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Special Interest Tourism (SIT) in Murmansk (Arctic NE Scandinavia): Touristic Route around the City to Explore the Oldest Rocks in Europe

Miłosz Huber [1,*], Olga Iakovleva [2], Galina Zhigunova [3] and Marija Y. Menshakova [4]

1 Department of Geology, Soil Science and Geoinformacy, Faculty of Earth Science and Spatial Management, Maria Curie–Skłodowska University, 2d/107 Kraśnickie Rd, 20-718 Lublin, Poland
2 Department of Applied Linguistics, Faculty of Humanity, Maria Curie Skłodowska–University, 5 Maria Curie–Skłodowska Sq, 20-031 Lublin, Poland
3 Department of Philosophy and Social Sciences, Murmansk Arctic State University, Captain Egorov, 15, 183038 Murmansk, Russia
4 Laboratory Monitoring and Preservation of Natural Ecosystems of the Arctic, Murmansk Arctic State University, 183038 Murmansk, Russia
* Correspondence: milosz.huber@mail.umcs.pl

Abstract: The city of Murmansk together with the neighboring town of Kola is an agglomeration in the Arctic, in the northern part of the Kola Peninsula on the Barents Sea fjord. Some of its roots date back to the 16th century when the foundations of Russian civilization were built in this region. Rock paintings and labyrinths indicate that there were peoples living in this area before then: the Saami were here much earlier. This historic heritage is superimposed on the extraordinary environment of the far north, with a relatively mild climate associated with the warm Norwegian stream. An important and inseparable element of the city's landscape is a non-freezing port on the coast, which offers a window to the world, and numerous hills forming an interesting city landscape built of Archean gneisses as old as 3.75 billion years. These are among the oldest rocks in Europe. Murmansk, with its wealth of tourist features and as a center of science, industry, and trade, also aspires to be the capital of the entire Arctic. Walking the streets of this city, which is just over a century old, past its neoclassical buildings, one can observe several inanimate natural forms that show visitors the unusual nature of the city's topography. Efforts to promote these have been partly implemented around the Monument to the Unknown Soldier, where a small ecological route has been marked out. However, tourist interest in the city is increasing, and this article attempts to answer this interest by proposing a loop of tourist routes displaying many interesting features of the city.

Keywords: Murmansk city; Arctic Scandinavia; geoheritage; touristic values

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1. Introduction

The creation of urban tourist routes is a tradition known all over the world. Particularly interesting are the thematic routes that allow tourists to familiarize themselves with the historical, urban, and cultural values of the city, as well as with its nature and the aspect of the land. Such solutions are successful for both tourists and residents, allowing them to become acquainted with their place of residence from a different angle, sometimes paying attention to aspects omitted in their daily lives. Examples of such routes can be found in many countries. In Berlin, the most popular is the route dedicated to the former wall dividing the city [1,2]; in Krakow, there is the route of the fortress and military fortifications [3,4]; in Rome, there is a route pertinent to the city's significant cultural and historical heritage [5,6]. In Katowice, there is a trail of technical objects [7,8], and in Kielce a geological trail [9]. Many geotourist routes allow one to pay attention to the natural aspects, including the ground on which the cities are located [10]. In Russia, the most famous example is Moscow [11,12], which has several thematic city routes (architectural, historical, cultural, space, etc.). Nonetheless, these proposals are still scarce in Russia, especially when it comes to cities outside the country's inner city. So far, the literature in these regions has mainly dealt with areas of recognized natural values (Baikal, Altai), while there are very few such proposals for cities. This trend is currently changing intensively, but there is still a great need for detailed studies of such regions as the Kola Peninsula or Murmansk city.

Murmansk is located on the Kola Bay of the Barents Sea Gulf, with an interesting regional history dating back to the 16th century and earlier, and contains memorabilia of the presence of man in the region and important (Figure 1), objects related to various events of the 20th century. It is a window to the world, enabling Russia to trade with America and Asia while bypassing the straits of the Baltic Sea or the Black Sea. This city is also a thriving center of science and technology, and aspires to be the capital of the Arctic [13]. The Murmansk agglomeration, together with the adjacent cities that make up the common metropolis, is undoubtedly the most populous in the entire Arctic, and has no equivalent in any other country. This city attracts people looking for work and people wanting to visit Murmansk and see the polar day in the summer and the polar night with the northern lights aurora in the winter. These tourist attractions of the city are known throughout the world and have long gained recognition. There are tourist centers in the city, an internet portal, a network of hotels, restaurants, and other entertainment venues. However, tourists visiting this area rarely look under their feet and pay scant attention as they walk around. They do not notice that the ground of the city is built on the oldest Archean gneisses in Europe [14], together with garnets, staurolite, sillimanite, graphite, and many other minerals that are exposed here and there, cut through with numerous veins of dolerites, lamprophyres, and pegmatites of various ages. They create hills that reach up to 300 m above sea level, constitute a border of the Kola Gulf (e.g., fjord of Barents Sea), and form the bends, cuttings, and bowls of lakes numerous in this region and also in the city center. These rocks create numerous forms of inanimate nature, which contributes to the characteristic landscape of the city, also seen from the viewpoint of the city ring road climbing about 200 m above the center. This article deals with these qualities and makes a proposal for their promotion. At present, there is no synthetic description of the rocks in Murmansk in the geotouristic context. This study aims to draw attention to the advantages of the geodiversity and geomorphology that are found in the city and include them among other attractions that are usually shown to tourists in this city. They are as important as the city itself, because they contribute to understanding the geological history, not only of this region but also of the whole of Europe, that created the oldest rocks of the Baltic Shield [15–22]. Noting the rocks in the city, there is a need to display selected objects in the form of a trial combining the aspect of tourism and other natural, cultural, and historical values.

Figure 1. Localization of Murmansk on the Kola Peninsula, and the panorama of the city center.

The solution to this problem is to propose such an educational and tourist trail along with the necessary infrastructure proposed in this text.

2. Materials and Methods

The authors conducted their observations in the years 1999–2020, visiting the area repeatedly. When selecting the objects proposed in this study, the classification of James -Williamson et al. was used [23], with modifications from Williams [24] and Woo et al. [25], in accordance with local needs. In selected places, factors such as natural values (presence of interesting plant communities) were assessed, and the values of inanimate natural features (the nature of the topography, rock forms, and sediments of various origins) were taken into account. Historical values related to the development of the city of Murmansk as well as the important infrastructure devoted to the exploration of the far north were taken into account. When assessing the sites, the landscape values, such as geomorphological features, the possibility of near and far observation of various forms, and the view from a given place were also taken into account. These studies were carried out following the diagram in Figure 2, during field observations conducted by the authors.

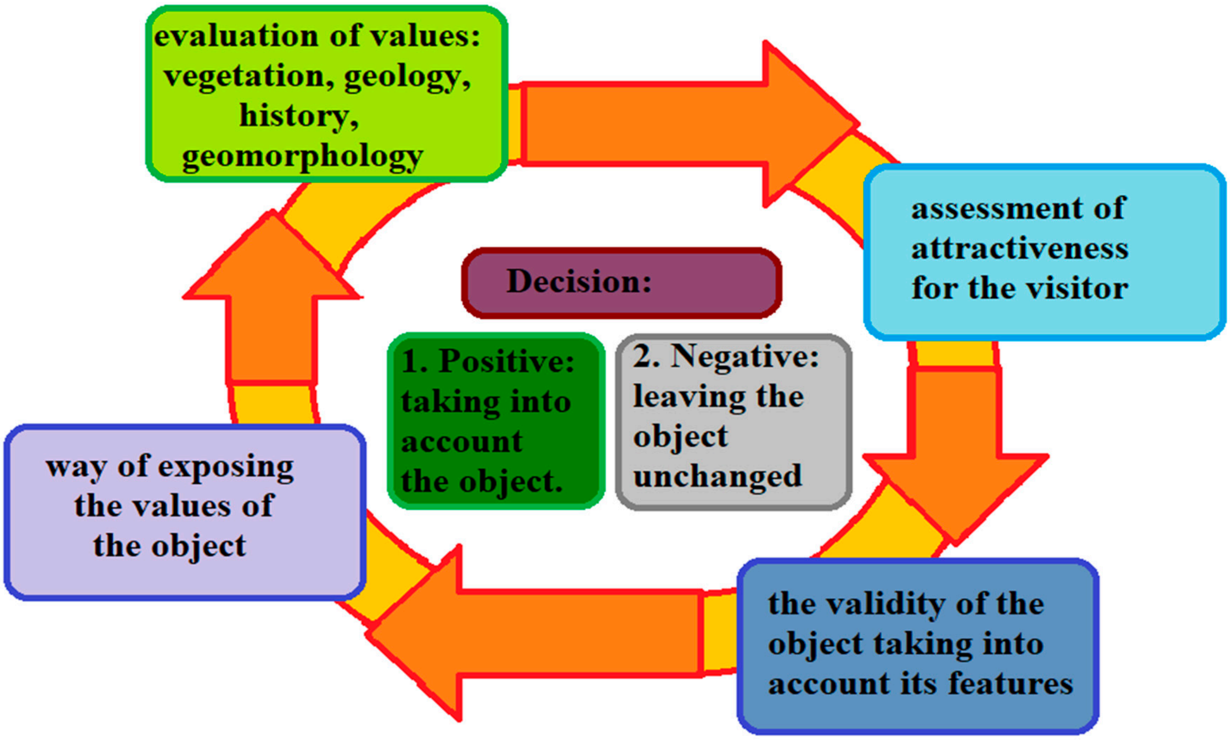

Figure 2. A diagram symbolizing the method of selecting the discussed objects.

Accessibility for tourists was assessed based on the premises that allowed the authors to visit the sites in question. The distances, type of transport (pedestrian, public, private), and the possibility of stopping and observing the object in question were taken into account. In the case of the display method, the aesthetic features and the state of the object's behavior were examined. The weight of an object was a subjective assessment of the authors based on the repeatability of the discussed values in the area of the study. To define the weight of the discussed values, the analyses described below were also performed. In the course of fieldwork, an inventory of the technical condition of utility buildings was made, paying attention to the appearance of their facades and the damage caused by the climate. The plant communities that were located in the discussed places were also observed. When documenting the discussed points photographically, attention was also paid to the structure of the subsoil, taking rock samples for further research. The obtained samples were prepared for thin plate preparations, which were observed using the Leica DM2500P optical polarizing microscope in transmitted and reflected light, and then under the Hitachi SU6600 scanning electron microscope with an EDS aperture. The general advantages of a given place, the possibility of its exposure, and accessibility for tourists were also noted. During the laying out of the route, the travel time and the degree of difficulty were also calculated.

Within an area of 154.4 km^2 of urban space, areas were selected for their attractiveness and transportation accessibility. The selected sites were characterized by existing tourist infrastructure (e.g., nature trails in the Semyonovskoe Lake), which was taken into account as an element that complemented their description and enabled the expansion of the system based on the existing network. The authors tried to select the objects in such a way that their distance from each other was not great, and that the trail would allow the city's residents to learn about its heritage as well. Hence, many of the proposed sites are located in the vicinity of residential neighborhoods. The location on the city map of the most important stations and hotels was also taken into account, so that finding the trail would be relatively easy for tourists. Objects that were scientific sites dedicated to monitoring the city's environment, and also those places to which access could be difficult (due to complicated access) were not taken into account. Additionally, for obvious reasons, sites located within or near existing technical, industrial, and strategic zones were omitted. Based on the collected research results, sixteen objects were selected, as well as routes providing access to them. Among the many objects located in the city of Murmansk, sixteen sites were selected that were characterized by exceptionally important cultural, historical, natural, geological, and aesthetic values (Figure 3, Table 1).

Figure 3. Situated map of Murmansk city with geo attractions (described in the text).

Table 1. The geographic position of the selected sites in Murmansk.

No	Latitude	Longitude	No	Latitude	Longitude
1	68°58′13.9″ N	33°04′28.4″ E	9	68°56′43.3″ N	33°10′04.2″ E
2	68°58′26.1″ N	33°05′13.0″ E	10	68°55′51.5″ N	33°08′50.1″ E
3	68°59′10.1″ N	33°05′38.0″ E	11	68°54′30.6″ N	33°08′11.0″ E
4	68°57′42.3″ N	33°06′18.6″ E	12	68°53′32.6″ N	33°06′52.7″ E
5	68°59′30.4″ N	33°05′51.8″ E	13	68°52′36.7″ N	33°01′35.1″ E
6	68°59′37.7″ N	33°03′49.9″ E	14	68°54′38.3″ N	33°01′22.5″ E
7	68°59′24.9″ N	33°09′57.1″ E	15	68°55′44.7″ N	33°05′19.9″ E
8	68°57′41.8″ N	33°09′34.3″ E	16	68°58′29.1″ N	33°03′36.8″ E

The characteristics and assessments of the values of the site were determined based on their accessibility and the presence of significant qualities (cultural, historical, environment, geomorphology, exposure, availability) that determined their affiliation. Introducing a scale from 1 (low values) to 3 (high values), the nature of the features in question was determined as being of local (+), regional (++), and supra-regional (+++) significance, taking into account the uniqueness of the sites compared to the rest of the city in accordance with the description of heritage values discussed in Sections 3.1–3.5.

3. Results

Significant biotic and abiotic elements of the environment, including cultural and historical factors, are characterized in the following subsections. The final section of this chapter describes the proposed route based on selected locations in the city.

3.1. Environmental Conditions

Murmansk is located on the Kola Peninsula in the North-European part of Russia above the Arctic Circle, and this influences the specific climate of the place. However, compared to similar cities in the Arctic, e.g., cities in Siberia and Alaska, the climate here is much milder [26,27]. It has a climate mitigated by the influence of the warm North Atlantic Current—one of the branches of the Gulf Stream Current. Unlike many cities in the north, winter in Murmansk is relatively mild and begins about a month later than in other polar areas, and temperatures in the coldest months (January–February) range from −10 to 11 °C. Snow stays on average for 210 days, melting away completely during May. Summer is short and cool (the average temperature in July–August is approximately +13 °C). The polar night phenomenon lasts from 2 December to 11 January, and polar day lasts from 22 May to 22 July [26,27]. Similarly to most modern cities, Murmansk is also marked by the stigma of civilization. Several problems related to environmental degradation can be noticed, including exhaust gas pollution from vehicles, accumulation of solid waste, and industrial pollution of the city and its surroundings. In Murmansk, the atmosphere is mainly contaminated by coal, sulfur, carbon monoxide, and nitrogen oxides. This effect is intensified due to the long-lasting heating season (about 8–9 months), where a large mass of pollution is generated by the burning of fuels for heating apartments and the waste in incineration plants [28–32].

The climatic conditions described above are related to the influence of the Atlantic Arctic climate. The activity of warm sea currents from the Atlantic significantly alleviates the city's climate. The winter temperature in Murmansk is about −10 °C and frost is rare. It may happen that temperatures in the vicinity of zero degrees Celsius persist for a long time. A frequent occurrence is also a thaw. In general, winter arrives in the city a month later than in other cities located in similar latitudes. In the summer, it often rains and is relatively cold, due to the high humidity of the sea air. However, when winds from the south appear, they can significantly reduce winter temperatures and increase temperatures significantly in summer. During winter, frosts may reach up to −30 °C and in summer the temperature can rise to +28 °C. Snow cover is maintained in the city for about 210 days. The minimum temperature was recorded on 6 January 1985 and 27 January 1999 (−39.4 °C) and the maximum was recorded at +32.9 °C on 9 July 1972. Due to the location of the city, polar night lasts from December 2 to January 11 and polar day from 22 May to 22 July [26,27].

Thanks to its location, tourists in the summer can observe the so-called polar day, when the sun does not go below the horizon, and the phenomenon of white nights, when the sun hides under the horizon line, but it is still bright. This state lasts the entire summer period, ending only in the second half of August. In turn, during the winter there is the phenomenon of the polar night, when the sun does not rise above the horizon at all, and "day" usually means a little diffused light around noon, but it is possible to observe the northern lights and beautiful, colorful city illuminations. Winter in Murmansk is also very picturesque, snowy, and not as cold as the city's location would suggest. Climatic conditions also affect vegetation [26,27].

3.2. Flora and Fauna

In the Murmansk region, there is a tundra forest (Figure 4A), represented by such plants as birches, pines, spruces, rowan, and stunted forms (dwarf birch, dwarf willow, etc.). In the city, there are plantings of introduced species from the south, such as small-leaved lime and even an apple tree. These trees bloom at the end of July, but there is not enough time to produce fruit buds, so they do not bear fruit. The undergrowth is dominated by similar species to the surrounding environment, including numerous blueberries, cloudberries, mosses, and lichens. The latter, due to the humid climate, grow even on urban buildings and flower beds. In the areas of drainage depressions, sedge plants, such as cotton wool and marsh accumulate. Due to the large exposure of rocks in the city, such places are relatively numerous. Growing directly on the rocks are numerous lichens, including those with a geographical pattern (*Rhizocarpon geographicum*) [33,34]. Despite the urban nature of the environment, there are many areas in the Murmansk region where numerous species of rare plants can be observed.

In the Kola River area (point 13 of the proposed route), there are ecological trails. Here, one can find typical mountain-tundra species, such as marsh grass (*Sesleria caerulea*) and subarctic astragalus (*Astragalus* sp.), which can grow on bare sand, thanks to its ability to have a symbiotic relationship with nitrogen-fixing bacteria. This ability allows it to survive in extremely poor soils. During the summer months, the riverbank is literally dotted with flowers: lush carnations, round-leaf bells, violets, geraniums, and wild bulbs are plants characteristic of the area. A little farther upstream, on a sunny day, it is possible to find the fragrant Saami aphrodisiac (*Hierochloe odorata*). It has an unusually strong and lingering scent of sweet almonds, especially lingering when it is rubbed and crushed between the palms of the hands. After walking a few dozen meters, one will find moss-covered rocks where the insectivorous buttercup plant lives (*Pinguícula vulgáris*). Its leaves are usually dotted with tiny insects, which it feeds on. This is another way to overcome soil poverty.

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Figure 4. Photographs of the examples of plants from Murmansk: forest-tundra landscape in the Gorela Mt (**A**); veined willow (*Salix reticulata*) against a background of berries and lichens in the city of Murmansk (**B**); blueberry (*Vaccinium myrtillus* L.) against a background of lichen (*Cladonia* sp.) (**C**); cloudberry (*Rubus chamaemorus* L.) (**D**); woolens (*Eriophorum vaginatum* L.) near Semyonovskoe Lake (**E**); orchid (*Orchis* sp.) in the Semyonovskoe Lake area–(**F**).

The shores of the Kola Gulf (point 14) are very interesting. This is where one can most often observe birds. It is possible to walk along both the western and eastern shores. Flora and fauna are richer on the western shore (Figure 4B–D). Here one can see, touch, and even taste typical coastal plants that have been a source of vitamins for centuries. These include *Ligusticum Scoticum*, which tastes like celery, sour sorrel, and an herb. The latter can be tasted as early as the end of April, when a thaw begins to appear on the shore. It is a biennial herb, and its leaves grow very quickly in the spring, from the first rays of the sun. A cushion plant that can also be seen here is spreading gonkenia (*Honckenya peploides ssp. diffusa*). Its thick, fleshy leaves, similar to those of tropical fat plants, store water in the same way as cacti. Coastal sands and gravels cannot provide enough nutrition for the plants, so they grow on algal outcrops that form a residually nutritious substrate. Here, sand tussock and reed grass are common. A little farther from the water's edge, one can observe lush inflorescences of valerian elderberry. At low tide, one can see various macrophytes, such as ulva or sea lettuce enteromorpha (*ulva lactuca*), which looks like hollow tubes, and various species of fucus.

The best examples of tundra vegetation are on Gorela Mountain (point 15). It is dominated by heathlands where berries grow (bilberry, lingonberry, bog bilberry) and species with inedible fruits (rosemary, coltsfoot, and arctoides -*Arctous sp*., which the Saami call thimbleberry, because of the crimson hue of its fruit). Water berry, also producing edible but rather watery fruit, is also common. Sheep's fescue, a typical tundra cereal, has leaves with a structure similar to feather grass; they are rolled up in a tube to conserve moisture. There are also many semi-parasitic plants that draw water and mineral salts from the roots of other plants. Another northern berry is the cloudberry, whose color changes from green to red and then to amber-yellow as it ripens. Furry and downy berries have an interesting appearance: their fruits have long stems, and cotton balls seem to hang from the stems. The seeds of these plants are the most important food for tundra birds.

The Semenovskoe Lake (point 7) is built up, however, and there it is also possible to see the trifoliate rookery (*Corallorhíza trífida*), a northern orchid that lacks normal leaves and photosynthesis but thrives with the help of bacteria. There are also a lot of typical plants present, such as cotton (*Eriophorum vaginatum* L.) and orchids (*Orchis* sp., Figure 4E,F).

3.3. Historical View

The oldest archaeologically documented human sites date back to around 2000 years BC. Rock petroglyphs and stone labyrinths have been discovered from this period. The indigenous people are represented by nomadic Saami peoples, who in this region usually live away from the larger cities [35–37]. The history of Russian settlement in this region dates back to the 13th century, initially as summer settlements of fishermen who left the Arkhangelsk region through the White Sea. Over time, Pomeranians established permanent settlements, examples being Kolvica, Varzuga, Kuzomien, and Kola. The town of Kola was founded in 1565, and today is part of the Murmansk agglomeration [38]. Although the city of Murmansk itself was founded in 1916, it is located just a little further south of Kola, which today is a suburban area of the agglomeration of the city, but which is over 450 years old [38]. The history of the city starts with the construction of the railway line from St. Petersburg and the construction of the port in a more convenient place. The city of Murmansk, though established relatively recently, has undergone a steady development due to its strategic location and to climatic conditions, which have not been bad in this region due to the warm Norwegian Gulf Stream. The city played a key role in the years of the October Revolution (1917) and during World War II and later. Due to the convenient connection and abundant raw materials, the Kola Peninsula has constantly undergone expansion, becoming the Soviet and then the Russian "window to the world." During World War II, the city suffered terribly from bombing; the destruction flattened 90% of the city's buildings, which were rebuilt in the post-war period in neoclassical style, and in further areas of the city eclectic high-rise buildings dominate. Murmansk is home to Russia's longest block of flats, which is 1611 m in length.

Murmansk is a scientific, cultural, and industrial center. It is an important transnational and international communication hub. The city is the northernmost part of the non-frozen winter port, used for communication between northern Russia and the rest of Europe, the Americas, and through the so-called "North Route" to Asia [13]. To this end, icebreakers are docked in the city and assist to ply ships through the Arctic Ocean. In Murmansk, there is also a railway station and a transshipment station, which allows a permanent connection to St. Petersburg, Moscow, and the rest of Russia. This station is also used for freight and passenger links in international traffic. The city also has an airport of similar importance. From Murmansk, there is a road linking Russia with Finland and Norway. There are also consulates in Norway and Finland. There are numerous universities in Murmansk, including the Murmansk Arctic State University, the Murmansk State Technical University, and other schools. There are numerous theatres, museums, and oceanariums in addition to the schools in the city. At the same time, it is one of the largest cities in the

Arctic, earning the title of the "Arctic capital" with nearly 300,000 inhabitants [39]. It also has a very interesting history due to its location in the foothills of the Kola Bay on the Barents Sea, and this has contributed to the increase in its population. The role of the city at that time was constantly changing with the population. The nearby hills permit visitors the chance to enjoy a beautiful, picturesque view of the city [13].

3.4. Geodiversity

In the Murmansk region, Archean granite gneisses have been discovered, and form the oldest known link in the Kola Peninsula series [14]. These rocks are exposed in the city area, on the slopes of the Kola Barents Gulf, and in the ring road trenches. These rocks form numerous rapids, sometimes reaching several meters in size, especially in the vicinity of Kola Gulf. They form picturesque rock walls, while the elevated zones are dominated by erosive outliers in the form of isolated rock blocks as well as postglacial polish, showing the geological diversity of this area (especially visible after rain). The proximity of the bedrock contributes to minimal sedimentary soil coverage in Murmansk, limited mainly to numerous depressions filled with boggy lakes. Thanks to this, these rocks are visible in many parts of the city, protruding on the surface of the land. Elsewhere, urban development has obliterated the rocky slopes that make up the freshly exposed walls to enlarge the space for building houses. However, thanks to this, it is possible to observe changes in the lithology of rocks. Sometimes, in winter, they are used as a decorative element for illumination.

Their occurrences are limited to individual blocks forming hills, intersected by faults, between which there are lowering zones filled with weathered deposits and Pleistocene sediments (Figure 5B). They are included in the structure—the Central Kola Block [15–22], whose age is estimated at over 3.75 billion years [40–46].

From the north, it borders on the Uraguba–Kolmoziero–Voronia promontory, and further on the rocks of the Murmansk block; from the east it borders with the unit of western Kieyvy; from the south it is limited by the zone of the verdant belt of Imandra-Varzuga and the Monchetundra, Monchepluton, and Lapland Granulite Belt and Khibina with Lovozero [47]. The mosaic of these diverse geological units is visible in the field. When visiting Murmansk, one can see changes such as this when undertaking a tour of the city. It is dominated by granulite gneisses of the Kola series. These rocks are garnet–mica–pyroxene–quartz–plagioclase gneisses, which bear traces of multiple metamorphisms and sometimes also migmatization, and are cut by various vein properties [19]. These rocks are also accompanied by enderbits and granodiorites of various types of granitoid in vein form, filling the spaces between the rocks in fault zones as well as mica–amphibole–pyroxene gneisses and amphibolites. Important rocks from this intrusion are vein deposits of lamprophyre and dolerites, both found in the Murmansk region and other intrusions, including Monchepluton. Their age is estimated at 2500–1767 million years old (using the U-Pb isotope ratio method throughout the zirconium crystal, [22]). The youngest are the postglacial sediments and the regolith of the Great Pleistocene and Holocene. These rocks are described below.

- **Gneisses** are grey–silver rocks with a red–pink accent (Figure 6A). They are mainly made of quartz and plagioclases, which are accompanied by biotite, phlogopite, muscovite, and numerous accessory minerals, including garnets. These rocks have grano-nematoblastic, fine-blasted, slate, gneiss, and grain textures. They form a complex containing lamellae built of dark and light minerals of varying proportions and thicknesses in one place, resembling slate in other gneisses. In the microscopic image, quartz is usually visible, together with plagioclases (of different compositions) and orthoclase from light laminates in the rock. In the discussed rocks, quartz most often has suture boundaries. Garnet usually occurs in the vicinity of these minerals, although there are also varieties almost free of these minerals, with much darker colors and a greater proportion of biotite (Figure 6C). In addition to these minerals, the rock has dark laminates composed of feminine minerals, such as biotite, sometimes accompanied by phlogopite and muscovite. Present pyroxene and apatite sporadically appear. In some rocks, sillimanite and staurolite are abundant, which accompanies the microdislocation zones in the rock co-occurring with biotite and deformed garnet crystals. Ore minerals are represented by polymetallic sulfides, such as pyrite, chalcopyrite, galena, and pentlandite, which are accompanied by ilmenite, chromite, iron oxides, and hydroxides. These rocks are the backbone of the Kola series, revealing themselves in many parts of the city. It is from these rocks that the hills, outskirts, and numerous rocky slopes are built. Their importance for the city's geomorphology is paramount.

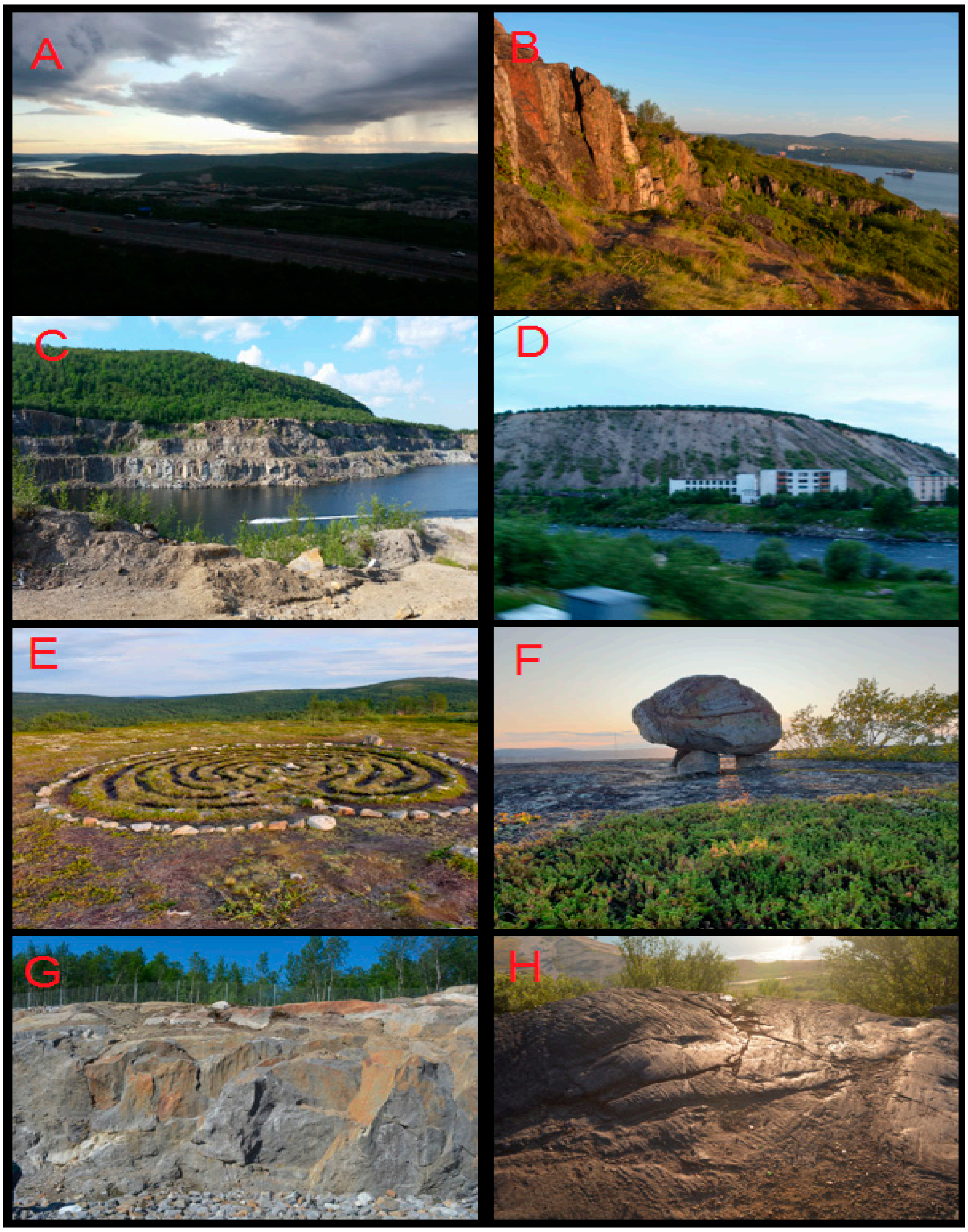

Figure 5. Typical Landscape from Murmansk city: south-west view of the city from the highest elevation in the area (**A**); typical gneiss exposures in the Kola Gulf of Barents Sea (**B**); closed quarry above Ledovoe Lake serving as a wild rest site (**C**); barriers from Pleistocene in the area of Kola city (**D**); reconstruction of the labyrinth (**E**); and "seid" (**F**); in the area of the "Ogni Murmanska" Hotel in Murmansk, non-weathering exposures of rocks in the area of the city ring road (**G**); gneiss smears in various parts of the city (**H**).

Figure 6. Macro photographs (**A**,**B**) and microphotographs (**C**,**H**) of the typical rock samples: granulites with visible garnet (grt) and light minerals(**A**); pegmatite veins with tourmaline (tour) and sulfides (**B**); granulite with visible garnet deformation (**C**); and biotite (bt), a similar zone in the gneiss highlighted by crystals of sillimanite (sill) and staurolite (sta) (**D**); enderbites with orthoclase (kfs), plagioclase (pl) biotite (bt) and hypersthene (**E**); pegmatite with muscovite (mu) and quartz crystals (**F**); lamprophyre with visible serpentinized olivines (ol) as well as augite crystals (aug, (**G**)); dolerite with ophthalmic structure highlighted by plagioclase and augite crystals (**H**).

- **Granitogneisses** are rocks, usually grey–pink. They accompany the gneisses discussed above in their migmatisation zones. Their importance is secondary, limited to the zones of gneiss ultrametamorphism. The best exposures of these rocks are visible in the area of the Monument to the Unknown Soldier (object No. 6, Figure 3). Resembling granitoid and often bearing clear traces of migmatisation, they are crossed by numerous veins and other rock formations. Together with gneisses and schists, they form a rock found in the Murmansk region. These rocks are mainly made of quartz, orthoclase, and plagioclase, with numerous accessory minerals (Figure 6D). They have grano-lepido-nematoblastic, coarse crystalline, porphyry structures, and compact, random, streaky, gneiss, nebulite, pseudocellular, pseudofluidic textures. In the microscopic image, the rock background is represented by quartz, orthoclase, and plagioclase (labradore, bytownite), which form aggregates of various crystal sizes, often crushed or deformed, sometimes also containing sericite and iron oxides and hydroxides. The occurrence of these rocks in the geological structure of Murmansk is limited by the area of their occurrence. These rocks are exposed only in a few places, but due to the discussion of the processes of the Kola series sediments in question, their significance is high.

- **Amphibolites** are rocks that constitute a complex of structurally diverse formations. They usually occur as paleosomes in migmatized granite. They are composed of plagioclase and amphibole from the hornblende group. They most often have grano-nematoblastic structures. The microscopic image shows common hornblende, sometimes arranged along the longest axes, forming flat-parallel structures in the rock. It often forms symplectic and idioblastic adhesions, having titanite, magnetite, and zirconium infixes. The amphibolites in the complex in question are a small admixture of rocks formed in the ultrametamorphism processes of older deposits. Their exposure in Murmansk is less frequent, giving them secondary importance.
- **Enderbites** and granodiorites occurring in the discussed rock region are gray–green rocks with visible crystals of pyroxenes, amphiboles, biotite, quartz, and plagioclases. These rocks most often have a grano-lepido-nematoblastic structure, and the texture is dense, random, less often directional, and underlined by mafic xenoliths and grinds. In the microscopic image, there is quartz, which is accompanied by plagioclase (oligoclase and labradore). Biotite lamellae, sometimes also common hornblende, are seen in are seen between of plagioclases, which form aggregates in the rock along with the ore minerals and hypersthene crystals present in them (Figure 6E). Additionally, apatite and ore minerals represented by ilmenite and magnetite appear in the rock. These rocks are exposed in tectonically limited zones, usually east of Murmansk. Their occurrence can be correlated with old intrusions, which, similarly to the Kola series granulite gneisses, have undergone metamorphism. However, the exact position of these rocks concerning the tracks of the Kola series is unknown.

In the Murmansk region, along with the above-mentioned rocks, there are numerous vein formations of different ages and mineral compositions. Most often, they are pegmatites, as well as dolerites, lamprophyres, and picrites. These rocks are visible in many exposures (objects No. 5,7,8,11, Figure 3), sometimes also intersecting with each other.

Some of these veins can be up to several meters thick. Their importance in geomorphology is rather small; however, due to the processes taking place in the vicinity of these rocks and the aesthetic aspect, they are important.

A description of these rocks is presented below.

- **Pegmatites** (Figure 6B,F) are rocks that usually have a crystal size not exceeding a few cm. In the Murmansk region, there are pegmatites with muscovite, epidote, quartz, and tourmalines (shoerl). They are often found in the field. Their thickness is up to 1 m or more. However, in the vicinity of this unit, there are LCT pegmatites that also contain spodumene and columbite. Detailed studies of these rocks may permit us to find similar analogies in the Murmansk region. In the rocks in question, quartz and orthoclase are usually visible, forming the background of the rock. In addition to these minerals, there are the above-mentioned phases as well as sulfides (pyrite, chalcopyrite) and sometimes also carbonates.
- **Lamprophyre** is a veined rock in which the main ingredient is orthoclase. Next to it, there are augite and olivine. Olyvines are often cracked in the rock. They also show

serpentinization (Figure 4G). Next to them, there are also numerous tiny magnetite crystals. Rutile is present in pyroxenes, often in the direction of pyroxene cleavage.

- **Dolerites** are rocks with an ophthalmic structure, usually emphasized by plagioclase crystals Figure 4H). Apart from these minerals, there are also augite and biotite. They are accompanied by numerous magnetite and ilmenite as well as individual sulfide crystals.
- **Meta-Picrites** are black scales with a fine-crystalline structure and have a dense, random texture. The microscopic image shows mainly orthopyroxene crystals, accompanied by fine crystals of clinopyroxene and talc. Apart from these minerals, olivines are also visible, usually single, strongly chlorinated crystals. In addition to these minerals, garnets are also visible, usually with numerous rutile in rims. This rock also has hornblende and epidotes.

The rocks described above within the central Kola block in question form single isometric or lenticular structures with diameters up to several kilometers wide. Their centers are built of late Archean granitoids, granodiorites, charnockites, and enderbits, which are separated by faults [22]. In some cases, the discussed works show a rhythmical covering of more melanocratic and leukocratic rocks, forming a diverse gneiss complex [21], highlighted by the occurrence of alternately melanocratic and leukocratic zones. The complex of these rocks is metasediments filling the Murmansk basin, where the abraded conglomerates of older igneous and metamorphic deposits were deposited, probably forming one of the first embryos of the continental crust [19]. Their age using the U-Pb TIMS method in zirconium crystals was determined at 3.75 billion years. [14]. The rocks of this complex underwent double metamorphism in granite facies, which was determined according to age: 2830 + 10 Ma [14–22] for the first and 2724 + 49 Ma [19] for the second metamorphism by the method of U-Pb isotope ratios in the entire zirconium crystal. The gneisses there were defined as a metamorphosed formation of aluminosilicate sandstone [19,21]. They contain metamorphic minerals, such as garnets, amphiboles, sillimanite, staurolite, and cyanite. Polymetallic mineralization is visible in these rocks. They can be seen in the crystals of magnetite and ilmenite, but also in pentlandite, pyrrhotite, galena, sphalerite, and native silver. There are numerous veins present in the rocks consisting of materials such as granite, dolerite, pegmatite, and others (Figure 6B,F–H). Carbonates also occur in some rocks. The Archean gneisses studied here are the seeds of the oldest foundations of the continent, currently revealed in the structures of the Kola series. These deposits were created as deposited extracts of the former magmatic and metamorphic deposits. The youngest ones are visible postglacial traces and the weathered rocks in question. In postglacial sediments, there is a variety of rock materials, usually scattered, and with a variable fraction. Larger pebbles are usually well covered. Together with the smaller fraction, they form moraine outflows and covers, usually lying in the hollows. There, they are also accompanied by a dust and clay fraction, creating clays in which small lakes and swamps usually occur. Their role in the urban landscape influences its variety. The places where these rocks occur are also often the subject of urbanistic destinations, as it is easier to build houses on such settlements than directly on rock formations. In the Kola Gulf of the Barents Sea, there are more of these sediments, and in the vicinity of Kola, there are moraine runs forming dikes visible from many kilometers away.

3.5. Study City

Murmansk is located mostly in the eastern part of the Kola Gulf of the Barents Sea. It has a character stretched southward along the seashore. The sixteen sites under discussion were chosen for their unique character, standing out from the city limits. All the discussed objects (insert in Table 2) have good to excellent exposure. Their availability is variable, as it depends on the physical fitness of the tourist and (in some cases) on the availability of their means of transport. This applies in particular to the exposures of very important geological and geomorphological importance located on the city bypass. In the case of natural values, most of the objects in question also have them, except for the very center (vol. No. 1) and the port (vol. No. 16). In the case of historical–cultural values, they apply only in some selected objects. These objects are discussed in detail below. Table 2 shows the essential features of selected objects that determine their value.

Table 2. Assessment of the values of the objects described in the text.

Object No.	Values					
	Cultural	Historical	Environment	Geomorphology	Exposure	Availability
1	++	++			+++	+++
2	+++	+++	+++	+++	+++	++
3	+++	+++	++	++	+++	+++
4			+	+++	++	+++
5	+++	+++	+++	+++	+++	+++
6	+++	+++	+++	+++	+++	+++
7			++	+++	++	+
8			+++	+++	++	+
9	+++	+	++	+++	+++	++
10			++	+++	+++	+++
11			++	+++	++	+
12	++		+	+++	+++	+
13	+++	+++	+++	++	+++	+++
14	+		+	+	+++	+++
15	+	+	++	+++	+++	++
16	+++	+++			+++	++

3.6. Proposed Trails and Objects

The objects described below are located mainly in the city center (1–4, 16) and its northern part (5–6). Some of them are also located along the city's eastern bypass (7–12) and around the city of Kola (13). Their coordinates are shown in Table 1, the characteristics of values in Table 2, and the location against the background of the city map in Figure 3.

1. City center, Five Corners Square, and train station.

The city center is Five Corners Square, through which the most important lines of city transport run. It is about 500 m away from the railway and bus station. This square is home to Azimut Hotel, formerly known as Arctica, the tallest building in the city, which also houses a tourist information center. The square also hosts the most important open-air celebrations. It is in this square that there are numerous illuminations in winter, the celebration of the sun on the last Sunday of January (end of the polar night), the celebration of the sailor, and other similar events. It is a lively place, the starting point for exploring the city. Above the square, there is also a web camera that allows online observations of this place, where tourists are able to watch the weather outdoors in Murmansk. In the vicinity of the square, there is also an art museum, where there are many interesting paintings also devoted to the far north.

2. Museum of National History.

The museum is located in the very center of the city (90 Lenin Street) in a large building with several floors. In this museum, one can learn about many aspects of the region, from its history through examples of flora, fauna, and cultural objects (Figure 3) to its minerals. In this multi-story building, exhibits from the entire Murmansk region have been collected and put on display in such a manner that it is possible to take a close look at them and read the information in many languages. It is worth visiting this place before going on a city tour, because visitors will gain a deeper picture of this place. It is not the only museum in the city, but here, the collection of minerals and rocks is the most extensive. It is presently closed to the public as it is undergoing extensive refurbishment, but is expected to reopen in the near future and will feature interactive displays etc. Nearby (about 300 m further along on Volodarskogo Street), there is also the Murmansk Shipping Company History Museum, which is also worth visiting.

3. Monument to fallen sailors located on the rock ledge.

This monument in the lighthouse was built in 2002 as a symbol to commemorate the victims of the sailors who gave their lives in the post-war era. At the top of the hill is the Christ the Savior on the Waters church. Steps set directly on the rock lead to these places. In their vicinity is a forest-tundra, and the exposed rocks are granite–sillimanite–staurolite gneisses with garnet stones. They are heavily weathered in these places, but they form geomorphological forms overlooking the city. Some of these rocks are damp, and in winter, frozen waterfalls form on them.

4. Exposure of granulites in some city blocks.

At the junction of Karl Marks and Knipovich Streets, there are rock formations with exposed granite gneisses with sillimanite and staurolite. Going up Knipovicha Street, one reaches the chapel of St. Peter and Fievroni, patrons of lovers (the equivalent of St. Valentine in the Western Church). Walking along this street, one can trace the contemporary large prefabricated slab facade buildings in Murmansk, observe the protruding Archeanzne rocks, and ascending, observe the view of the gorge, which opens from the north-eastern side, created as a result of the disjunctive faults. The gorge is partly marshy, and its opposite slopes are covered with forest-tundra. In the distance, from this place, one can also see the TV tower, which in winter is decorated with dynamically changing illumination.

5. Educational paths area and Semyonovskoe Lake recreation center.

In the area of Semyonovskoe Lake is the largest sports, cultural, historical, and recreational complex in the city. On the northern side of the lake, there is a waterfront, along which a promenade runs. Around the lake is a forest-tundra with interesting plant complexes, along which there is a scientific and didactic path devoted to ecology. In the southern part of the lake is a historical site—a monument commemorating the extensive destruction of the city during the Second World War. There is also a park by the lake, with bicycle paths, playgrounds, and a ship-shaped community center, with numerous cultural and educational organizations operating there. In summer, there is a fountain with illumination on the lake, while in winter, an ice figure festival takes place on the lake. There is a club used by human "walruses" who dip into the water via holes cut into the ice during winter on the southwest side of the lake, and a small oceanarium on the north side with various types of long-eared seals and walruses. Directly on the lake shore is the statue of the cat "Semyon". It is a monument dedicated to the loyalty of a cat that was accidentally abandoned by its owners and traveled about 2000 km to finally return to his home in Murmansk.

6. The vicinity of the Monument to the Unknown Soldier.

The most interesting object (Figure 3) is the area of the Monument to the Unknown Soldier (Figure 3, object No. 1 on the map) popular with local residents and visitors. It is a twenty-meter-tall monument named Alyosha that stands on a hill looking west, from where German troops were pressing during the war and convoys of aid for Russia were arriving. This structure and gathering point towers over the city, and is visible from afar (Figure 5H). It contains urns filled with soil taken from numerous fronts during World War II. A short distance from the monument is a plaque commemorating Russia's gratitude for the help of convoys, and marbled inlays detailing Russia's hero cities. This hill is tectonic and is separated from the lower areas by faults with visible rock walls and rock debris at the foot. The rocks occurring there have picturesque forms, such as ridges and protruding outcrops. The area of the hill has numerous rock formations and is swampy in places and replete with interesting plant communities. There are eriophorum (*Eriophorum angustifolium*), cloudberry (*Rubus chamaemorus* L.), lingonberry (*Vaccinium vitis-idaea* L.), and blueberry (*Vaccinium myrtillus* L.) plants. In spring one can find orchids (*Dactylorhiza maculata (L.) Soó*), and next to them are dwarf birch (*Betula nana* L.), veined willow (*Salix reticulata* L.), and many other Arctic plants. In the top zones of the hill, there are erosive outliers in the form of large, multi-meter rock blocks. This hill is built of gneisses and migmatites crossed by various veins. Behind the panorama of the city and glacial erosion in these rocks, one can observe various structures related to the characteristics of the rocks. There are pegmatite veins, and the migmatized granite gneisses contain garnets, staurolite, and sillimanite. A sample of rocks recently collected from around the monument showed their old age. By walking around the monument and heading towards the gulf, one can see those rock forms that are eagerly chosen by city residents on warm days for rest due to the nature of the landscape. Semyonovskoe Lake is an artificial reservoir, built via the construction of a small dam. The ecological route mentioned above is located here. In the vicinity of the north-west of the hill, there is also a monument to the waiting woman, "Zhdushcha", which was erected relatively recently in 2017. It commemorates people awaiting the return of sailors from a voyage.

7. Uncovering rocks in the area of the ski slope near the ring road.

In the eastern part of the city is a bypass running along the hills, reaching a height of 350 m above sea level in some places. These hills overlook the skyline of the city and the Kola Gulf of the Barents Sea. In the Vierkhnie Rostinskoe Shosse Street region, there are hills covered with forest-tundra and interesting plant communities. These hills are tectonic, forming logs and partially marshy ditches. Close to the discussed point is the Bolshoe Lake, which fills the basin of erosion–tectonic cavities. There is a cross-country ski run in this area, which is lit by electricity for skiers in winter and for cyclists in summer. In the vicinity of the ring road, there are numerous rock ridges artificially made during the construction of the road. They reveal granulite gneisses cut by numerous dips of other rocks (pegmatites, dolerites). The granulites from this exposure contain sulfides and graphite, which were formed during the formation of the rock complex (meta-experiments) with the participation of seawater and the first forms of life. The exposure of these rocks due to the minerals preserved in them deserves attention, and is an example of one of the oldest rock formations in Europe, documenting the beginnings of life on Earth.

8. Rock ridges of the bypass area.

Further proposed facilities are located in the northeastern part of the city in the area of the city ring road. Some ponds fill that bowl cleft of fault with Maloe, Sredny, and a lot of smaller (unnamed) lakes (Figure 3, object No. 2 Figure 3G). All these lakes have mirrored surfaces at different heights. This is due to the geological structure of the bedrock and tectonics, which create various rock shelves on which there are lake basins. It creates a very picturesque complex covered with Arctic vegetation. There are various plants to be found here, such as eriophorum (*Eriophorum angustifolium*), cloudberry (*Rubus chamaemorus* L.), lingonberry (*Vaccinium vitis-idaea* L.), blueberry (Vaccinium myrtillus L.), bear edible fruit (*Phyllodoce coerulea*), a lot of lichens (*Cladonia rangiferina* L. *Weber ex F.H. Wigg.*, *Rhizocarpon geographicum* L. *DC.*, *Cetraria islandica* L. *Ach.*, *Nephroma arcticum* L.), alpine clubmoss (*Lycopodium alpinum*), dwarf birch (*Betula nana* L.), and veined willow (*Salix reticulata* L.). As it rises (towards the south), the panorama of the city is also revealed, which initially towers over the valley with lakes and then aligns with it to further show the lower streets and the Kola Gulf of the Barents Sea visible in the distance. The view here is very picturesque. The rocks in question at this point are metamorphic formations accompanied by various igneous bodies. Between them are visible struts made of granulite gneisses with garnet, staurolite, and biotite, and sometimes also cut with various veins. These places are well exposed along the beltway road, which is located in the vicinity of these lakes and runs around the city up to the road junction towards the city of Kola (Figure 3, objects No. 3–6). Following this path, it passes many exposures, which have been renewed due to renovation works. It is therefore possible to observe a Kola series of rock sequences. Along the road, there are crushed rock blocks on its edges, which can also be observed up close. When examining the exposure along the road, one can notice various dolerite veins (Figure 3, object No. 5), lamprophyre veins (Figure 3, object No. 5,4) and pegmatites (Figure 3, object No. 3). In these zones one can find beautiful crystals of phlogopite, muscovite, tourmaline, and epidote up to several cms in size. The discussed rock complex shows a large mineralogical and petrographic diversity, making it possible to trace many geological processes in the rocks in question, which are there.

9. Cultural and historical reconstructions.

Nearby is another hill on which can be seen reconstructions of the Saami labyrinth and the so-called "Seid", or a large boulder placed on top of smaller stones. This place is interesting due to the panorama stretching out over Murmansk; from the north, it is limited by a fault and a wall of several dozen meters. On this hill, objects that refer to the historical heritage of this region are pointed out. While the original Saami labyrinths are found far outside the city and are usually in hard-to-reach places, this reconstruction allows one to observe what such labyrinths looked like in real life surrounded by nature. The boulders called "Seid" have a legend related to their origin [35]. According to legends, they are monuments of ancient civilizations that marked places with unique religious aspects. These stones were therefore thought to be an emanation of power, an object of worship. Geologically, such objects may have arisen naturally during deglaciation, when a larger block of rock suspended in the ice after it had melted, is deposited on smaller rocks. However, there are relatively many such objects in the Kola region, so it is possible they were created by people imitating natural objects. Behind the discussed hill to the east there is a rocky cliff with a tectonic rock wall, behind which one can observe one of the many marshy gorges in this area. This place also has interesting plant habitats. There are peat-swamp groups with liverworts, and cloudberry appears in the transition zone along with moss–lichen mats; representatives of tundra vegetation are visible, forming dense clumps slightly protruding above the surface of the marshy zones and above the forest-tundra with dwarf birch, rowan, and spruce trees.

10. Interesting rock exposures in the area of the sports and recreation complex.

Further south is the sports and recreation complex "Ogni Murmanska". At this point, there is a hotel, an indoor pool, and a sauna complex, including the "Russkaya Banya" hot sauna, which also includes the ritual of pouring plant infusions on the heated stove stones for inhalation and beating the body with small birch or nettle twigs for better blood circulation [37]. A sauna in Russian culture is an object embedded in the centuries-old Slavic tradition. Its prevalence is also visible in Murmansk, where there are many such facilities, including those open 24 h a day. The complex also includes T-bar lifts and ski slopes. However, tectonic hills and ravines are also visible there, and on one of them, there is a restaurant with a view of Murmansk, where Arctic cuisine is also served (reindeer meat and fish dishes). Boulders from many places in the Kola region were also brought into the vicinity of this site, creating a small lapidarium, allowing the observation of these unusual rocks that make up NE Fennoscandia (Figure 3, object No. 7). There, one can observe numerous gneisses of different ages and Archean rocks of the band iron family BiF, which were formed in the Archaic when there was no oxygen in the Earth's atmosphere (Figure 3, object No. 8, Figure 5E,F) [48]. These and other rocks can be observed in the open air there, which makes it possible to imagine the variety of rocks found in the Kola area.

11. Rocks with dikes of the bypass.

One of the highest exposures is the ring road, located at a height of 226 m above sea level, allowing observation of the city from this height. This is where one can see the panorama of Murmansk and the nearby city of Kola, Kola Gulf of the Barents Sea, the seaport, and the easily visible Tułoma River, which flows towards the sea. The rocks visible in this place form a complex of granite gneisses, accompanied by dolerites and olivine picrites. These are visible rocks, the observation of which refers to the above-mentioned Archean rocks of the Kola series. At present, this road is better traveled by car; it is not possible to walk everywhere on the side of the road because there are no designated footpaths. However, there are car parks and places where vehicles can stop to enable tourists to see the rocks in question, which are also clearly visible from the car windows, and in winter some of them are illuminated with colorful LEDs (around point 7).

12. Area of entry to the city.

The whole route along the city ring road is about 16 km long. It is very diverse and suitable for trekking. It allows the observation of many plant communities and rock outcrops. At this point, at the entrance to the city, permanent illuminations have been installed symbolizing the city with its coat of arms. At the entrance, there is one of the many crossings along this road, and rocks belonging to the Kola series are also exposed there. They are accompanied by pegmatites with tourmalines and sulfides. In the rock complex in question, grenades and orthopyroxenes are also visible. The discussed point also has an exit leading to Teribierka lying about 130 km to the east, located on the shores of the Barents Sea. If one travels south, one can reach the village of Saami at the foot of the Lovozero and Khibina mountains, the highest massifs in this region; these reach an altitude of 1200 m above sea level. Going west, the road leads to the village of Kola (where there is another interesting point).

13. Historical and geomorphological complex in the vicinity of the city of Kola.

The town of Kola was founded in the 15th century, although today it is part of the Murmansk agglomeration, and one can notice urbanization elements characteristic of this old center. The central part of the town is a wide street that probably used to be a square. Rows of trees are planted around it and buildings are built in the neoclassical style. The old buildings are no longer there because they were wooden, and the sacred buildings were destroyed after the October Revolution in 1917. At present, there are partially rebuilt churches and information boards showing the former large religious complexes that existed in this settlement during the Russian Empire. Currently, it is a rather quiet town with a street leading to the airport serving passenger traffic for the entire Murmansk agglomeration, as well as towards Finland and Norway. There is also a railway line connecting Murmansk with St. Petersburg, and including a branch that is the northernmost railway line in Europe to Pechanga. It is worth visiting this town to walk the streets, look around the historic buildings and look at the Kola Gulf of the Barents Sea from the south. In the area near where the River Kola flows into Kola Bay, one can see a once-frozen glacier in the gulf. The height of the buildings is up to 30 m (building No. 10, Figure 5D). They are made of various crumbly materials. Here, it is possible to observe the Tuloma River estuary and the changes in the sea level caused by the tides. From the west side of the gulf, next to the newly built road bridge, there is also an interesting place where, apart from the rocks in the ground, one can admire the panorama of Murmansk from the sea (building No. 11).

14. Kola Bay and Murmansk panorama from one of the longest bridges in the Arctic.

In the area of the bridge connecting Murmansk with its district on the other side of Kola Gulf (Abram Mys), one can admire the panorama of the city from the sea. At this point, it creates a bay about 2.5 km wide, partially flooded at high tide, and at low tide showing numerous sea plants and crustaceans stuck between the rock blocks that make up the bay shore. The bridge, which opened in 2005, was at the time of its construction the longest Arctic road crossing of the world. This bridge is connected with numerous important cultural and sporting events. A "Murmansk mile" run is organized over the bridge; under the bridge on the east side, there is a large beach, where sports events, as well as outdoor music performances, take place. Ships in parade formation sail through the bay during the festival of the sea. For tourists using a car, after taking the E 105 road about 10 km further north, there is a very beautiful view of the City from the other side of the gulf. From the west, apart from the city panorama, one can observe the fluctuations in sea level and the seashore with numerous boulders located on its shore. These are scattered boulders that were left by the glacier during the Pleistocene glaciation.

15. Recreation area in a closed quarry.

The area of Ledovoe Lake in the southern part of the city is dominated by a hill in which there is now a disused quarry about 130 m above sea level (Figure 3, object No. 9, Figure 5C). At present, it is an area used for recreation in summer by the local population.

When it is flooded to reasonable levels, the inhabitants are often seen swimming, sunbathing on the wild natural beach, playing football, etc. However, at the moment there is no tourist infrastructure, not even toilets. In the lake, one can observe the sequences of metamorphic rocks binding the discussed substrate together with various vein formations. In these gneisses, there are inserts with graphite and carbonates that can be observed at currently inactive operating levels.

16. Historical and cultural complex in the vicinity of the passenger port.

The last closing point of the proposed sites of the city is the passenger port located on the eastern shore of the Kola Gulf of the Barents Sea. There are many attractions related to the technological and historical development of the region. Alongside the quay, there is the world's first nuclear icebreaker, "*Lenin*", which is now a museum ship that can be viewed on guided tours after the purchase of tickets. Next to it, there is a magnificent building of the Murmansk Marine station, and further on, the museum of the Murmansk commercial port, which opened in 2015 in an inconspicuous building (free entry). To return to the center, one must cross the footbridge over the train station.

The entire route is 50.4 km long and can be covered in 667 min (on foot), or 103 min (by car). Table 3 below shows the average travel times between individual points of the route on foot or by car.

Table 3. Average times of transition between the individual points discussed above [time in minutes].

Site Distance	Walking Time	Travel Time by Car	Site Distance	Walking Time	Travel Time by Car
16-1	(16-1) 16	8	8–9	60	13
1–2	8	2	9–10	13	4
2–3	24	4	10–11	59	11
3–4	41	7	11–12	29	2
3–5	20	3	12–13	71	7
5–6	15	9	13–14	47	4
6–7	39	5	14–15	120	12
7–8	39	3	15–16	66	9

Between individual points, it is possible to travel by public transport (buses, trolleybuses, around the ring road) or with the help of a taxi (relatively inexpensive). In the case of the maze (site 9) and the Ledovoe Lake in the quarry (site 15), one must walk a small distance. These involve distances of 900 m by mountain trail (site 9) and 500 m by a closed road (site 15), respectively. At present, there is no other way to reach these places. The difficulty of these routes is average, but at present, there are no facilities for older people. The times given in the table may differ significantly in winter when snow cover makes it difficult to walk. In the case of the route located on the ring road, it must be remembered that at present there is no tourist infrastructure there. There is no protection available in the event of severe or inclement weather, and designated footpaths are virtually non-existent, making it highly dangerous for pedestrians.

4. Discussion

Murmansk is the capital of the region, located beyond the Arctic Circle. Due to its location in the Arctic and recent history, it is a city willingly visited and growing in popularity. The annual number of tourists is systematically increasing. By 2018, the number of tourists coming to this region exceeded 2 million. At present, in Murmansk, there is only a small ecological and natural nature trail in the area of the Semyonovskoe Lake. Due to the large historical, cultural, and natural–geotouristic potential, and the growing number of tourists, there is a need to highlight important points that could create a niche market urban route similar to many other cities in Europe and the world. In many European cities, such routes allow people to learn about important aspects of the city's history (Krakow, Belin) [1–4] and cultural heritage (Rome) [5,6]. The planned routes also make it possible to become acquainted with the richness of the architecture and the natural environment (Vienna) [49,50], including the geomorphological and geological aspects (Kielce, Lublin) [9,51]. There are also areas where the industrial or post-industrial heritage is promoted by the proposal that tourists pay attention to technical monuments (Katowice, Totino) [7,8,52].

In Murmansk, within the city, there are many areas with various qualities and interesting geology to be discovered. There are no problems with tourists becoming lost or with loss or lack of communication [53]. The tourist office, located in the city center, does not have maps that could offer tourists visiting some of the most important points. This solution is standard in many cities in Europe and the world. In Berlin, Krakow [3,4], and other cities, horizontal markings are also used to enable navigation along the thematic route. Usually, they can be painted signs, but sometimes more tourist-friendly signs are also used, such as a cube with a distinctive color embedded in the pavement, etc. Online guides are a relatively good solution, enabling visitors with a smartphone to navigate by uploading an application that combines the advantages of navigation and information about objects one may encounter on a tour around. Such applications exist for Rome [5,6], Vienna [49,50], and many other cities. An interesting solution is also the so-called "City Card" for transport and admission to museums, and interesting objects and attractions [54–56]. In addition to the already existing museums and technical facilities (the *Lenin* icebreaker), it is important to expose the rocks, highlight them, and properly design and layout squares and pavements so that objects such as natural walls and exposures become an integral part of planned routes [57–60]. Places that were previously seen as wastelands can be transformed, giving them a public function. This is the case, for example, in Kielce, where the former quarries within the city limits were transformed into parks, an amphitheater was built in them, and open-air events were organized there [61–65]. On the existing nature trail, attention should be paid to the rock aspect of the ground, adding information about what rock forms are passed along the way. A sensory garden can be created, where the different textures of the stone and its different varieties will affect the aesthetic and physical experience of visitors (Lublin) [51]. Building rock gardens in the city, incorporating natural rock outcrops into the facades of buildings, and finally, appropriating information boards and souvenirs made of stone will change the residents' perception of the ground, and they will start talking about their next attraction [66–70]. The proposed facilities form a network of stands with a wide range of values [71–77]. The route described above includes technical objects, historical sites, post-industrial zones with great recreational potential (the former quarry near Ledovoe Lake), and sites of interesting geomorphological, geological, and natural values. Visiting these places can be an alternative to the solutions currently used in the city, allowing visitors and residents to find out about places [78–84]. The crossing times shown in Table 3 indicate that this route may be divided into several sections. Most of the points (outside the city ring road) have a convenient connection with the use of public transport. This makes it possible to plan one's city tour, depending on the weather conditions and terrain, in stages. In places of particular interest, there should be information boards and QR codes [81–89], redirecting the tourist to visit the appropriate internet portal, and showing information about the observed sites.

The route proposed in this study also aims to draw the attention of residents and city authorities to the multifaceted aspects of heritage and environmental protection, which can affect the better development of the city. The need to introduce various forms of landscape protection and to pay attention to the aspect of geoheritage allows for improvement in the quality of life of residents. The postulated route can contribute to discussions regarding the future development of the city and the nature of the residents' immediate surroundings. The demonstrated qualities in the proposed sites are also intended to draw the attention of tourists visiting Murmansk to the uniqueness of the forms of its natural environment, including its inanimate aspects (geomorphology, rocks), which are unique in the world due to their age and mineralization.

5. Conclusions

The city of Murmansk is located in the Kola Gulf of the Barents Sea, where rock elevations reach 300 m above sea level. It is an important administrative and tourist center of the region. The city has hotels, cinemas, restaurants, and entertainment venues, including numerous offices and companies offering tourist services. In the discussed area of the city, there are several technological, historical, urban, and cultural monuments. Against this background, there are several geomorphological and geological forms associated with rock formations. The Kola series gneisses are 3.75 billion years old and are currently considered the oldest rocks in Europe. They are overgrown with interesting plant communities classified as forest-tundra with numerous acto-alpine species. Along with the city's arctic location, the added value is the ability to observe the northern lights and other atmospheric phenomena in winter and the midnight sun in summer. The proposed sixteen sites for sightseeing in the city are characterized by many natural values. Their location in places with interesting landscapes allows people to become acquainted with the geomorphology and geology of the Baltic Shield. It is formed by the rocks of the ground and by hills cut with faults and vein formations. They were also mined in several quarries around the city, and their fresh exposures are also near the city's ring road, located east of the center. At present, despite the growing tourist interest, the basic elements of the tourist infrastructure are missing. The lack of city maps, route marking, and a tourist guide makes visiting the city much more difficult. Given the great need for tourism development in the area, further detailed studies are needed to monitor the progress of infrastructure development and identify suggestions for thematic trails. Conducting these studies may involve some difficulties due to the strategic nature of this area. The multifaceted nature of the proposed facilities may significantly increase tourists' interest in this place. This offers the prospect of tourism development in the region, starting with its capital—the city of Murmansk.

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