of publishing my review in your journal. It is too late to transfer it to another journal". The 6.5-page review was submitted to the journal editorial office on March 2, 1999 and was rejected on November 4, 1999. The monograph by V. G. Chuvardinsky was published in 1998. There was no response to the letter. The practice of silencing the fundamental anti-glacial work was successful.

In the sixth chapter of his book, Krapivner specifically examines the problem of formation of fiords on the Baltic shield, previously covering the history of the origin of the hypothesis of glacial plowing in the crystalline rocks of the deepest fiords how this hypothesis, for no good reason, turned into one of the main foundations of the powerful glacier theory. Krapivner carried out works on the Murmansk coast of the Kola Peninsula, which is the region of large and small fiords. Using satellite images and ground surveys, he came to a clear conclusion that the fiords of the Kola Peninsula and Fennoscandia as a whole have fault-tectonic origin, and neither cover glaciers nor gletchers took any part in their formation.

As for the presence of grooves and striation on the granite sides of the fiords, polishing of rocks, as well as the development in the contour of the fiords of skerry relief with roches moutonnées and sheep-like rocks, their fault-tectonic genesis only strengthens the conclusions about the fault nature of the fiords.

Since supporters of the glacier do not even dare to think of abandoning the idea of the glacial origin, it would be useful to provide at least brief evidence of fault-tectonic genesis of other types of exaration relief as well. The review by Krapivner was rejected by the academic editorial office 20 years ago and it was only published in his book in 2018, but now we can see that as far back as 1998 the question of the fault-tectonic genesis of this relief was answered.

Further research led to a crucial addition: the formation of medium and small types of exaration relief, roches moutonnées, sheep-like rocks, furrows and striation, polishing of rock surface on a number of tectonically active structures (especially in the Northern Ladoga region) continued in the Holocene, i.e. after the disappearance of the hypothetical glacier. This issue will be the subject of a new monograph by Chuvardinsky.

Below is a summary of the conclusions on the genesis of the exaration relief (according to the works of Chuvardinsky).

Studies on the Baltic shield, which is the region of classical and diverse types of exaration relief, made it possible to confirm that the relief has a fault-tectonic origin. Extensive

use of aerial and space images together with detailed ground survey showed a paragenetic connection of the exaration relief with neotectonic faults, the zones of recent tectonic activation. Summing up the data collected over many years, we can give the main conclusions here:

1. The crystalline basement of the eastern part of the Baltic shield is broken by a dense network of neotectonic breaks where we can point out deep, regional and near-surface faults like shears, reverse faults, downthrows, thrust faults, and gappings.

2. Systems of deep and regional neotectonic faults and large "exaration" landforms, such as fiords, skerries, or lake basins in crystalline rocks, form a single paragenesis. Those types of "exaration" relief are a geomorphological expression of the latest faulting and neotectonic dislocation on faults in the pre-Cambrian crystalline shield experiencing horizontal tectonic compression.

3. The paragenetic connection of smaller "exaration" types of relief (roches moutonnées, sheep-like rocks, polishing of rocks, systems of striation and grooves) with formations like thrust faults, reverse faults, downthrows and shears is established. The mass development of these landforms is observed at the ends of large shears, and they are essentially fault planes and slickensides of the ruptured formations, especially near-surface thrust faults and numerous shears, their displaced elements are broken into small-block and block material, which subsequently was shifted by gravitation to the base of the slopes. The formation of grooves, striation, and roches moutonnées also continued in the Holocene.

The fault-tectonic genesis of that formation is further confirmed by the following data:

a) in the contour of large exposures, one can see the immersion of polished and grooved slopes of roches moutonnées and sheep-like rocks under the hanging walls of thrust faults, reverse faults and gentle downthrows.

b) in typhons during gravitational sliding of blocks, polished surfaces of typical roches moutonnées of intrablock origin are massively exposed.

c) the mirror surface of the roches moutonnées is covered with a film of mylonitised rocks, and the groove and striation systems have a parallel and subparallel arrangement typical of tectonic structures.

The listed wide range of morphostructures and tectoglyphs of slickensides is included in the arsenal of consequences and signs of the newest tectonic dislocations, which is essential for geodynamic research and paleogeographic reconstructions for reliable abolition of the glacial theory. Materials on tectonic genesis of fiords, skerries, and lake basins also contribute to the same task.

The system of regional and deep faults of the crystalline basement underpins the largest types of "exaration" relief, i. e. fiords, lake basins in the bedrock, as well as skerries. The confinement of these formations to neotectonic faults can be seen extremely clearly on space images, their configuration being associated with the system of orthogonal faults. Fiords, skerries, and lake basins are often oriented in 4 directions, have sharp knee-shaped bends and cruciform shape with their greatest depths at the intersection of orthogonal faults.

There are different forms of relief, laid on the faults of tectonic compression. In this case, on their sides there are numerous shears, secondary thrust faults, tectonic slickensides, striation, and grooves. For forms of relief laid on the extension faults detachment terraces and downthrows are typical, whereas polishing and striation is not typical.

If we accept the tectonic genesis of fiords, skerries and lake basins, there will be no need to resort to unrealistic glacial structures, to glacial plowing of deep basins, gorges and valleys in the crystalline rocks. Especially deep glacial plowing is assumed during the formation of fiords - up to 2.5–3 km (!).

5. Glacial large erratic masses, glacio-dislocations, their origin and mechanism of formation

Erratic masses and glacio-dislocations have always been the stronghold of the glacier theory, the unshakable foundations of the glacier doctrine. In scientific publications, the largest,

sometimes giant erratic masses of platform cover rocks have always been set as an example of the incredible glaciotectonic, bulldozing and cutting activity of glacial covers. Ordinary geologists and noted scientists could not even think that the continental glaciers have nothing to do with this miracle of nature.

But Rudolf Krapivner, being a practicing field geologist, as he faced the said phenomena in Western Siberia, and then in the European part of Russia, decided to study them thoroughly in order to understand their actual nature. He was able to study the exposures of a number of those formations, analyse available drilling materials as well as geological and geophysical data. Additional drilling of the most representative erratic masses and "glacio-dislocations" was carried out and, as a result, solid evidence of their fault-tectonic and plicative-tectonic genesis was collected.

The study of rupture neotectonics, especially deep faults, and Krapivner's original tectonophysical models have brought greater clarity to the mechanism of formation of these intraplatform formations.

In his book «The Crisis of the Glacier Theory: Evidence and Facts», the origin and mechanism of formation of erratic masses and "glacio-dislocations" is considered in different sections and chapters; the author uses materials on Quaternary geology, geomorphology and, especially, on the dynamics of modern glacial covers of Antarctica and Greenland.

For the reader, the previous monograph by Krapivner, Rootless Neotectonic Structures (Moscow, Nedra, 1986, 204 pp.) and his very significant publications in the Geotectonics journal can be of great value.

In the Introduction of the reviewed book, Krapivner states: "The nature of near-surface (rootless) dislocations of Quaternary and pre-Quaternary sediments, as well as allochthonous blocks of rocks which are believed to be glacial erratic masses, has long remained a stumbling block". Krapivner's doctoral thesis, Structure and Conditions of Formation of Neotectonic Dislocations (1990), is an attempt to solve this problem using the methods of tectonophysical analysis. Thesis defence took place at the Institute of Earth Physics (IFZ). Extracts from the transcript of the defence are cited below.

Having covered the walls of the audience with pictures of geological sections and diagrams, the speaker was valiantly giving evidence of the tectonic origin of glacio-dislocations and erratic masses, explaining the mechanism of formation of these geological phenomena.

The famous popular science communicator R. K. Balandin wrote on this issue in his book, «While the Trail Is Cold [Po kholodnym sledam]» (1975): "If the anti-glacialists just somehow, in their own way, would be able to explain the origin of the erratic masses and glacio-dislocations, there would be a dangerous gap in the glacier theory".

Krapivner did not just "somehow", in his own way, manage to "explain the origin" of the formations. He gave a clear tectonophysical substantiation of the conditions of formation of erratic masses and dislocations, showed their geological and tectonic structure on the structural schemes and sections compiled based on the results of drilling in specific natural objects and their geological and geophysical study.

Krapivner's conclusion was definite: glacio-dislocations and erratic masses of the platform cover are associated with deep faults of the Earth's crust and formed as a result of discontinuous tectonic dislocations and manifestations of diapirism in the neotectonic epoch. We highly recommend reading the book by Krapivner, Rootless Neotectonic Structures (Moscow, Nedra, 1986), where the formation of these tectonic structures, which are the stronghold of the glacier theory, are considered with the necessary detail and evidence.

Meanwhile, clouds were gathering over Rudolf Krapivner. The statistics was not in his favour: two official opponents (out of three) were very negative about the thesis. Collective negative reviews had already been read out (positive reviews had not been read out; they sort of had been there but their content remained unknown). Many members of the board treated the conclusions of the applicant unkindly:

"How can we deny the glacial nature of these gigantic formations? It is well known that this is the work of the glacier, no other force can break the layers of rocks and reject them", – that was the common theme of their questions and speeches. They clearly were determined not to allow a breach in the usual paradigm, although it had already been pierced by the mentioned book, and the thesis, although it strengthened the book, did not change the case.

But suddenly, the floor was taken by the member of the Academy of Sciences M. A. Sadovsky who appeared in the conference room amidst the discussion. Pointing to the bulk of geological sections and structural schemes, he stressed the large factual base of the thesis and summarized: "This is an outstanding structural-tectonic work, and the author's innovative approach to the problem and the debatable nature of the thesis only strengthen his arguments".

The thesis received 2/3 positive votes by a narrow margin.

Next, we will consider the erratic masses and glacio-dislocations, as Krapivner was directly involved in the study and revision of their genesis.

Glacial erratic masses

Vyshnevolotsko-Novztorzhsky rampart is a series of Europe's largest erratic masses well known in the geological literature. In publications, this rampart usually appears as an example of the grand dislocating and transporting activities of the glacier. Indeed, this is a phenomenon. The almost meridonial strip of the erratic masses is 120 km long (from Lake Mstino to Staritsa Town), 10 to 15 km wide, and its relative height is 70 to 87 m. The erratic masses of the rampart are represented by rocks of different ages and different lithological composition: sands, limestones and coal clays of the Lower Carboniferous period, Upper Devonian sediments, Silurian (Ordovician) and Lower Cambrian rocks. Limestones of the Middle Carboniferous (the rampart also lying in the field of these limestones) and boulder-block deposits underlying the erratic masses also are part of the rampart structure.

According to the conclusions of a number of researchers, the masses were transferred by the glacier from two main places. Limestones, sands and coal clays of the Lower Carboniferous were transported from the Valdai Hills that are 150 km away (A. I. Moskvitin, D. B. Malakhovsky, E. Yu. Sammet, and Yu. A. Lavrushin). Deposits of the Silurian (Ordovician) and Lower Cambrian were brought by a glacier from the Finnish clint area which is 330 km away. The source of rejected Upper Devonian deposits is not specified. However, all these rocks are local, and there is an undisturbed section of the platform cover of the area that was opened by a well in Kuvshinovo, 30 km to the west of the rampart. It can be said that all rocks of the sedimentary section are part of the structure of this belt of erratic masses: these are Lower Cambrian clays; Ordovician and Upper Devonian deposits; Lower Carboniferous rocks, i.e. limestones, sands, coal clays; Middle Carboniferous limestones and marls, and boulder-block deposits.

According to Krapivner, the belt of erratic masses is confined to the neotectonically active Torzhok fault of the reverse fault-shear type, which, in the north, joins the Krestsy aulacogen. The erratic position of the Lower Carboniferous, Upper Devonian, Ordovician and Lower Cambrian rocks is associated with their removal to the surface by secondary reverse faults and reverse fault-shears from the upper, middle and lower horizons of the sedimentary cover, from a depth of 100–150 m (limestones, clays and sands of the Lower Carboniferous) and from a depth of 1,000–1,200 m (Lower Cambrian clays).

As for the boulder-block formations, they seem to be part of the tectonic breccia of the basement and cover and have been brought to the surface along the same faults.

The wording of the famous geologist V. D. Sokolov dating back to the 1930s that the Vyshnevolotsko-Novztorzhsky rampart "is the geotectonic axis of the Kalinin region, so to speak, its interior turned to the surface", is quite fair.

A large number of erratic masses of Cambrian and Ordovician rocks (individual blocks of them up to 8 million m3) and tectonic breccias (called glacial breccias) from Devonian, Ordovician and Cambrian rocks are mapped in the southern Ilmen region along the Lovat, Polist, and Porusya rivers. D. B. Malakhovsky and E. Yu. Sammet believe that the erratic masses have

been brought by the glacier from the area near the southern shore of the Gulf of Finland. The considered band of erratic masses was highlighted by A. P. Karpinsky as a large fault-tectonic structure, Polistovsko-Lovatsky rampart with a length of 90 km. Krapivner analysed the materials on tectonics and geology of the area and came to a conclusion that the existence of this neotectonically active structure is a reality, and it is connected to the Krestsy aulacogen.

It can be emphasized that the set of erratic rocks of this submeridionial fault zone also corresponds to the section of the sedimentary cover of this area. Obviously, there is no need for a hypothetical glacial movement of huge outcasts for hundreds of kilometres. The distance of their movement is only a few hundred meters, a thousand times less than the distance allegedly covered by the glacier. This is defined from the dislocated section of the cover according to reverse fault-shears that make up the structure of the Polistovsko-Lovatsky rampart.

According to R. B. Krapivner and I. L. Zayonts, the formation of well-known Samara and Yugan erratic masses in Western Siberia is associated with the tectonic removal of blocks and scales of Lower Eocene gaizes (Samara mass) and Jurassic siltstones and clays (Yugan mass) to the surface. The amplitudes of vertical tectonic displacements of allochthonous blocks of gaizes reach several hundred meters, and of Jurassic clay rocks in the Yugan erratic mass — up to 2.6–2.8 km.

In general, as studies show, the processes of clay diapirism have reached their maximum in Western Siberia. It has been established that, in different regions of the West Siberian Plain, there are large-amplitude intra-mantle dislocations and erratic blocks of Jurassic, Cretaceous and Paleogene rocks brought to the surface by the processes of clay diapirism. For example, it is proved that clay diapirism brought large erratic masses of Upper Cretaceous rocks on the Lyamin river from a depth of 850–900 m, and there is evidence of large erratic mass of Upper Cretaceous rocks having been brought to the surface from a depth of 900–1,000 m (the area of Siberian ridges) during the formation of a large diapiric structure.

Dislocations

Kanevsky dislocations. Based on the detailed data analysis of previous drilling and electric prospecting works as well as their own research, Krapivner and Yudkevich also came to a conclusion about the tectonic nature of Kanevsky dislocations. According to their materials, the dislocations are represented by a series of allochthonous plates of the north-western strike, in which Mesozoic and Cenozoic deposits, including alluvial, participate. The amplitude of the horizontal overlap of the Quaternary alluvium is 400-450 m, and the vertical displacement of the scales is up to 200-250 m. Available data show that the dislocations are part of the extended zone of dynamic influence of the Dnieper fault. In the neotectonic era, it functioned as a left-handed fault with an upthrust component of the wing shift. As a result, the near-surface part of the cover section (to a depth of 200–250 m) was pushed to the right bank of the Dnieper, forming Kanevsky ridges that consist of a series of upthrust scales, or skibs.

Now let us have a look at the results of the study of glacial covers of Greenland and Antarctica and data on through drilling. Was it possible to identify the "bulldozer" effect in real (not fictional) glaciers? These materials and subsequent conclusions are given in the initial sections of the book by Krapivner. I would like to summarize the main points.

1. The cover ice of Antarctica, Greenland, and the Arctic islands neither plows nor dislocates underlying rocks; in their section, including the bottom parts of glaciers, only dust-like, finely dispersed inclusions, mainly of volcanic ash, are found.
2. The lower bottom parts of glaciers do not participate in the general movement of ice, for hundreds of thousands of years they have been dead weight lying in place and protecting, preserving the pre-glacial geological surface.

Now it becomes obvious that the cover ice from the stronghold of the glacier theory becomes a part of its debunking, and the theory of bulldozer-cutting glacial effects moves into the category of erroneous, ridiculous hypotheses.

Field geologists should be aware of the conclusion drawn by J. Goguel, a French specialist in tectonics, whose findings are also supported by Krapivner: "Tectonics of the sedimentary cover is predominantly caused by deformations of the basement".

6. Pechora and West Siberian Lowlands

The origin of the relief of rocks and boulder loams of the Pechora and West Siberian Lowlands is considered by Krapivner in the third chapter of his book. Of particular interest are the stratification of relief in the vast valley of the Pechora river and the facts of the distribution of marine transgressions of the Quaternary time. Much attention is paid to the marine transgression, which left sea terraces and beach ridges at 90–120 m above sea level. The author calls this the Chuleysky sea border (the coastline of Chuleysky basin).

In the references on glaciation of the Pechora Lowland, this sea level is usually interpreted as a glacial Lake Komi. However, the findings of shells of marine molluscs and foraminifer complexes in the sections of the 100-meter sea terrace refute the entire paleogeography of the supporters of the great glacier theory, although they enthusiastically repeat their version that the marine fauna was brought by the glacier from the shelf of the Arctic seas. This shelf glacier, allegedly, at the same time dammed the flow of the Pechora River, forming a huge Lake Komi, but those glacioscientists cannot explain the natural marine foraminifer complexes and finds of shells with closed valves in the sections of a 100-metre terrace and in the mass of glacial-marine boulder loams (diamicton according to Krapivner).

In 1966, the capital multi-authored monograph, Geology and Prospects of Oil and Gas Potential of the Northern Part of the Timan-Pechora Lowland, was published [6]. In this book, the authors, based on sound factual material, came to the conclusion that there were no continental glaciations in the basin of the Pechora river and for the first time they mapped sea levels at 90–120 m. Geologists headed by P. N. Safronov attributed these levels to the marine transgression, which was called the Keynmusyuran transgression, the marine phase of the Boreal Sea. This phase is best expressed on the slopes of hills ("musyuras"), starting from the Pechora Sea to the middle reaches of the Pechora River.

In the chapter "Geomorphology and development of relief" P. N. Safronov writes: "The position of the sea level in the Keynmusyuran phase was most stable during the regression of the Boreal Sea, which is confirmed by the clarity of the forms of abrasion, the straightening of the coastline of large lagoons due to barrier spits and beach ridges".

The third chapter of the book The Crisis of Glacial Theory presents materials on the tectonic genesis of "glacio-dislocations" on the right bank of the Lower Pechora, i. e. of large exposures Vastyansky Kon and Markhida, the stronghold of glaciations on the Pechora. This chapter provides evidence of the ice-sea genesis of diamicton (former moraine) and highlights the continuation of the valleys of the Pechora River and Ob River as well as the shelves of the Barents Sea and Kara Sea. This also indicates that the shelves of these seas were drained at some stages of the Quaternary period but have never been a steppingstone for hypothetical cover glaciations of the Arctic sea shelf.

7. Shelves of the Barents and Kara Seas

Extremely important and large factual material was collected by Krapivner during marine expeditions aimed at studying the shelves of Kara Sea and, especially, Barents Sea. The questions are discussed in the fourth and fifth chapters of the book. In these studies, the main emphasis was placed on the study of Quaternary and modern sedimentation processes, the analysis of lithological types of sediments and the facies composition of poorly consolidated modern silts.

For marine geologists and Quaternary geologists, the following discoveries by Krapivner may be of great interest. Based on the results of offshore drilling and core studies of numerous core samplers, it was established that the structure of the upper structural tier on the shelf is dominated by massive, poorly sorted sand and clay deposits with an admixture of erratic and

local coarsely fragmented material. These deposits sometimes are very (hundreds of meters) thick, but usually their thickness amounts to dozens of meters. Glacioscientists routinely designated these sediments as glacial, moraine, or till. Krapivner uses the term "diamicton" and he also gives decisive evidence of their marine (glacial-marine) genesis. "Diamicton, as well as diamicton silt, almost everywhere contains foraminifera, forming natural tanatocenoses", which is a sign of normal sea salinity in the formation of diamicton and diamicton silts, as Krapivner points out.

Moreover, in the section of diamicton in the Pechora Sea, a pinniped bone was found.

Another discovery of Krapivner is the establishment of the marine genesis of band and layered silts and band clays, which have always been thought to be left by the glacier and its fluvioglacial waters. However, rich complexes of foraminifera contained in the band sediments argue against the glacier waters. This microfauna also forms natural tanatocenoses.

Lithological and paleogeographical studies of Krapivner on the shelves of the Barents Sea and Kara Sea and on the Arctic islands prove that the shelves of these seas were not covered by continental ice in the Quaternary period, and the Arctic islands had ice caps, about the same as today.

Marine geologists from Norway also refute the idea of cover glaciation of the Barents Sea shelf in the late Cenozoic era. According to their materials, even in the area of the Svalbard archipelago, the Barents Sea was ice-free and was characterized by high productivity and the number of planktonic foraminifera. The sea water temperature was about +3 to +4ºC [7].

8. On glacioisostasy of the Baltic shield

Among glacioscientists, the idea of crustal warping of Fennoscandia under the influence of glacial load was extremely widespread. Vice versa, when this load disappeared due to the glacier melting, the Earth's crust hypsometrically rose quickly. Glacioisostatic elevations within the Baltic shield were assessed differently by different scientists: according to M. Sauramo, it is 500–700 m, according to A. A. Nikonov — 400 m, according to B. I. Koshechkin — 1,200–1,300 m. The Earth's crust caved in by the same amount when the cover glacier moved in again. What initial data are taken as a basis of these calculations? First of all, they are based on the opinion that in Quaternary time Fennoskandia was covered by a 3–3.5 km thick glacier. This allowed scientists to use the simplest arithmetic operations and, based on the density of ice, its thickness and density of crystalline rocks to assume that the Earth's crust caved in under the ice by 1/3 of the glacier thickness, i. e. on average by 1 km, if you assume the thickness of ice is 3 km. At the same value of 1 km the earth's crust rose when the glacier melted. The difference in the figures of scientists depended on the thickness of ice taken as a basis by certain supporters of the glacier theory.

In section 6.3.1 of the sixth chapter of his book, Krapivner consistently showed the fallacy of the glacioisostatic theory and gave calculations of the viscosity of the asthenosphere, which is several orders of magnitude higher, so that the vertical glacial load cannot cause the asthenosphere to spread and the Earth's crust to cave in. Moreover, according to Krapivner, the glacioisostatic nature of the uplift of Scandinavia contradicts to the stable orientation of the maximum horizontal compression of the Earth's crust, which coincides with the direction of spreading in the northern part of the Mid-Atlantic Ridge.

In recent years, geologists specializing in tectonics began to draw the line with the glacioisostatic hypothesis and began to explain the lowering and rising of the Earth's crust, including that of the Baltic shield, with the usual neotectonic movements. Glacioscientists were in ferment: a group of scientists began to secretly abandon the ill-fated theory, while others continued to postulate it, continuing to copy glacioisostatic schemes of the old masters. The copyist's record now belongs to V. V. Kolka, head laboratory of Quaternary geology of the Kola scientific centre of the RAS, who shamelessly copied everything from the old textbook by M. A. Lavrova, who, in turn, borrowed the glacioisostatic scheme of the Kola Peninsula from the Finnish scientist M. Sauramo.

Still, we must give credit where it is due. One of the former vocal advocated of glacioisostasy A. A. Nikonov who ventured to abandon the extremely popular glacial support hypothesis. In his publications of the last decade, Nikonov calls this glacial conception "invalid", being not in line with the tectonic data, and he even rated Fennoscandia, the former stronghold of glacioisostasy, as "an underestimated seismogenerating province". This scientist had other new formulations, i. e. "movements on the Baltic shield were made not due to glacioisostasy, but as a result of pan-regional intra-crustal driving forces" [8].

More importantly, scientists have finally recognised that the Earth's crust on the Baltic shield is in a state of horizontal tectonic compression, which directly refutes the influence of vertical glacial pressure.

Nikonov's foregoing the orthodox hypothesis should not be taken for granted because his doctoral thesis was completely based on the glacioisostatic idea and this thesis was published as a book in 1977. There were no signs that this basis would turn out to be unreliable and the doctorate student who had once been a passionate proponent of the glacier theory would suddenly switch to conventional neotectonics.

Considered all, these actions look like the repentance of a sinner, but other glacial sinners do not even dare to repent fearing that Thesis Boards and the stern State Commission for Academic Degrees and Titles will wake up from their sweet dreams and require them to give up (as earlier a party membership card) their doctoral certificates, previously handed to an ovation and approval of every kind.

Rudolf Krapivner warns us from totally abandoning the glacioisostasy. It was not the case on the Baltic and Canadian shields due to the lack of glaciation, but it can have its influence in Greenland and Antarctica. This can be a subject to study.

The right non-glacial path can be shown to scientists by works of F. N. Yudakhin, a prominent geophysicist, corresponding member of the RAS, who proved the invalidity of the glacioisostasy theory for Fennoscandia. He writes: "The main reason for the modern rise of Fennoscandia is not the glacioisostatic "surfacing", but the presence of the asthenospheric lens in the Earth's lower crust and upper mantle. One more factor is horizontal tectonic compression in the upper layers of the Earth's crust, which directly contradicts the postulates of vertical glacial warping of shields and platforms. Numerous definitions of stresses in the Earth's crust indicate that in the territory of Fennoscandia horizontal stresses are 10 to 20 times higher than vertical ones" [9].

Conclusion

In the introductory part, Krapivner writes, "Once I heard the following from a famous top-ranking tectonic geologist: "Cover glaciations undoubtedly existed in the past. Do you know why I am so sure? They still exist, which means that the glacier theory is absolutely correct.""

The conviction of a high-ranking scientist, and, moreover, a specialist in tectonics, in the validity of the glacier doctrine is symbolic. After all, he essentially acts as an independent thought leader, his conclusion is clear and loud, and it sounds like the death knell of anti-glacialism.

Naturally, it inspires supporters of the glacier theory and gives pause to some advocate of the domination of the seas, who value personal safety and the ability to defend their theses without any complications above all. But there is still natural selection: Krapivner remained a pillar of anti-glacialism, and even published a capital book, which in fact abolishes the powerful glacier theory.

In addition, if you think about it, the lofty statement of a high-ranking scientist is mediocre, boring, if not empty. Anti-glacialism has never denied modern ice sheets; on the contrary, the study of glaciological processes was part and parcel of their studies. And their work on drilling the ice sheets of Antarctica and Greenland, and the ice caps of the Arctic islands, carried out as part of international projects, has brought very significant and long-expected results. It was found that the bottom layers of glacial covers and ice domes do not participate in

the general movement of glacial masses, but glaciers reliably preserve the subglacial bed, protect it from weathering, and even more so, from the notorious exaration. And yet, the cover glaciers do not invade the rocks of the bed, do not rip out boulders from it, do not engage in plucking and are not able to carry boulders across the expanses of European and American plains. According to drilling data and ice exposures, only rare inclusions of dust-like matter, mainly volcanic ash, are recorded in the bodies of cover glaciers.

Where would the anti-glacialists take their arguments and facts for their monographs, if there were no blessed glacial covers but only interglacial periods? It is not clear why Krapivner did not explain to that high-ranking scientist that the glacier theory is actually based on really existing geological and geomorphological criteria, i. e. erratic boulders, the moraine, bright and vivid types of exaration relief, huge erratic masses and concomitant "glacio-dislocations", eskers and ice-pushed ridges. The monograph by Krapivner proves their fault-tectonic and plicative-tectonic origin, we only have to read and study his book!

At the same time, it would be interesting to ask other outstanding specialists in tectonics, honoured workers of science, professors of the Moscow State University A. G. Ryabukhin and N. V. Koronovsky who encouraged them to this epoch-making conclusion: "The discovery of the ice sheets of Greenland and Antarctica completely dispelled all doubts about the reality of ice ages". Maybe they did it on the tip from a brilliant high-ranking tectonics specialist? Oddly enough, the very same wording was introduced into the glacier theory by many other glacioscientists as far back as the 1950s. This is how E. V. Shantser and Yu. K. Efremov encouraged scientists at the Moscow meeting in January 1953: "How can you doubt the continental glaciations of the past, when here they are, the great ice sheets of Antarctica and Greenland?"

What do these ice sheets really give science? They give a second wind to anti-glacialism, they give it an opportunity to better debunk the glacier doctrine. And praise the geological god that he created ice sheets in the polar and circumpolar regions of the Earth. Without study and through drilling them, it would be much more difficult to explain the effect of the "emperor with no clothes". However, it has taken us a long time to come to this.

Let us hope that the outstanding, fundamental work of Rudolf Krapivner and the enormous factual material collected in his numerous expeditions will play the crucial role in debunking and abolition of the glacier theory.

References

1. Krapivner R.B. The crisis of glacial theory: arguments and facts / R.B. Krapivner - M .: GEOS, 2018. 320 p.
2. Krapivner R.B. Rootless neotectonic structures / Krapivner - M .: Nedra, 1981. 204 p.
3. Hellem E. Great geological disputes. / E. Hellem - M.: Mir, 1985. 216 p.
4. Nye J.F. A method of calculating the thicknesses of the ice-sheets / J.F. Nye – Nature, vol. 169, 1952. p. 501-530.
5. Bolshiyanov D.Yu. Passive glaciation of the Arctic and Antarctica. / D.Yu. Bolshiyanov - SPb .: AANII, 2006. 295 p.
6. Geology and oil and gas prospects in the northern part of the Timan-Pechora region / ed. V.A. Dedeev - L .: Nedra, 1966. 275 p.
7. Rasmussen T.L. Paleoceanographic evolution of the SW Svalbard margin (76°N) since 20,000 14C yr BP / Rasmussen / Quaternary Research. 67, 2007. P. 100-114.
8. Nikonov A.A. The problem of modern geodynamics of the Baltic Shield: research in the light of new developments / A.A. Nikonov, O.A. Usoltseva, N.G. Gamburtsev, O.P. Kuznetsov / Tectonics and geodynamics of the continental and oceanic lithosphere: general and regional aspects. Vol. II, M.: 2015. P. 11-15.

9. Yudakhin F.N. On the nature of geodynamic processes in Fennoscandia. / F.N. Yudakhin - Petrozavodsk, 2002. / The deep structure and geodynamics of Fennoscandia, marginal and intra-platform transit zones. - p. 271-274.

Reference:

Chuvardinsky V.G., Skuf'in P.K., Evdokimov S.P. **Review on book of R.B. Krapivner "Crisis of glacial theory: arguments and facts"** // Russian Journal of Ecosystem Ecology. 2019.