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CHUVARDINSKY'S ANTIGLACIAL (GENERALIZED GEOLOGICAL) CONCEPTION

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АНТИЛЕДНИКОВАЯ (ОБЩЕГЕОЛОГИЧЕСКАЯ) КОНЦЕПЦИЯ ЧУВАРДИНСКОГО

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Abstract. Based on the analytical study of V. G. Chuvardinsky's monographs for the revision of the generally accepted glacial theory, the authors of the review concluded that there was convincing evidence of a fault-tectonic origin of 'ice-exaration' relief of the Baltic Shield. Developed by Chuvardinsky, a radically new methodology of boulder prospecting of ore deposits not only refuted old glacial theory, but also led to the discovery of copper-nickel deposits, a new apatite alkaline massif, promising manifestation of copper-nickel ore, platinum group metals, native gold, chromite and other mineral resources. A thorough drilling of ice sheets in Greenland and Antarctica for the international project established the absence of boulder material over the entire thickness of the ice, only pulverulent and fine particles (mainly volcanic ash) are recorded in ice. Bottom ice layers are immobilised, their function is preservation of the geological surface. V. G. Chuvardinsky far outstripped western and Russian scientists in the field of Earth Sciences. His field studies on the Baltic Shield not only refuted the mighty glacial theory, but also created and substantiated a new geological concept instead of it. Professor V. Z. Negrutsa was quite right when he wrote in his review of Chuvardinsky's work (journal *Geomorfologiya*, 2003, no. 1), 'Evidence of Chuvardinsky about tectonic origin of geological and geomorphological features traditionally associated with the Quaternary glaciation is so obvious and reproducible both by field observations and by geological modeling that is presented irrefutable and undeniable in its essence'. In general, assessing the scientific significance of V. G. Chuvardinsky's works, it can be argued that his work would have done honour to research institutes of geological and geographical orientation according to the level of study of the geological material and the value of his field studies. His books are ready material for several doctoral theses. Radiocarbon dating of fossil organic residues excluded continental glaciation of Fennoscandia as well as Eurasian plains. The glacial theory is hopelessly outdated but now it is continues leadership functioning.

Key words: fault tectonics, icesheet, iceexaration relief, boulder prospecting, radiocarbon dating, new antiglacial conception.

Аннотация. На основе аналитического изучения монографических работ В. Г. Чувардинского по пересмотру положений общепринятой ледниковой теории авторы данной обзорной статьи пришли к выводам об убедительности его доказательств разломно-тектонического происхождения «ледниково-экзарационных» типов рельефа Балтийского щита. Разработанная им принципиально новая методология валунных поисков рудных месторождений не только опровергла замшелую ледниковую методику, но уже привела к открытию медно-никелевого месторождения, нового апатитоносного щелочного массива, перспективных рудопроявлений медно-никелевых руд, платиноидов, коренного золота, хромитов, других полезных ископаемых. Сквозное разбуривание ледниковых покровов Гренландии и Антарктиды по Международным проектам установило отсутствие валунного материала по всей толще льдов, в них фиксируются только пылевидное и мелкозернистое вещество, в основном, вулканический пепел. Придонные слои льда обездвижены, их функция – консервация геологической поверхности. В области наук о Земле В. Г. Чувардинский далеко обогнал западную и нашу науку. Его полевые исследования на Балтийском щите позволили не только опровергнуть могущественную ледниковую теорию, но и взамен нее создать и обосновать новую геологическую концепцию. Совершенно прав был профессор В. З. Негруца, который в своей рецензии (Геоморфология. 2003. № 1) на работы автора писал: «Доказательства В. Г. Чувардинского о тектоническом происхождении геолого-геоморфологических признаков, традиционно связываемых с четвертичным оледенением, столь очевидны и воспроизводимы как натурными наблюдениями, так и геологическим моделированием, что представляются неопровержимыми и несомненными по своей сути». В целом, оценивая научную значимость трудов В. Г. Чувардинского, можно утверждать, что по уровню проработки геологического материала, по ценности полевых исследований его работы сделали бы честь крупным коллективам научно-исследовательских институтов геологической и географической направленности. Его монографии в принципе представляют собой готовый материал для нескольких докторских диссертаций. Радиоуглеродные датировки ископаемых органических остатков исключают материковое оледенение Фенноскандии и евроазиатских равнин. Ледниковая теория безнадежно устарела, но, будучи встроенной в бюджетную систему феодального типа, продолжает руководящее функционирование.

Ключевые слова: разломная тектоника, покровное оледенение, экзарационный рельеф, валунные поиски, радиоуглеродные датировки, новая неледниковая концепция.

Introduction

Glacial theory is one of the main fundamental paradigms of the Earth science. According to this theory, massive glacial covers with an ice thickness of 3,5–4,5 km were a burial shroud for flourishing plains of Europe, North America and North Asia. Even shelf seas of the Arctic Ocean are painted covered with continental ice. Considered firmly established is the thesis that glaciers not only buried sea and land but gouged and cut deep fiords and trenches, numerous lake kettles and skerry relief, drumlins and sheepbacks in the rocks of crystal shields. They scarred crystal rocks with furrows and striae; they polished them. An opinion was established that glaciers crushed bedrocks into blocks and boulders, including them into their bodies and translocating them thousands kilometers away.

On platform plains, glacial tectonics is depicted as very powerful and dynamic: glaciers extrude enormous outliers from deep horizons of the platform mantle and translocate them many hundred kilometers away; they disrupt the sedimentary cover and tear it apart, down to its crystal base; they erect glacial-tectonic terminal moraine swells, 150–180 m high and many hundred kilometers long.

Materials and methodology

The main body of data of geological-geomorphological profile was obtained by the geologist V. G. Chuvardinsky during his field research in the eastern (Russian) part of the Baltic shield in 1962–1998. After freezing of the geological sector, he started independent field studies in the key regions of the Baltic shield (within the boundaries of the Kola Peninsula and Karelia). V. G. Chuvardinsky is the author of 14 monographs, in which he undermined the dominating glacial theory, as well as advanced and grounded, from geological, geomorphological and biogeographical positions, a new original concept of nature evolution in the Quaternary. There are more than 30 informative reviews of Chuvardinsky's monographs published by prominent geologists and geographers (mainly in the reviewed journals of geological-geomorphological profile).

The main results and methodology of V. G. Chuvardinsky's works are described in his geological reports illustrated with geological maps, as well as in a series of monographs. Out of the monographs, three books have the highest practical value; they describe the methodology of boulder search for ore deposits and the search results obtained by this method [1–3].

In those three books, as well as other monographs, Chuvardinsky systematically grounds a non-glacial origin and the real mechanism of formation of many "glacial" forms of relief and boulder sediments. Paleographical problems are also considered [1–14].

Results of research. Origin of "exaration-glacial" types of relief

It is generally considered that the most important and graphic signs of past glaciations are "exaration-glacial" types of relief: fiords, skerries, lake kettles, sheepbacks, curly rocks, polished crystal rocks and rock furrows/striae.

These formations are a "stronghold" of glacial theory; they provide a basis for the ideas of huge glaciations, covering plains of the northern hemisphere – with a thickness of the ice cover of 3,5–4,5 km.

The long-term studies conducted by V. G. Chuvardinsky on the Baltic shield, an area with classical and diverse types of exaration relief, allowed him to conclude that this relief had a fracture-tectonic origin. A wide use of aero- and space images combined with scrupulous field research demonstrated a paragenetic connection of exaration relief with neotectonic fractures, with zones of modern tectonic activation. The collected data can be summed up in the main conclusions made by V. G. Chuvardinsky [1–4].

1. Crystal foundation of the eastern part of the Baltic shield is divided by a dense network of neotectonic fissures, among which one can distinguish deep, regional and near-surface fractures: side-thrusts, up-thrusts, down-thrusts, over-thrusts and thrusts-apart (Fig. 1, 2).
2. The systems of deep and regional neotectonic fractures and large "exaration" forms of relief (such as fiords, skerries and lake kettles in the crystal rocks) form united parageneses. These types of "exaration" relief are a geomorphological expression of fracture neoformation and neotectonic dislocation along fractures under the conditions when the Precambrian crystal shield undergoes a horizontal tectonic compression.
3. There is also a connection between smaller "exaration" types of relief (sheepbacks, curly rocks, rock polishing, systems of furrows and striae) with such structures as over-, up-, down- and side-thrusts. Massive occurrence of these forms of relief is observed at the ends of large shifts, and they are essentially dislocators and slickensides of the above-mentioned fracture structures – especially, near-surface over-thrusts and numerous spalling spots, whose dislocated elements were crushed into small-boulder material and then gravitationally displaced to the bases of the hill slopes.

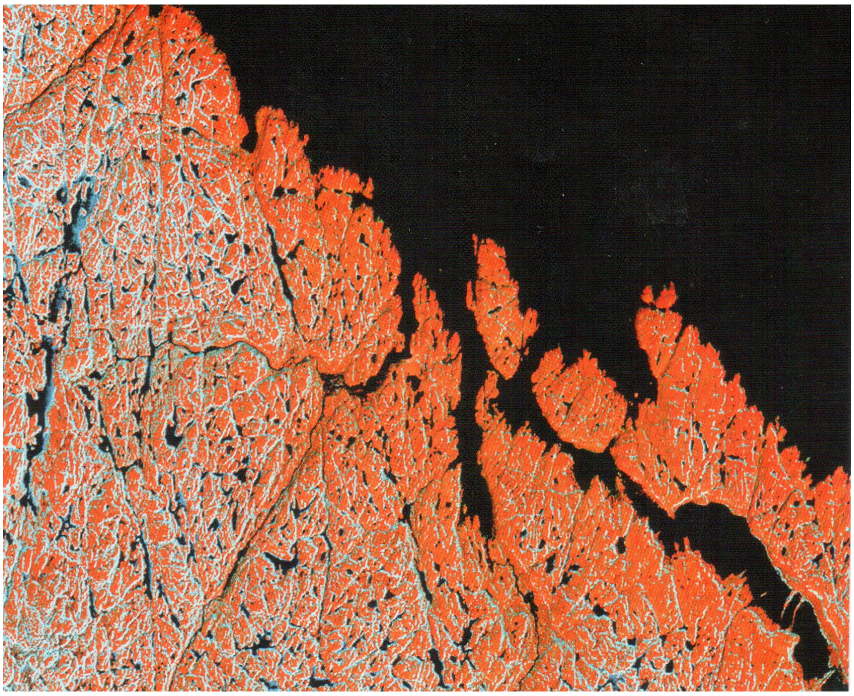

Fig. 1. A space image of the north-eastern part of the Kola Peninsula: the Murmansk geoblock of Archean granitoids divided by a dense network of neotectonic fractures and fissures. The intersecting fractures and fissures form numerous lakes, which are the deepest at the sites of fracture intersection. The coast of the Barents Sea is complicated with fracture-tectonic zones, fiords

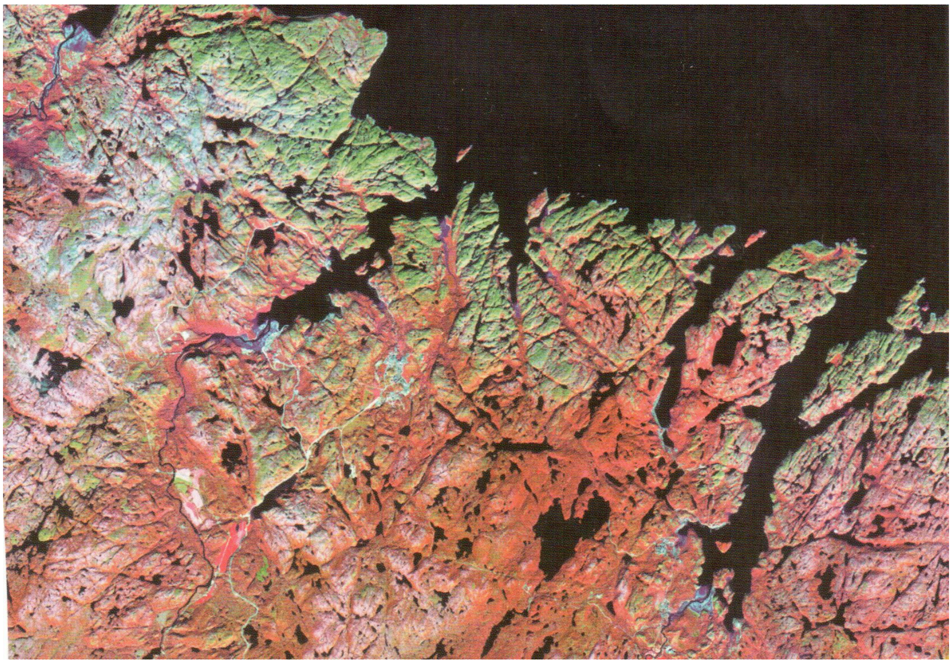

Fig. 2. A space image of the north-western part of the Kola Peninsula: the Murmansk geoblock of Archean granitoids. Neotectonic fractures and regional fissuring are well-developed and form numerous tectonic lakes with granite sides and bottom. The deepest lakes are located at the sites of intersection of orthogonal fractures. The coast of the Barents Sea is complicated with fracture zones, forming fiords

The fracture-tectonic genesis of these structures is additionally confirmed by the following data:

1. It can be seen in the contour of large outcrops of crystal rocks that polished and striated slopes of sheepbacks and curly rocks sink under the upper walls of over-thrusts, up-thrusts and flat down-thrusts. The polished and striated rocks sink deep into other rocks and have an evident fracture-tectonic genesis (Fig. 3, 4).

2. Gravitational sliding of rock blocks in intrusive massifs leads to massive outcrop of polished surfaces of typical sheepbacks of intrablock origin (Fig. 5).

3. The slickenside of sheepbacks is covered with a film of melanite rocks, and the systems of furrows and striae go in parallel and subparallel, which is typical for tectonic structures.

Fig. 3. Neotectonic scale over-thrusts (“curly rocks”) in Proterozoic migmatites. One can see sinking of polished and striated slickensides under the adjacent rock blocks; the Island of Putsaari, northern part of the Ladoga graben (photo by V. G. Chuvardinsky)

Fig. 4. Slickenside of a side-thrust: a general view of the arched side-thrust and the zone of tectonic crushing. The Ovechy Island, Kandalaksha Bay (photo by V. G. Chuvardinsky)

Fig. 5. Tectonic formation of sheepbacks on grandiorites. In the process of gravitational sliding of rock blocks, spherical and egg-shaped polished surfaces of intrablock origin come out. The development of sheepbacks of this type is related to the neotectonic growth of the roof of intrusive rocks (grandiorites). An island near the Cape Impiniemi, Ladoga skerries (photo by V. G. Chuvardinsky)

The largest types of “exaration” relief: fiords, lake kettles and skerries – are located along the system of regional and deep fractures of the crystal foundation. Association of these formations with neotectonic fractures is most evident on space images: their configuration mirrors the system of orthogonal fractures. Fiords, skerries, lake kettles are often oriented in four directions: they have abrupt elbow bends and cross shapes – they are formed at the sites of intersection of orthogonal fractures.

The relief forms going along side-thrusts differ from the forms along thrusts-away. In the first case, the sides of the relief forms have numerous spalls, secondary over-thrusts, tectonic slickensides, striae and furrows. For the relief forms lying along stretch fractures, steps of isolation and down-thrusts are characteristic, while polishing and striae are not.

Given a tectonic origin of fiords, skerries and lake kettles, one does not need to construct unreal glacial hypotheses: gouging of deep kettles, canyons and valleys, erection of huge glacial dislocations, and translocation of outliers hundred kilometers away.

Results of glaciological studies

The scientists from universities and research institutes who are united in "scientific-glacial" schools constantly refer to glacial covers of the Antarctic and Greenland. In their opinion, it is these covers that carried out a colossal tectonic work. They deem the very existence of these enormous glaciers as a proof that the glacial doctrine is true and inviolable; they believe that in the Quaternary, those glaciers gouged the Baltic shield, scouring crystal rock strata up to 200 m thick.

To get at the truth, one has to examine glaciological activity of these ice covers, which have successfully carried out their glacial functions for many million years.

By now, glaciologists, geologists, drill specialists and geophysicists have obtained detailed information on the dynamics and specifics of movement of cover glaciers – across their entire profile. Of special significance are the results of through drilling of the Antarctic and Greenland ice covers – down to their foundations – which were obtained within the framework of international projects. A thorough investigation of multi-kilometer ice columns, examination of vertical ice steeps and ice from the tunnels drilled in the foundation of glaciers yielded unexpected results. It turned out that instead of moraine-containing ice strata filled with huge blocks and boulders (which is usually depicted in the textbooks on general/Quaternary geology and geomorphology), the continental ice only contained inclusions of sandy-loam and melkozem matter. Even in the near-bottom parts of glaciers – the parts where a rich moraine stuffed with huge blocks and iron-shaped boulders is usually drawn (see, for example, V. M. Kotlyakov's and N. V. Koronovsky's schemes) – the only inclusions found were small lenses, clots of loamy and sandy matter and scarce sand grains. The content of those mineral inclusions is of a few hundredth of a percent, and they mainly consist of volcanic ash, microcosmic particles, aeolian dust from far deserts, rare inclusions of melkozem terrigenous matter, spores and pollen. Glaciologists also established that the near-bottom ice strata of cover glaciers (which, according to the glacial theory, should perform all the geological work) are not involved in the general movement of ice masses: they have been lying idle for hundreds thousand years, preserving the subjacent rocks from denudation and weathering. Moreover, ice covers conserve large paleotectonic lakes with their relict, very ancient water, protecting them from the notorious "gouging".

Thus, contrary to the canons of glacial theory, ice covers do not scour, gouge and pluck the subjacent rocks, do not form exaration types of relief and do not form various "glacial-tectonic" constructs. They do not include blocks or boulders, and after thawing they can only leave a thin, irregular layer of sandy-loam sediments. That will be the true – basic or ground – moraine of ice cover.

However, followers of glacial theory have no intention to accept the results of drill studies in the Antarctic and Greenland. They are convinced that Quaternary cover glaciers created all the types of glacial-exaration and glacial-tectonic relief, chipping blocks and boulders from the bedrocks and translocating them thousands kilometers away. Ice of the Antarctic and Greenland has fallen out of favor with glacial armchair scientists who, meanwhile, are busy with theoretical enlargement of mineral particles found in the Antarctic ice strata to the size of gravel.

Mineral particles in the cover ice strata

Scientists may be very reluctant when it comes to changing their beliefs, with the factual anti-glacial data often being ignored. Even worse – some armchair scientists shamelessly try to "enlarge" the matter found in ice. Here is an example.

Scientists from the Institute of Geography RAS wrote an anonymous collective review (negative, of course) of the manuscript of an anti-glacial paper send in the journal "*Priroda*". They wrote: "Chuvardinsky's views that cover glaciers cannot gouge the bedrock drastically are not acceptable for us, since *the Antarctic ice was established to be enriched with mineral particles sized from the loamy to gravel fraction*" (borehole 5). Well, let us see what this "gravel fraction" actually is. A large paper by V.Y. Lipenkov et al. [15] gives a detailed description of borehole 5, the ice samples of which from the depths 3311, 3538 and 3608 m were found to contain inclusions of mineral matter. Here are the conclusions made by the authors: "Microscopic examination of ice inclusions show that they are clusters of powdered aluminosilicate particles, which are concentrated in a small volume of ice around larger particles a few millimeters in diameter. The overall size of these particle clusters is 5-8 mm." (p. 255). Everything is clear now: these are only clusters of particles concentrated inside ice aggregates ("small volumes of ice") – ice of a lumpy texture. This is the very ice that makes the main part of the mineral-ice mass – the mass that scientists from the Institute of Geography RAS boldly pass for a "gravel fraction" of moraine. Upon ice thawing, these mineral-ice aggregates will desintegrate into water and loamy particles, and a moraine will be formed.

No doubts, aggregates of ice and mineral particles can be larger – up to the size of ice-mineral "boulders". Yet upon thawing of the glacier, they will desintegrate into water and single mineral particles. By the way, other researchers also mention an increased content of mineral matter in the bottom parts of cover glaciers. However, the occurrence of mineral particles (sized from 1 mm to 1–5 mm) is very low even in the near-bottom layers of ice: 2–25 particles per 1 m of ice core (Leychenkov, Popkov) [16].

How has it been possible to hide for such a long time that there is no boulder-block moraine-containing strata in the lower (or any other) parts of cover glaciers? The pulverescent melkozem matter, traces of which can be found in ice, has been skillfully presented by glacial scientists as near-bottom moraine, and everyone has been convinced of that! Naturally, how else could it be? If the terms "moraine-containing strata", "near-bottom moraine" are used authoritatively and instructively, the glacial strata must contain blocks and boulders. Ice should be stuffed with them, exactly like many schemes and profile pictures illustrate! A great help for glacial theory was the opinion letter by Evteev and the likes of him. For half a century have they thrown glacial dust in everyone's eyes.

One cannot help but to remember Hans C. Andersen's tale "The Emperor's New Clothes" (1837). In the tale, chamberlains and other courtiers skillfully ignored the absence of any clothes on the emperor's body and praised the "new garments invisible to commoners" to the skies. And here we have followers of glacial doctrine, who have been zealously singing praises to moraine-containing strata of the Antarctic and Greenland glacial covers and ice caps of arctic islands for decades. This is the real moraine ice, they say, the real "iron-boulderous" ice!

That is how they magically transformed a mere volcanic ash and rare terrigenous matter.

To support these claims, a field documentation supplemented by photo-documentation is needed, and such a documentation was presented by glacial scientists for the Antarctic glacial cover. Published in "The Glaciological Dictionary" [17], a fundamental book, was an image of moraine-containing ice (image X.19) with the following legend: "Layers of moraine-containing ice in the iceberg near the shores of Wilkes Land" (Fig. 6).

Fig. 6. Layers of moraine-containing ice in the iceberg near the shores of Wilkes Land, the Antarctic (The Glaciological Dictionary, 1984. Image X.19)

Indeed, as can be seen in the profile of the overturned iceberg, there are strips of blackened (contaminated with mineral matter) ice alternating with pure ice. Yet what is this moraine matter? It is clear that this is a melkozem matter, with spots where while ice appears through the blackened layers. In literature, such textures are referred to as "dirty ice"; their moraine matter is represented by loamy-silt material. No inclusions – even of a gravel/pebble size, not to mention boulders – have been registered so far in the moraine-containing ice of cover glaciers. The large groups of followers of glacial doctrine cannot find anything more graphic than this image, but they must understand that upon thawing, such a moraine-containing ice will yield only millimeter-centimeter layers of a loamy-silt sediment. This sediment is what should be considered the real near-bottom moraine of a cover glacier.

What is this contaminating matter? What is the size of its particles? What is the mineral composition of the matter and its percentage in the ice core? Alas, the authors of the workbook, VSEGEI (All-Union Scientific Research Geological Institute) scientists F. A. Kaplyanskaya and V. D. Tarnogradsky, humbly refrain from the discussion of these questions but, nonetheless, use the term "moraine-containing ice". Yet even the bottom parts of mountain-valley glaciers contain no boulders (Fig. 7).

Fig. 7. A natural tunnel in the near-bottom part of the mountain-valley glacier Matanuska, Alaska. The tunnel was made by temporal glacier water streams. In this three-dimensional exposure of ice, no boulders or smaller rock pieces can be seen: not in the glacier walls, nor in its foundation, nor in the ceiling – nothing is left from the thawed ice, although the outer surface of the glacier does contain large-clastic material fallen on the glacier back from the overhanging hillsides. The photo-documentary material confirms the conclusions made by E. Evenson and J. Clinch who studied the Alaskan glaciers "MacLaren" and "Gulcana" that bottom moraine is completely absent there

Now, what about the "glacial-boulder formation" of the Russian Plain, which is attributed to the Fennoscandian glacial cover? Quite an accurate lithologic characteristic of this formation is given in the work by I. I. Krasnov et al. [18]: "In general, characteristic for the glacial formation is scale-shaped bedding, a close relation to the composition of the subjacent rocks, capture structures, presence of glacial outliers, and a wide spread of local moraines containing inclusions of practically all the horizons of the subjacent pre-Quaternary rocks". We can add: including blocks and boulders of the rocks of crystal foundation uplifted with tectonic breccia through deep fractures of the foundation and mantle. The "glacial" formation described by Krasnov et al. is, in fact, a fracture-tectonic formation formed in the seam zones of active neotectonic fractures and in the region of their dynamic influence. There are some other natural processes leading to the formation of boulder formations, but we cannot consider them here because of text length restrictions.

Boulder deposits of the Baltic shield

Let us consider the Baltic shield. What is the main (bottom) moraine of this vast neotectonic structure comprised of Archean-Proterozoic crystal rocks? First of all, these are boulder-block deposits with loamy sand filler, lying right on the pre-Cambrian rocks. The average thickness of this boulder-block formation is about 3 m.

Moraine of the Kola Peninsula consists of boulders and blocks (30–40 %), melkozem (sand, loamy particles; about 30 %) and material of gravel-pebble size (about 25 %). The "bottom moraine" lies directly on bedrocks. Its thickness ranges from 0,5 to 15–20 m, with the average thickness of 3–5 m. Boulders and blocks in the moraine are sized from parts of a meter to 1–2 m in diameter. Blocks 10–15 m long and 5–7 m high are not an exception. Sometimes, even larger blocks are found. The size of such blocks often exceeds the thickness of "moraine", and they can be mistaken for outcrops (Fig. 8).

Fig. 8. A tectonically over-thrust block of gneissic granites crushed into large-boulder material. West of Murmansk Region; the Paust river (photo by V. G. Chuvardinsky)

Fig. 9. Desintegration of a neotectonically active gabbro-norite protrusion into large-block material. South-west of Murmansk Region, the Lake Krivoe (photo by V. G. Chuvardinsky)

For understanding moraine genesis and for the purpose of boulder search, it is important to study the composition of "bottom moraine" boulders. It was as far back as 150 years ago when A. A. Inostrantsev found that boulders of the Karelian "moraine" were composed of the same material that the subjacent bedrocks. That important observation was met with suspicion, but nowadays many studies in the eastern part of the Baltic shield, in Finland, Sweden and Norway confirmed A. A. Inostrantsev's observations. A close dependence of the composition of the boulder-block material of "moraine", its melkozem and even its color on the composition of the subjacent and local rocks was established (works by G. S. Biske, A. V. Sidorenko, R. Kujansuu, O. Holtedahl).

The materials on the petrographic composition of boulders and pebble fractions of "bottom moraines" of the western part of the Kola Peninsula, which demonstrate their close connection to the local bedrocks, are given in V. G. Chuvardinsky's reports on boulder search, as well as in a number of geologocal-surveying reports of the Karelian, Central Kola and Thematic expeditions of Production Geological Association "Sevzapgeologiya". It looks like the glacier shrank its duties on translocation of blocks and boulders. As for the boulders and blocks of crystal rocks that contain striae and furrows, this is the most convincing sign of their fracture-tectonic origin.

Boulder search for ore deposits

In the Baltic shield region (especially, in Finland), the method of boulder-glacial search for ore resources has been used for a long time. It is based on the theory of glacial gouging, scouring and plucking of bedrocks and translocation of boulders by the cover glacier hundreds and thousands kilometers away. At the same time, the boulder-clastic method has been in use – irregardless of any theory – for a long time: Ural masters of mining craft successfully used it to seek for copper, coal and gemstone deposits.

On the basis of long-term geological boulder survey conducted by V. G. Chuvardinsky on the Kola Peninsula and in North Karelia and thorough study of neotectonics, a conclusion was made that it was not glaciers but neotectonic fracture deformations that were the key to understanding the process of formation and translocation of boulder-block sediments. This concept was described in V. G. Chuvardinsky's books [1, 2, 12], yet it remains unknown or little-known beyond Russian borders.

For our readers, of most interest are the conclusions relating to the fracture-tectonic concept:

1. In the zones of neotectonic fractures, crystal rocks are crushed to blocks, boulders, tectonic blocks and wedges. Such brecciated large-clastic formations are located along the fractures in accord to the displacement vector of their limbs. In the regions of up-thrusts parts of the dislocations, a part of brecciated boulder-block masses outcrops. The same processes go in over-thrusts and up-thrusts.
2. Translocation of friction breccias in the seam zones results in pelletization of boulders, their polishing, striation and transformation into flattened and iron-shaped boulders.
3. Spatial orientation of boulder trails coincides with the direction of neotectonic dislocations; boulder trails are also formed in the zones of outcropping up-thrusts and over-thrusts; forming along deep dislocations, are series of superseding cones of boulder separation.
4. Large-clastic masses are translocated both actively (as parts of near-fracture seam breccias) and passively (on the surface of dislocating fracture limbs). Depending on the scale of tectonic processes, the distance of transport of boulder material along fractures varies from a few tens and hundreds of meters to a few kilometers. In the zones of deep dislocation, subhorizontal translocation of brecciated masses long fractures reaches 20 km.
5. In case of such a tectonic mechanism, a part of boulder-block material, including ore material, was brought out to the surface from the zones of fracture seams lying at depths from several tens to a few hundreds of meters. This makes it possible to use ore boulders as indicators of the location of blind ore-bearing massifs. Thus, the boulder method of search for ore deposits becomes not only surface but under-surface as well.

These theses are grounded by complex geological geophysical and geochemical data, as well as prospect drilling. Using this method, V. G. Chuvardinsky's team discovered a number of ore objects, including a copper-nickel deposit, a new apatite-bearing alkaline-ultrabasic massif of central type, platinum-bearing massifs, a number of basite/hyperbasite bodies with copper-nickel mineralization, deposits of magnetite quarzites, chromites, uranium-containing metasomatites, and gold mineralizations in bed rocks.

The same regularities were revealed on the Siberian platform (Norilsk Region).

With geological profiles of ore and barren horizons and materials of boulder survey, V. G. Chuvardinsky came to a simple conclusion: ore blocks and boulders (as well as blocks and boulders of the container barren rocks) of the unique Talnakhsky copper-nickel deposit outcropped along fractures as a part of tectonic breccia. The main part of ore blocks and boulders came to the surface owing to the Norilsko-Kharaelakhsky deep dislocation and the branching fractures. It turned out that the glacier had nothing to do with that.

P. K. Skuf'in, Doctor of Science, a recognized specialist on copper-nickel ores from the Geological Institute of KSC RAS, wrote in his review (journal Izvestiya SmolGU, 2014, no. 1): "The analysis of distribution of ore boulders in the contour of ore and near-ore bodies of the Talnakhskoe copper-nickel deposit convinces us – as it did V. Chuvardinsky – that the trail of ore boulders was formed in the process of outcrop of tectonic blocks and friction breccias along the deep Norilsko-Kharaelakhsky fracture and the systems of smaller branching fractures. Even the composition of these fragments – a lot of which are ore varieties from deep horizons of the deposit inaccessible for mythic glaciers – confirms the conclusion made by Vasily Grigorievich, who wittily described the situation in his monograph, opposing the advocates of glacial plucking of "moraine" fragments: to explain this unusual composition of moraine, one has to supplement the glacial theory with a notion of "underground" gouging".

For further illustration, we present images of near-surface tectonic desintegration of bedrocks into blocks (Fig. 10, 11). The process is accompanied by the formation of sheepbacks in the foundation of over-thrusts.

Fig. 10. Process of release of the rocks of tectonic sheepback from under the massif and desintegration of a part of the massif into block material. The polished surface of sheepback can be traced under the uudisturbed block. Granitoids. Skerries near the Kulkhonniemi Peninsula, Northern Priladozhie (photo by V. G. Chuvardinsky)

Fig. 11. A down-thrust plate crushed into large-block material of nepheline syenites. Khibinsky massif. The vertical wall (outcrop of nepheline syenites) is a slickenside of the down-thrust

Fennoscandia and radiocarbon dating of mammoth bones and fossil wood

In his papers of 1970, in which he analyzed materials of radiocarbon dating, V. G. Chuvardinsky raised a question about absence of continental glaciation of Fennoscandia during the Würm.

Thirty years later, very similar conclusions were made by a group of competent authorities: Y. K. Vasilchuk, A. K. Vasilchuk, O. Long, E. Jall and L. D. Sulerzhitsky – who had a much larger body of radiocarbon dating material (presumably, mammoth bones) at their disposal [19]. These authors argued that mammoths continuously existed in the north of Eurasia – at least, 40–10 thousand years ago. In their opinion, this was a proof of unreality of cover glaciations in the spaces of northern plains.

The authors further wrote: "Of special interest in this respect are results of late pleistocene dating of mammoths in Scandinavia – they indicate a spread of Scandinavian population of mammoths 40–10 thousand years ago; probably, a cryolite zone with large non-glacial regions was there alongside with glaciers".

The authors are very careful in their conclusion, but this is enough to debunk the traditional view of Fennoscandia as a center of massive cover glaciation with ice thickness up to 4 km.

Thus, the former massive, monolithic glacial shield turned out to be divided into "large non-glacial regions" and scattered ice fields or caps. Those non-glacial spaces could not be mere summits towering above "enormous glacial cover": such summits were simply devoid of vegetation, a source of mammoth's food.

Therefore, a paleogeographic perspective gives not reasons to consider Fennoscandia a center of European glacial cover, and many glacial constructs look merely scholastic.

One can say that mammoths decided the fate of glacial theory not in favor of its creators.

After the breakthrough paper by Y. K. Vasilchuk et al., new data on the habitation of mammoths in Fennoscandia during the last cover glaciation appeared. The monograph "Evolution of European ecosystems upon transition from Pleistocene to Holocene (24–8 thousand years ago)" [20] shows a scheme of distribution of mammoth fossils in Sweden and Finland, in the so-called central glacial zone where they had lived over the entire "glaciation".

Earlier, A. Heintz published key papers on the radiocarbon dating of mammoth fossils (a tusk and jaws) found in the central part of Norway, in the valley of the river Logen [21]. The values obtained were 19 000 ± 120, 20 000 ± 250 and 23 370 ± 98 years ago. Hence, the animals were pasturing and breeding in that lively valley when the Würm cover glaciation was at its height!

Another Norway researcher, Leif Kullman, came to the conclusion – on the basis of radiocarbon dating of fossil birch wood and materials of other authors – that during the summit of the last glaciation (21–17 thousand years ago), there were ice-free areas in the northern part of Norway, which contained wood vegetation [22].

That is not all, however. A large group of scientists led by L. Parducci (see Parducci et al. [23]) not only confirmed L. Kullman's conclusions, but also established that pine and spruce grew in the north-west of Norway during the last glaciation. The following results of radiocarbon dating were obtained for the fossil wood of spruce and pine: 22 000, 19 200 and 17 000 years ago. Such an age of the wood coincides with the summit of glaciation – yet again, the scientists do not abandon the idea of Scandinavian glaciation, confining themselves to a supposition that the region where the wood was found was "ice-free".

The authors of "Evolution of European ecosystems…" were also careful in their wording: "The data on Fennoscandia show that even in this region, there existed isolated populations of animals living on ice-free areas".

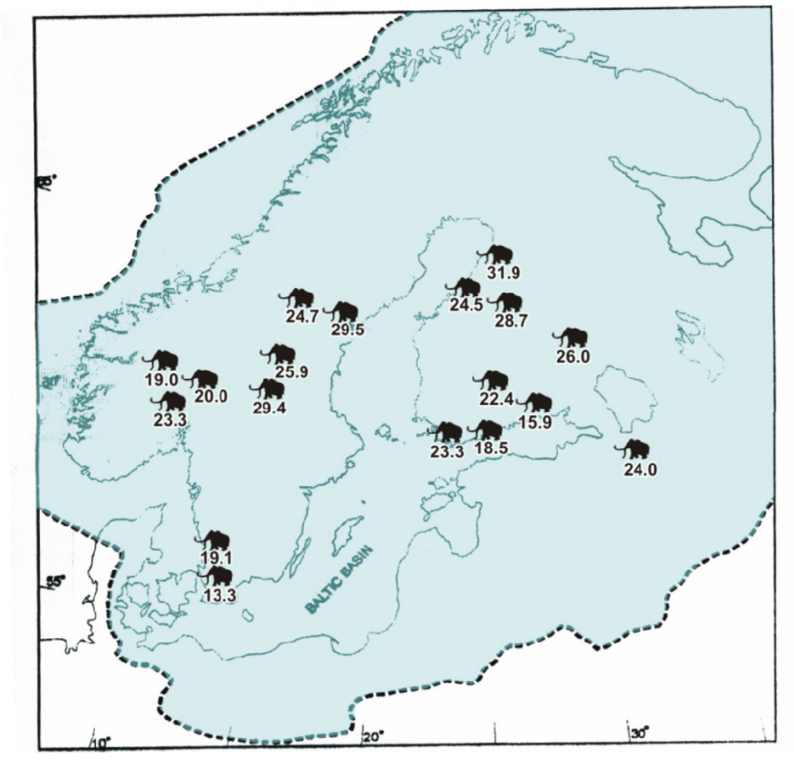

Fig. 12. Locations of mammoth fossils in Fennoscandia dated by the time of the last (Würm) cover glaciation (26–10 thousand years ago). The absolute age of the samples was determined by the radiocarbon method (shown as a number of thousands years ago). The dashed line shows the area of the Fennoscandian glacial cover (the scheme was made by V. G. Chuvardinsky on the basis of data by P. Ukkonen at al. [24, 25]; A. Heintz [21]; A. A. Nikonov and L. D. Fleyfel [26])

The data on the habitation of mammoths in Sweden and Finland and on wood vegetation in Norway and Sweden during the last glaciation are constantly widening. New data on the radiocarbon dating of mammoth bones and fossil wood confirm time and again that during the period 26-10 thousand years ago, there was no any glaciation in Fennoscandia. Here are new results of radiocarbon dating in Fennoscandia (in thousands years ago): 25,9; 24,7; 24,5; 23,3; 22,4; 22,0; 19,2; 19,1; 18,5; 17,0; 16,9; 14,0; 13,3; 13,0; 12,9; 11,7; 11,0; [22–26]. These dates correspond to the time of the last (Würm) broad and massive glaciation (as it is presented on the paper, of course): its beginning, summit and degradation (Fig. 12).

There are also new radiocarbon data on mammoth bones and vegetation fossils which fall into the interglacial period: 26,2; 28,7; 29,4; 29,5; 31,0; 31,9; 34,5; 37,0; 40,2; 41,0 thousand years ago [24–26]. The Holocene fossils (mainly peat and wood fossils) are also well-studied. There is, therefore, no escape in the attempts to interchange “glaciation” and “interglaciation”, as suggested by some scientists. One also cannot put glaciation into the Holocene: there is evidence of wood vegetation and mammoth habitation in Fennoscandia during both glacial and interglacial periods. Yet the glacial system does not change – apparently, it would yield only if the body of radiocarbon data was so large and their spatial distribution so dense that only small mountain glaciers could be placed on the map.

Scientific reviewing

There are more than 30 reviews of V. G. Chuvardinsky’s monographs. Most of them were published in reviewed journals approved by the Supreme Certification Board (Ministry of Education and Science of Russian Federation). The reviews were written by prominent scientists (geologists and geographers), and their list is given below.

1. N. G. Chochna, *Geomorfologiya*, 1999, no. 3.
2. N. G. Chochna, *Vestnik Mordovskogo gosuniversiteta* [Bulletin of Mordovia State University], 2000, no. 1–2.
3. V. G. Zaitsev, *Otechestvennaya geologiya* [National Geology], 2002, no. 5–6.
4. V. G. Zaitsev, *Otechestvennaya geologiya* [National Geology], 2013, no. 4.
5. V. S. Zarkhidze, E. E. Musatov, *Izvestiya Russkogo geograficheskogo obshchestva* [Proceedings of the Russian Geographical Society], 1999, no. 3.
6. V. S. Zarkhidze, E. E. Musatov, *Izvestiya Russkogo geograficheskogo obshchestva* [Proceedings of the Russian Geographical Society], 2001, no. 5.
7. Y. N. Golubchikov, *Geografiya* [Geography], 2004, no. 26–28.
8. Y. N. Golubchikov, *Geomorfologiya*, 2010, no. 1.
9. Y. N. Golubchikov, *Izvestiya Smolenskogo gosudarstvennogo universiteta* [Proceedings of the Smolensk State University], 2010, no. 2.
10. Y. N. Golubchikov, *Izvestiya Smolenskogo gosudarstvennogo universiteta* [Proceedings of the Smolensk State University], 2014, no. 2.
11. V. Z. Negrutsa, *Geomorfologiya*, 2003, no. 1.
12. S. P. Evdokimov, *Izvestiya Smolenskogo gosudarstvennogo universiteta* [Proceedings of the Smolensk State University], 2009, no. 2.
13. A. A. Predovsky, *Geotektonika* [Geotectonics], 2002, no. 2.
14. A. A. Predovsky, *Geomorfologiya*, 2002, no. 1.
15. A. A. Predovsky, *Izvestiya Smolenskogo gosudarstvennogo universiteta* [Proceedings of the Smolensk State University], 2013, no. 2.
16. A. A. Predovsky, *Izvestiya Smolenskogo gosudarstvennogo universiteta* [Proceedings of the Smolensk State University], 2015, no. 2/1.
17. P. V. Frolov, Proceedings of RGS, 2013, no. 3.
18. P. V. Frolov, *Izvestiya Smolenskogo gosudarstvennogo universiteta* [Proceedings of the Smolensk State University], 2013, no. 1.
19. V. N. Dolzhenko, *Razvedka i okhrana nedr* [Exploration and Preservation of the Earth Interior], 2003, no. 1.
20. V. N. Dolzhenko, *Izvestiya Vysshikh uchebnykh zavedeniy. Geologiya i razvedka* [News of Higher Schools. Geology and Exploration], 2002, no. 6.
21. L. R. Serebryanny, *Geomorfologiya*, 1999, no. 3.
22. P. K. Skuf’in, *Izvestiya Smolenskogo gosudarstvennogo universiteta* [Proceedings of the Smolensk State University], 2014, no. 1.

A number of reviews (by R. B. Krapivner, G. A. Belenitskaya, A. A. Predovsky, V. G. Zaitsev, V. Z. Negrutsa) were published in non-reviewed periodicals.

Out of 22 reviews published in SCB-approved journals, 21 are purely positive and, no doubts, informative. One review, although informative, is purely negative. This is a review by Leonid R. Serebryanny (Geomorphologya, 1999, no. 3), a renowned scientist from the Institute of Geography RAS. He and his advisers from the Institute of Geography and Moscow State University decided to teach V. G. Chuvardinsky a good lesson, pouring their polemic ardor into criticism of his book of 1998 [2]. However, the geologist under fire has always considered criticism – no matter how sharp – to be more useful than some panegyric reviews. Why? Because you can always give a detailed answer to a negative review and can even manage to publish it the same journal – exactly what V. G. Chuvardinsky did. His "Response to the Reviewer", an impressive dethronement of glacial theory, was published in Geomorphology, no. 1, 2001. His perplexed opponents (L. Serebryanny and his advisors) were going to follow with a contra-review; they compiled a working variant, but the matter did not get any farther. It's a pity. Such a discussion would have been bread for the geologist who had collected vast factual material in his field studies.

Twenty years have passed since that time. V. G. Chuvardinsky published other 12 monographs. However, the new editor of Geomorphology tabooed even mentioning Chuvardinsky's books, and nobody could publish in that journal even one more review. Here is the most vivid example.

The new editorial board of Geomorphology decided to reject not only anti-glacial papers by V. G. Chuvardinsky, but also reviews on his monographs sent by scientists from Moscow State University and Karelian Scientific Center. One of V. G. Chuvardinsky's books, "The Quaternary. A Novel Geological Concept" [8], was in the process of reviewing. A few months later, the author of the first review, Y. N. Golubchikov, was informed that both the hard and electronic copies of his review were "lost" in the editorial office. Another copy of the review was sent once more and finally, in March of 2013, the author received an astonishing reply. Here is its electronic version.

Dear Yuri Nikolaevich,

We appreciate your interest in our journal and we understand your point of view, thank you. The journal only publishes the book reviews that were solicited by the editorial board, and the choice of works to be reviewed, as well as reviewers, is the editor's prerogative. Unfortunately, the editorial board does not consider appropriate the publication of your review of Chuvardinsky's book of 2012.

With best regards,
E. A. Karasyova,
Chief Editor of Geomorphology

Another review of that book, by a Karelian researcher P. V. Frolov (Institute of Geology of Karelian Scientific Center RAS) was also "lost" without a trace in the editorial office of *Geomorfologiya*. The editorial board did not deign to give P. V. Frolov any explanation. The review by P. V. Frolov came out only a year later, in the journal *Izvestiya Russkogo geograficheskogo obshchestva* [Proceedings of the Russian Geographical Society], 2013, no. 3, whereas the review by Y. N. Golubchikov appeared in the journal *Izvestiya Smolenskogo gosudarstvennogo universiteta* [Proceedings of the Smolensk State University], 2014, no. 2 – both reviews were published without reduction.

The editorial boards of "orthodox-glacial" journals widely use anonymous reviews written by their staff reviewers to categorically reject anti-glacial manuscripts. V. G. Chuvardinsky readily publishes "explanatory" replies to such peculiar anonymous reviews. In particular, they are collected in his book "A Discussion with the Glacial Doctrine" [11].

Conclusion

The ideas about great glacial covers were born in the Alps almost two centuries ago. The European naturalists Ignaz Venetz, Jean de Charpentier and Louis Agassiz took mountain glaciers as a basic pattern and quickly extended glacial covers of enormous thickness over the entire Europe, North America and Russia.

By now, those constructs have been shaped into a powerful glacial theory united many Earth sciences: from geology and geography to climatology and ecology.

Opposing the glacial theory, the great naturalists Charles Lyell and Charles Darwin advanced a drift hypothesis, which suggested translocation of boulders with drifting ice floes and icebergs. However, the glacial doctrine remained unshakeable.

In the middle of the 20th century, the ideas of Lyell and Darwin were taken by the Soviet geologists A. I. Popov, I. D. Danilov, I. L. Kuzin, N. G. Chochna. On the basis of their own data, they removed glacial cover from the lowland, coastal territories of Western Siberia and the basin of the Pechora. The legendary Kiev zoologist Ivan Grigorievich Pidoplichko (1905–1975) went even further: he founded a new scientific doctrine, anti-glacialism. He published an epic 4-volume treatise "On the Ice Age" (1946, 1951, 1954, 1956), in which he rejected cover glaciation of Europe and Western Siberia on the basis of zoological and paleobotanical data.

Fig. 13. Academician of the Ukrainian Academy of Sciences Ivan Grigorievich Pidoplichko and geologist of Murmansk geological-geophysical expedition Vasily Chuvardinsky. Kiev, February of 1967

I. G. Pidoplichko had to endure the fire of the entire machine of Soviet official criticism, which later turned into a campaign of bitter slandering of the anti-glacialist. Yet being hardened during the years of the 2nd World War (as a member of fighting military units, he went from the Volga to the German river Wezer), he stayed firm. Besides, the slanderers, who had been sitting in Tashkent for the entire war period, did not dare to finish the veteran decorated with military orders.

However, anti-glacialism of I. G. Pidoplichko and marinism of Siberian geologists were both particular theories, since they admit the existence of massive glaciation in Fennoscandia and Canada. Both theories considered the exaration types of relief to be glacial, and the relief of sheepbacks, curly rocks, polishing, rock striae and furrows to be exemplary glacial. "It cannot be helped", they said, "These are indelible traces of a glacier!"

The Arctic geologist Vasily Chuvardinsky set himself a task which seemed unreal: to reveal the real origin and the real mechanism of formation of all those glacial traits, geological and geomorphological criteria that the glacial theory is based upon (Fig. 13). Decades were spent on field research, but he managed to prove the fracture-tectonic genesis of exaration relief and fracture-folded origin of eskers and terminal moraines, and he developed a new methodology of boulder search for ore deposits. In the end, he advanced and grounded a novel geological-tectonic concept, which replaced the outdated glacial theory.

Nowadays, we come to the understanding that since, at least, the Palaeozoic era, the Earth's Nature – both its lithosphere and the organic life on its surface – evolved gradually, without interruptions by mythical glaciation periods. A time has come to eliminate the huge blank spots in the complex history of the Earth.

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Skuf'in, P. K.

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