

Article

Earth Science Frontier at Urban Periphery: Geoheritage from the Vicinity of Kazan City, Russia

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Abstract: Characterizing geological heritage sites (geosites) available in Russia remains an urgent task. The present study focuses on two geosites from the vicinity of Kazan—a large city on the Volga River. They are attributed to the standardized geoheritage types and scored by means of several criteria. It is found out that the Pechischi geosite represents nine geoheritage types, from which the stratigraphical type (stratotype section of the Upper Kazanian regional unit of the Guadalupian) and the geohistorical type (history of the Permian System studies) are the most important. This geosite reaches 675 out of 750 maximum possible scores, and it is ranked globally. The Cheremushki geosite represents six geoheritage types, from which the stratigraphical type (reference section of the Urzhumian regional unit of the Guadalupian) and the paleontological type (locality of diverse fossils, including tetrapods) are the most important. This geosite reaches a score of 250 and is ranked nationally. The undertaken study allows for recommending several actions for the effective conservation and exploitation of these geosites. The innovative interpretation is that the presence of geosites at the urban periphery makes its general (not only geological) heritage value comparable to that of the city's center.

Keywords: geosite; Guadalupian Series; Tatarstan; tourism; urban heritage



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1. Introduction

Geological heritage (geoheritage) comprises elements of geodiversity that have cultural, educational, and scientific importance; these need to be evaluated [1], managed [2], and conserved [3]. Moreover, they have to be promoted through geoparks [4], geo-tourism [5], geoscience museums [6], and mapping [7]. Geoheritage studies constitute an important direction of contemporary earth science [8–17]. Significant attention has been paid to urban geoheritage, which also displays notable interactions between the geological and cultural environments [18–23]. Particularly, unique geological and/or geomorphological objects have been reported from such different cities as Bucharest (Romania) [24], Cairo (Egypt) [25], La Palma (Canary Islands, Spain) [26], Mexico (Mexico) [27], and Shiraz (Iran) [28]. However, some aspects of urban geoheritage, as well as its representative examples, are yet to be studied.

Due to its significant territory and outstanding geological diversity, Russia boasts a particularly rich geoheritage [29], which often has major international importance. For instance, this is the case of the Volga River watershed, where the Permian System was established more than 150 years ago [30–32]. Those developments laid the foundations for subsequent development of the regional standard of this system's subdivision into series and stages [33–35]. The related geological objects are not only valuable historically, but they are of major importance for the present-day research and are sites of national pride.

In other words, these are outstanding geoheritage sites (geosites). Some are located in the Republic of Tatarstan, which is a large region of the Russian Federation in the middle portion of the Volga River watershed [29,36]. Therefore, their systematic description with the use of cutting-edge approaches to geoheritage assessment seems to be urgent task.

The objective of the present contribution is to characterize a pair of the most important geosites from the Republic of Tatarstan. They represent the “classical” Russian, Permian-related geoheritage, as well as some other related features. Moreover, they are located at the periphery of the very large city of Kazan (the administrative center of the Republic of Tatarstan) with its notable architecture and active cultural life, and, thus, they are suitable to re-consider the “center–periphery” distribution of general heritage values in culturally and historically famous cities. Importantly, this study focuses on the relatively well-known and geologically well-documented features, and, thus, their geological characteristics are given only in an abridged form to avoid repetitions (indeed, the previously published information is summarized). However, the geoheritage value of these geosites and their properties are yet to be systematically considered, and they are the focus of the present study (in other words, our work is more heritage-focused than geology-focused).

2. Study Area

2.1. Geographical Setting

The Republic of Tatarstan is a large region, with an area of 68,000 km² and a population of ~4 million inhabitants (a bit more than half of whom are Tatars). It is situated near the confluence of the Volga and Kama rivers, from which the latter is thought to be the longest, left tributary of the former (Figure 1). The geographical setting of this region was characterized, particularly, by Burganov [37], Shaykhutdinova et al. [38], Ulengov et al. [39], and Yermolaev et al. [40]. The landscape is dominated by plains with numerous gullies. The climate is temperate, and both forests and steppes (grasslands) occur there.

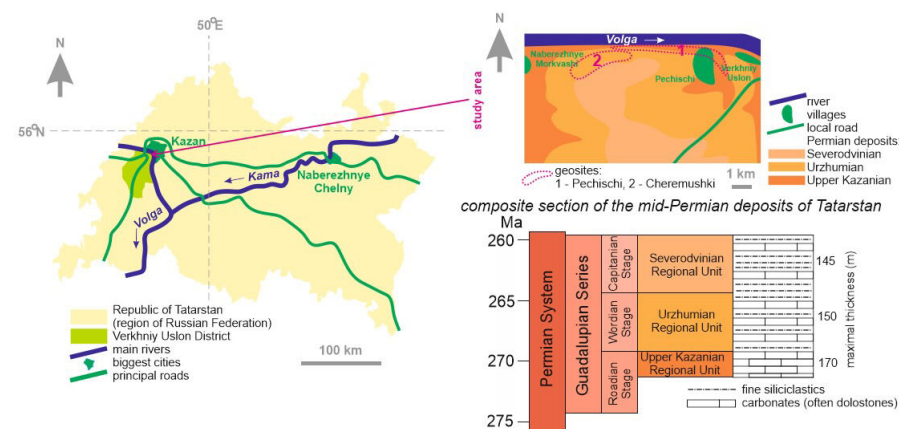


Figure 1. Geographical (left side) and geological (right side) setting of the study area. The local geological sketch map is modified from Nurgaliev [41]. The correlation of the global and regional mid-Permian standards follows [42]. The global units are colored according to the guidelines in [42].

The largest city of Tatarstan is its capital, namely Kazan (>500 km², ~1.2 million people). The city’s history dates back to longer than 1000 years ago, and it is one of the most important cultural, educational, financial, industrial, and transport centers of the entire country, as well as a popular tourist destination. The region consists of dozens of smaller administrative units, one of which is the Verkhniy Uslo District (>1400 km², 17,500 people), which is adjacent to the Kazan metropolitan area (Figure 1). The study area corresponds to the northeastern edge of the district, i.e., to the steep right bank of the very wide Volga River. It is situated near Pechischi (Figure 1).

2.2. Geological Setting

Tectonically, the study area corresponds to the eastern part of the Russian Platform, which is a substantial, stable domain in the central part of the Eurasian lithospheric plate (in its present meaning [43]). Before the mid-Paleozoic, there was a microplate (terrane) called Baltica, which later formed Laurussia together with North America (Laurentia) [44]. Later collisions in the east (with Kazakh terranes and Siberia) marked the onset of growth of the Eurasian plate [45,46], and multiple accretions followed by stabilization in the south (Scythian domain) shaped the present-day Russian Platform [47,48]. More precisely, the study area corresponds to the lengthy, northeast–southwest-oriented Kazan-Kazhim Trough separating the Tokmovo and North Tatarian domes of the Volgian-Uralian antecline dominating the eastern part of the Russian Platform [49,50].

The study area is dominated by mid-Permian deposits (Figure 1), which were characterized comprehensively by Nurgaliev [41]. A regional standard of their stratigraphy is developed, although its correlation to the global standard is matter for yet-to-be-completed investigations and discussions [34,35,41]. Tentatively, the Sokian (Lower Kazanian) and the Povolzhian (Upper Kazanian) correspond to the Roadian, the Urzhumian corresponds to the Wordian, the Severodvinian corresponds to the Capitanian, and, thus, the four noted regional units (regional stages) constitute the Guadalupian Series [42]. These correlations are based on various paleontological data. In the Republic of Tatarstan, the Middle Permian consists chiefly of carbonates (dolostones and limestones), fine siliciclastics (siltstones and shales, often red-colored), and mixed lithologies (marlstones); their total thickness reaches 500 m [41].

The Guadalupian deposits of the study area formed west of the Hercynian Uralian mountains, at the transition between a landmass with terrestrial, desert-like environments to the west and epeiric seas, shallow water, and shrinking, with brackish and hypersaline lagoons bounded by carbonate buildups [41,51]. Early diagenetic dolostones and sabkha facies are common in the Upper Kazanian marine carbonates and evaporites, and paleosols are common in the Urzhumian terrestrial strata. The paleoclimate was arid. Marine basins differed by configuration and conditions between the Late Kazanian and Urzhumian. Paleoecosystems were rich, as evidenced by the common presence of such fossils as bivalves, brachiopods, conodonts, and foraminifers in the Late Kazanian sea, and tetrapods, fishes, non-marine ostracodes, and bivalves in the Urzhumian lake-like basin [41].

3. Materials and Methods

Two geological localities of the Verkhny Uslo District, namely Pechischi and Chermushki, are well-known as highly important objects for the understanding of the Upper Kazanian (upper Roadian) and Urzhumian (Wordian) deposits of the eastern Russian Platform, as well as for the international stratigraphical correlation developments [33,41,52–58]. Detailed stratigraphical, sedimentological, geochemical, paleontological, and palaeogeographical characteristics of these localities are available (see references above), and it would be unreasonable to repeat them. However, it is very urgent to assess these localities in regard to their geoheritage properties, which requires new, special investigation, the outcomes of which are presented in this paper and determine its novelty.

Long-term field investigations in the Verkhny Uslo District, including those coupled with the field educational campaigns for geoscience students from Kazan Federal University, have allowed for accumulating observations, which can be used as materials for geoheritage assessment. Additionally, some information from the available literature has been used.

Several methods have been proposed for geoheritage assessment [1,15,20,59–63]. They have much in common, but they also differ both formally (by algorithms, criteria, and scoring systems) and in terms of their focus on particular aspects of geoheritage and geosites. Importantly, many of these methods are tied too strongly to the European environment, and alternative approaches are necessary for large, non-European countries [64]. The method proposed by Ruban et al. [64] is employed for the purposes of the present study for two main reasons. First, it does not depend on the “traditional”, European geo-

graphical contexts of geoheritage studies. Second, it has already been applied in the other regions of Russia [65,66], and, thus, its use in the Republic of Tatarstan contributes to the nationally consistent geoheritage assessment. To avoid repetition of the earlier published methodological notes [64,66], this method is explained below only generally.

Each geosite is assessed by several criteria (they correspond to principal geoheritage properties), for which scores are given (scores are indicated below in brackets) [64,66]. Some scores increase the geoheritage value and some decrease it, and, thus, both positive and negative scores are used. The basic geoheritage property with the highest scores is uniqueness (rank) depending on the spatial scale of rarity of a particular feature. Uniqueness can be local (+50), regional (+100), national (+250), and global (+500). For instance, if the feature represented in this geosite is known from only this locality in the country, but it exists in some other countries, its uniqueness is national, and it receives a score of 250. The next property is the number of geoheritage types represented in a given geosite. According to Ruban [67], these types are geomorphological, tectonic, stratigraphical, paleontological, sedimentary, palaeogeographical, igneous, metamorphic, geochemical, mineralogical, hydro(geo)logical, geothermal, engineering, pedological, economical, geohistorical (history of geological research and exploration), geocryological, cosmogenic, and complex (the latter means co-occurrence of two and more types). The presence of these types can easily be established in each geosite. The scores depend on their number (0 for single type, +10 for two–three types, +25 for four–ten types, and +50 for more than ten types). Accessibility can be easy in populated areas (+25), easy in remote areas (0), and difficult (−25). Vulnerability depends on anthropogenic stress (past, present, or future); any danger can be absent (+25) or potential (0), and the object can be partly damaged (−25) or fully destroyed (−50). An important technical property is the need for interpretation, which can be absent (+25) and require basic (0) or professional (−10) explanations, or even scientific analysis (−25). Scientific, educational, and touristic importance can be scored each depending on whether it is international (+25) or local (0). The aesthetic importance can be low (0), medium (+25), or high (+50). It should be stressed that this property can be addressed only subjectively, but on the basis of a well-justified set of criteria, which are not linked to specific coloring or panoramic views [68]. The total sum of these scores indicates the geosite value, which may require justification of the rank. For instance, any local geosite can have large aesthetic importance, which makes it a regional geosite. Finally, justified rank can be local (<100), regional (100–249), national (250–499), and global (>500). As noted above, this method was tested successfully (it brought meaningful results important for general judgments of geoheritage and further interpretations) in several areas, and not only Russian ones [64–66,69].

In addition to such a semi-quantitative assessment, each geosite is described qualitatively by the same criteria. Geoheritage properties, not “purely” geological characteristics, are emphasized in the course of this procedure, although the latter are also considered. In other words, geoheritage assessment is something more than just reporting and explaining geological peculiarities of the particular localities.

4. Results

4.1. Pechischi

This geosite is located in the north of the study area, along the right, steep bank of the Volga River (Figure 1). It is named after a small village located there, and its name also follows the traditional name of the lengthy section of mid-Permian deposits exposed in the high slope of the river’s valley. The geosite is very complex, and it includes several features of different origin (Figure 2).

The central element of this geosite is the lengthy section of the Upper Kazanian deposits (Figure 2a), among which early diagenetic dolostones prevail (Figure 2b). This is a stratotype of the Upper Kazanian regional unit (possible regional equivalent of the upper Roadian Stage [42]) with clear contacts with under- and overlaying deposits, which have been studied in detail for more than hundreds of years [41]. The deposits bear

numerous micro- and macrofossils such as bivalves, brachiopods, bryozoans, conodonts, fishes, foraminifers, gastropods, palynomorphs, and trace fossils, some of which were illustrated by Nurgaliev [41] and Haouz et al. [53] (see also sources cited in these works). These deposits bear celestine crystals and nodules, which are notable mineral features. The section reflects paleoenvironments of the Kazan Palaeosea with sabkhas, lagoons, and a wide tidal zone [51], as well as its paleoecosystems, taphonomical, and ichnological patterns. The other element of the geosite is represented by remnants of the former extractive industry. One of those is an almost complete oven (Figure 2c). Such ovens were used in the 19th century and until the 1930s for burning dolomite “flour” for subsequent use in the local building industry. The latter also required extraction of building stones directly from the exposed slope, which was performed as far back in time as the 16th century. The raw material for processing in ovens was extracted in galleries (up to 3 km in length), which were later abandoned and filled. However, they increased the vulnerability of the rock massif to karst phenomena, as a result of which deep (>15 m) sinkholes were formed (Figure 2b). Therefore, they have mixed, natural, and anthropogenic origin. It should also be noted that when these building resources were exploited, the steep slope was cleaned completely. Further erosion led to its coverage with rock debris. Natural rockfalls of hard, silicified dolomites resulted in the accumulation of huge clasts at the slope toe, which can be classified as coarse boulders and fine blocks (*sensu* [70]; alternatively, they are boulders *sensu* [71–73]). Yet, the other element of the geosite can be found on the top of the slope where microlandforms demonstrate the coexistence of karst and landslide phenomena (Figure 3e). On the basis of this description, nine geoheritage types can be individualized in the Pechischi geosite (Table 1).

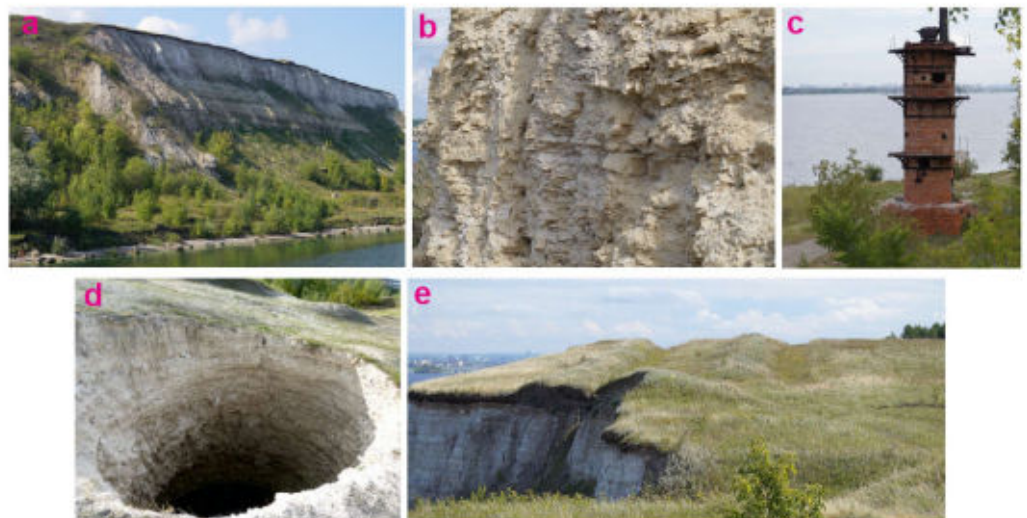


Figure 2. Pechischi geosite: (a) general view of the Upper Kazanian section, (b) Upper Kazanian dolomites, (c) abandoned oven, (d) karst sinkhole, and (e) combination of karst and landslide phenomena.

The geoheritage represented at Pechischi is peculiar in regard to its basic properties (Table 2) and seems to be a geosite of global relevance because of two reasons. On the one hand, it hosts the stratotype of the Upper Kazanian, which is a stratigraphic unit of international utility because it is essential for the world-scale correlations of the Guadalupian Series [35,42]. On the other hand, this section has major historical importance because it contributes to the understanding of the Permian System in the framework of regional stratigraphical standards developed during more than a century. The accessibility of the geosite is perfect. The outer accessibility has three principal options. The first one requires car/bus transportation from the center of Kazan to Verkhniy Uslo via a bridge, which takes no more than one hour. The second option is to use a car ferry connecting Kazan and Verkhniy Uslo (the time is generally the same in this case). The third option is to use river ships,

which operate between Kazan and Pechischi. This option does not allow the use of a car, but the time decreases to ~30 min. The inner accessibility is determined by the availability of local unpaved roads and trails, which lead from the settlements to the riverbank and cross somewhere in the section. The space at the toe of the steep slope is quite wide to allow easy hiking and accommodates even large groups of visitors. The vulnerability of this geosite is minimal because the anthropogenic stress is absent (except for an occasional accumulation of recreational waste in karst sinkholes). Although professional explanations would contribute to a better understanding of the geosite, basic geological knowledge is enough to assess its value. Pechischi has outstanding scientific importance thanks to its value as a stratotype section, richness in fossils, and facies peculiarities. Cutting-edge research has already been conducted there [51,53,56], and there is significant potential for further developments (especially in regard to the global correlation of the Guadalupian Series). The educational importance is determined by the utility of the geosite for explaining a series of geological phenomena to earth science university students, and, in fact, the site is regularly exploited for such purposes by Kazan Federal University with its strong geoscience educational programs. The touristic importance is also high because visiting this geosite allows for raising the visitors' awareness about the Permian System and the local extractive activities. Presently, geotouristic excursions are occasional, but one should note that Pechischi has been included into the routes of excursions at major international meetings [41]. The aesthetic importance is only moderate and determined chiefly by the picturesque landscape, panoramic views, impressive size of the outcrops, and the unusual view of karst sinkholes and man-made objects (oven).

The semi-quantitative assessment of Pechischi indicates that it reaches 675 scores (Table 2). This proves the global relevance of this geosite. It should be noted that the employed scoring system [64,66] allows for reaching a maximum total score of 750, and, if so, the value of the analyzed geosite amounts to 90% of the maximum possible value, which is a tangible proof of major importance.



Figure 3. Cheremushki geosite: (a) general view of the Urzhumian section exposed in the gully; (b) Urzhumian red fine siliciclastics; (c) paleosol horizons (indicated by red arrows; a bag in the lower right corner is provided for scale).

Table 1. Presence of geoheritage types in the considered geosites (only the present types are listed). The relative importance (low, moderate, or high) is indicated.

Geoheritage Types	Geosites	
	Pechischi	Cheremushki
Geomorphological	Moderate	Low
Stratigraphical	High	High
Paleontological	Moderate	High
Sedimentary	Low	Low
Paleogeographical	Moderate	Low
Mineralogical	Low	-
Engineering	Low	-
Economic	Moderate	-
Geohistorical	High	Moderate

Table 2. Semi-quantitative assessment of the considered geosites (scores are indicated in parentheses; see above for the explanation of the scoring system, and more details can be found in [64,66]).

Geoheritage Properties	Geosites	
	Pechischi	Cheremushki
Uniqueness	Global (+500)	Regional (+100)
Number of geoheritage types	Nine (+25)	Six (+25)
Accessibility	Easy in populated area (+25)	Easy in populated area (+25)
Vulnerability	No danger (+25)	No danger (+25)
Need for interpretation	Basic explanations required(0)	Basic explanations required (0)
Scientific importance	International (+25)	International (+25)
Educational importance	International (+25)	Local (0)
Touristic importance	International (+25)	Local (0)
Aesthetic importance	Medium (+25)	High (+50)
Total scores	675	250
Finally justified rank	Global	National

4.2. Cheremushki

This geosite is located north of the study area and corresponds to the short but deep gully, after which it is named (Figure 1). This gully cuts the steep slope of the Volga River valley. Although the considered geosite also has a certain complexity (see below), the different geological phenomena are linked chiefly to the same feature, namely the above-mentioned gully (Figure 3).

The geosite is dominated by outcrops of the Urzhumian deposits (Figure 3a), among which red terrestrial fine siliciclastics prevail (Figure 3b). This is one of the most important reference sections of the Urzhumian regional unit (possible equivalent of the Wordian Stage [42]), which has been studied for many decades [41]. The intercalation of red siltstones with bluish-grey marlstones is reported here (Figure 3c). These marlstones mark paleosols. Various fossils were found in Cheremushki, and the latter is known as the important locality of non-marine bivalve, fishes, non-marine ostracods, and tetrapods (representatives of both amphibians and reptiles are found) [41]. This section reflects the shrinking of the former wide marine basin, with chiefly continental deposits accumulated on alluvial-lacustrine plains in arid conditions. As for the gully (Figure 3a), it represents a common erosional

landform, which is typical to this part of the present-day Russian Plain [40]. This description allows for establishing six geoheritage types in the Cheremushki geosite.

The geoheritage represented at Cheremushki differs from that of Pechischi (Table 2). This seems to be a geosite of regional importance because the reference section facilitates the regional correlation of the Urzhumian unit, but other important sections representing this time slice are available in neighboring localities. The same is true for the paleontological content of this geosite. The accessibility of this geosite is ambivalent. On the one hand, the outer accessibility is perfect, the same as in the case of Pechischi. On the other hand, the inner accessibility is more challenging. One can easily reach the upper part of the gully and observe the sequence of outcrops, as well as spectacular panoramic views towards the Volga River (Figure 3a). However, hiking along the gully and climbing its slopes requires significant training and depends on weather conditions. In other words, the internal part of the gully, offering direct access to the Urzhumian outcrops, is inaccessible to many, if not the majority of visitors. If so, Cheremushki belongs to the category of viewpoint geosites, i.e., geosites from which unique geological features can be observed from a distance [74–78]. The vulnerability of this geosite is minimal because the object remains in its natural state, and anthropogenic stress is absent. The basic geological knowledge seems to be enough to assess this geosite. The international scientific importance of Cheremushki is underlined by its utility for the correlation of the global and regional standards of the Guadalupian Series (the established correlation [42] seems to be only preliminary and requires justifications). Some other worldwide-relevant research projects have been carried out there [33,41,54]. The educational and touristic importance is generally the same as in the case of Pechischi (see above), but here, it is more limited because of the lesser diversity of unique phenomena (Table 1) and lower status of the section as a reference section and not stratotype. Nonetheless, showing this geosite to university students and geology amateurs is a very reasonable opportunity. The aesthetic properties of Cheremushki seem to be high. They are linked to the red color of rocks (contrasting blue river and green vegetation in summer season) and panoramic views (Figure 3).

The semi-quantitative assessment of Cheremushki indicates that it gains a score of 250 (Table 2). This increases the rank of this geosite from regional to national. Taking into account the scoring system [64,66], the value of the analyzed geosite constitutes 33% of the maximum possible value.

5. Discussion and Conclusions

5.1. Perspectives of Protection and Exploitation

Geoheritage, especially when it is of global or national value, requires proper conservation, which includes its effective monitoring, protection, management, and promotion. The related principles and procedures were characterized by Burek [79], Crofts [80], Garcia et al. [81], Neto and Henriques [11], Mariotto et al. [82,83], and Prosser et al. [84–86]. In the study area, the intense research and the field educational campaigns for geoscience students from Kazan Federal University provide a unique opportunity to monitor regularly the state of the Pechischi and Cheremushki geosites. Taking into account their scientific and educational importance for local geologists, it is evident that even a minor danger to their natural state will be signaled, with consequent actions.

Even more important is that both considered geosites are designated officially as a Regional Monument of Nature (RMN), which is a particular type of specially protected area in Russia. The Pechischi Geological Section RMN was created in 1972 due to its stratigraphical importance, and the Cheremushki Gully RMN was created in 1986 due to its stratigraphical and paleontological importance [87]. Their status was proven several times (the last time in 2019). The Republic of Tatarstan is responsible for these RMNs. The signs (simple explanatory panels) informing about the features' names and their peculiarities, permitted activities (excursions and individual access), and protection measures are installed (Figure 4a). This official status establishes several restrictions that enable the avoidance of special or occasional anthropogenic stress. It should be noted that even if

RMNs are based on geosites, the two do not necessarily coincide, and geosites commonly occupy slightly larger areas. It is strongly recommended to undertake justification of the limits of the considered geosites, also taking into account the limits of the RMNs.

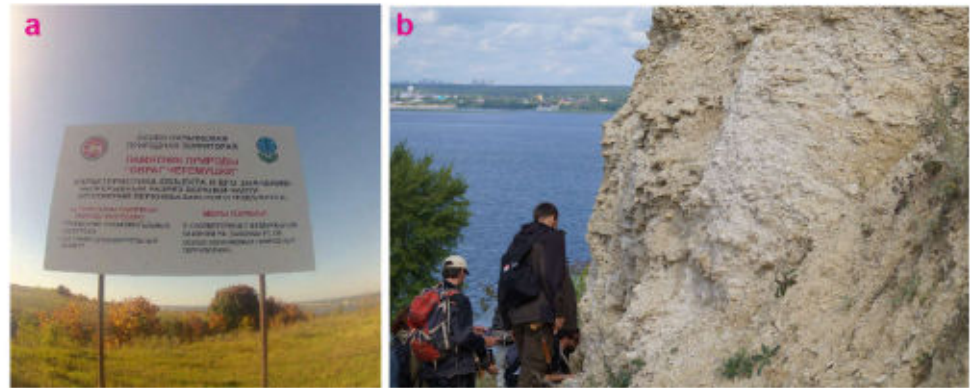


Figure 4. Geoconservational and geoeeducational aspects of the considered geosites: (a) panel informing about the Cheremushki geosite; (b) student excursion to the Pechischi geosite.

Although both objects do not demonstrate any vulnerability, some maintenance is required. The sections can be cleaned from slope debris to reach their historical state (before the local extractive activities were stopped about a century ago). These activities are costly, but simple actions would exhibit more portions of the stratigraphically important sections. Reinforcing the slope to avoid future debris accumulation and occasional collapses may be required in such a case. Similar actions undertaken effectively at the other localities deserve attention [88].

Currently, the exploitation of Pechischi and Cheremushki is related strongly to the educational activities of Kazan Federal University (Figure 4b). Indeed, they can be extended by offering the possibility to visit these geosites to students of some other universities with geoscience programs, which have field educational campaigns. Scientists (chiefly from the noted university, but also from some other institutions and international research groups) work actively at the sections. As for geotourism, it flourishes in the form of occasional academic geotourism, with irregular excursions offered to non-devoted visitors.

Two main challenges for the exploitation of both geosites are the absence of well-established routes and marked trails, as well as the need for interpretive panels explaining the essence of the unique features in detail. In the case of Cheremushki, some engineering solutions would be required for increasing the inner accessibility of the geosite. For instance, metallic stairs could be installed. Indeed, these challenges can easily be addressed, and the necessary investments can be provided by companies and authorities interested in the development of local tourism. The international experience with the infrastructural developments of geosites should also be taken into account [89–93]. The idea of geotrails [94] also deserves attention. More generally, the geosites need development plans to balance exploitation with conservation needs and to avoid even minimal damage of geosites with tourism-related modifications.

5.2. Heritage Complexity in Kazan and Its Vicinity

The recognition of two geosites with high value in the study area (Table 2) raises the question about the correspondence of this geoheritage with the other types of heritage available here. First, it should be stressed that the oven near Pechischi, which is interpreted above in terms of geoheritage, represents also an industrial heritage because it is related to the past industrial activities important for local identity. Such objects as old churches and museums (one of them is dedicated to the famous Belorussian poet, namely Yanka Kupala, who stayed in Pechischi temporarily) comprise cultural and historical heritage of the entire Verkhniy Usion District. Moreover, the latter is a typical rural district of the

Middle Volga territory (but simultaneously urban periphery of Kazan), and, thus, its rural heritage potential is also evident. However, the amount and the diversity of heritage in the urban area of Kazan, at the periphery of where the study area is situated, is impressive, and it has been researched actively [95–99]. This old and multicultural city boasts numerous heritage objects, from which the Historic and Architectural Complex of the Kazan Kremlin is the most important (Figure 5a). In fact, it has the status of UNESCO World Heritage Site.



Figure 5. The Kazan Kremlin: (a) general view of the UNESCO World Heritage Site; (b) details of the Kremlin's wall; food heritage of Tatarstan: (c) echpochmak and (d) chak-chak.

Generally, Kazan and its vicinity are heritage-rich areas, and, if so, geoheritage contributes to its diversity and value. The spatial integrity of heritage between the study area, the Verkhniy Usilon District, and Kazan is evident. However, this integrity is even stronger, taking into account that dolostones from Pechischi were used for construction of the walls of the Kazan Kremlin in the 16th century (Figure 5b). This permits the tracing of links between the cultural heritage in the city center and the geoheritage at its periphery. One may suppose that the most valuable heritage can be found in the historical center of the city, which seems to be “natural” due to the dominance of the urban peripheries by modern constructions. However, the presence of the geosites with global and national value (Table 2) changes the heritage distribution model, and a part of the urban periphery becomes important in comparison to the center. Indeed, the geosites from the study area mark a kind of frontier of earth science, which struggles to make advancements in the understanding of the Guadalupian stratigraphy and paleontology, and, thus, they extend the general heritage meaning of the urban area of Kazan.

Indeed, the above-mentioned interferences between the geological and other types of heritage of Kazan and its vicinity form a substantial basis for geotourism development. At least, it can be facilitated by the connection to the attractive cultural, historical, and other heritage. There may be some other opportunities. The Republic of Tatarstan and Kazan as its capital are famous for specific food, which is a kind of regional heritage. For instance, such food as echpochmak (Figure 5c) or chak-chak (Figure 5d) are elements of the national identity. Gastronomic tourism flourishes in the region, and it can facilitate geotourism development via mixed experiences. From the international experience, it is known that

local food and beverages, which often constitute heritage, enhance geotourism development [100–102] and can contribute to geoheritage marketing via geoproducts [103,104]. Taking into account the high level of organization of the tourism-related activities in the Republic of Tatarstan, it appears to be easy to merge gastronomic tourism programs with geotourist excursions referring to the already existing experience of merging gastronomic and cultural-historical tourism. Moreover, such a nature-framed development of gastronomic tourism would contribute to responsible and sustainable usage of food products and waste. The related issues are debated hotly [105–107]. Apparently, the integration of gastronomic tourism with geotourism at the urban periphery and in adjacent rural areas can be considered as a powerful strategy to increase skills in pro-environmental behavior of tourists in regard to food.

6. Conclusions

Generally, the present study indicates the presence of two valuable geosites at the periphery of Kazan city. One of them is ranked globally, and another is ranked nationally. These geosites represent a wide spectrum of geological phenomena, although they have much in common reflecting the mid-Permian world. These geosites need some geoconservation initiatives, and their effective exploitation requires infrastructural development. Although it is often thought that geoheritage concentrates in mountainous domains, the present example provides an alternative view demonstrating the presence of unique features in the eastern part of the vast Russian Plain.

This study aims at arguing innovatively that geoheritage on urban areas should be treated together with the other types of heritage (architecture, food, etc.). If so, finding geosites with high value at the periphery of such areas contributes to balancing the general (not only geological) heritage value between center and margins of large cities. This seems to be highly important for rational urban planning and management; particularly, this means that heritage-related initiatives should not be restricted to cultural and historical centers. Apparently, geosites found at the peripheries of urban areas would contribute to their sustainable development via attraction of tourists (with socioeconomical benefits in the form of local income, new jobs, and infrastructure improvement) and homogenization of the city environment with joint heritage management.

The present study reveals the potential of geoheritage exploration in the Republic of Tatarstan. This seems to be a starting point for further research, which should focus on finding and assessing new geosites in this region of Russia. Indeed, a comprehensive geoheritage description of this region cannot be achieved by a single research team, and, thus, significant efforts and several decades of investigations will be required. However, documenting this geoheritage will permit the revealing of new geological resources, the exploitation of which can bring substantial socioeconomical benefits. Additionally, examples from different countries should be compared for the conceptual treatment of geoheritage in the spatial structure of urban environments.

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