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Quaternary Sediments in Geosites: Evidence from the Western Caucasus

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Abstract: Some previous studies have already highlighted the importance of Quaternary sediments as geoheritage, although the related knowledge remains incomplete and geographically biased. Unique Quaternary features are often overlooked in areas famous for their pre-Quaternary geoheritage. Moreover, the already established high-value linked to pre-Quaternary phenomena require comprehensive descriptions; therefore, it is reasonable to analyze the related Quaternary features (even if these are only locally unique). For the purposes of the present study, three localities that form parts of larger geosites, and which represent Quaternary sediments of Mountainous Adygeya in the Western Caucasus, are characterized. They are assessed qualitatively, with a general description of sediments and attention paid to their origin, potential scientific importance, and accessibility. The Rufabgo Canyon hosts colluvial megaclast sediments. The Dakh–Sakhray Confluence exhibits typical alluvial sediment where detrital clasts are mixed with rather numerous Fe-rich concretions washed out from the parent rocks. The Stonesea Range exhibits mixed eluvial–deluvial sediment formed as a result of the karstification of carbonates and the erosion of overlaying red siliciclastics. All these sediments are of interest to scientists because they can be employed for promising research projects, revealing the peculiarities of the local patterns of Quaternary sedimentation. The localities under consideration are geoheritage points within the larger geosites and are perfectly accessible. Aside from their use by scientists, these localities can potentially be used by geosciences educators to train university students in sedimentology. In two cases, the sediments are also aesthetically important for attracting tourists. Generally, Quaternary sediments should be considered together with the other unique features represented in the geosites of Mountainous Adygeya.

Keywords: Adygeya; alluvium; geotourism; karst; megaclast; slope deposits; siderite

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1. Introduction

Geoheritage studies have become an important focus of modern geoscience research [1–9]. As a result, a broad spectrum of unique geological and geomorphological features has been investigated; these include rocks, minerals, fossils, tectonic structures, volcanoes, geothermal sites, and landforms. Some are represented in situ, i.e., in natural and artificial outcrops, whereas samples of the others are stored in museums, exhibits, and archives. These features have been investigated as precious resources for exploitation with socio-economic benefits. Geotourism activities have grown exponentially since the beginning of the new millennium [10–16].

Indeed, Quaternary geologists could not overlook this important research movement. Quaternary features have been interpreted as geoheritage in many countries. Studies in the Broome region of Western Australia allowed Clifford and Semeniuk [17] to relate geological and archaeological features and to propose geoheritage that revealed the Holocene history of human–environment interactions. Dempster and Enlander [18] summarized the knowledge of the rich Quaternary geoheritage of Northern Ireland, which can be employed in geopark development. Volcanic sites of Quaternary age present on Hainan Island (China) were suggested to be geoheritage by Duan et al. [19]. Górska-Zabielska et al. [20] focused on erratic boulders, which constitute an important piece of the geoheritage of the Przedbórz Region in Poland. The work conducted by Németh et al. [21] in the Arxan–Chaihe volcanic field in China contributed to our knowledge of Pliocene–Quaternary geoheritage features. Niculiță [22] recognized the potential of the Bahluieț Valley as a geosite due to its archaeological, geomorphological, and palaeogeographical features; in particular, the oldest palaeolandslide in Romania was found there. Notably, many of these studies revealed the potential importance of Quaternary sediments as geoheritage.

Although contemporary geoheritage studies have focused on unique phenomena of the Quaternary age, they often remain "marginal" compared to older features when both are available in a given territory. Naturally, outcrops of Precambrian rapakivi granites or spectacular fluorite veins in quarries attract more attention than "just alluvial sands" or "obvious" slope debris. The only unusual landforms are common Quaternary geosites. Moreover, Quaternary features such as specific sediments can be found within many already established geosites, the value of which is determined by pre-Quaternary phenomena. Such features often do not receive adequate attention, although their consideration would facilitate better understanding of these geosites. Such a situation is typical of the Western Caucasus, a domain with well-documented and rich geoheritage and significant geodiversity, located in the southwest of Russia [23]. Its unique geological sites are chiefly Late Paleozoic–Mesozoic in age, whereas Quaternary geosites are limited to landforms and karst. The highly complex, multi-phase tectonic development of this domain caused the co-occurrence of essentially different features in a relatively small territory. Quaternary sediments are distributed widely in the Western Caucasus but have remained in the "shadow" during previous geoheritage inventories, even when they are found within valuable geosites. This knowledge gap should be filled.

This contribution presents new lines of evidence of Quaternary sediments found in the geosites of the Western Caucasus. These sediments themselves deserve to be recognized as geoheritage, even if they are not especially unique. In any case, it is reasonable to study them because all geosites require comprehensive description, rather than attention being paid only to the features (often pre-Quaternary) that determine their value. It should be stressed that this work aims to provide a preliminary description that is sufficient for geoheritage judgments, whereas "purely" sedimentological studies are in progress. A more general purpose of the contribution is to demonstrate that attention to peculiar Quaternary sediments can contribute to a better understanding of territorial resources and the possibility of exploiting geosites.

2. Methodology

2.1. Study Area

The study area corresponds to the famous Russian tourist destination of Mountainous Adygeya. It is located in the southwest of the country, where the Greater Caucasus, a lengthy mountain chain, stretches between the Black and Caspian seas (Figure 1). The Western Caucasus is a western segment of this chain, which borders the Black Sea from the northeast. Mountainous Adygeya is situated on the northern slope of the mountain chain, ~100 km southeast of the large city of Krasnodar.

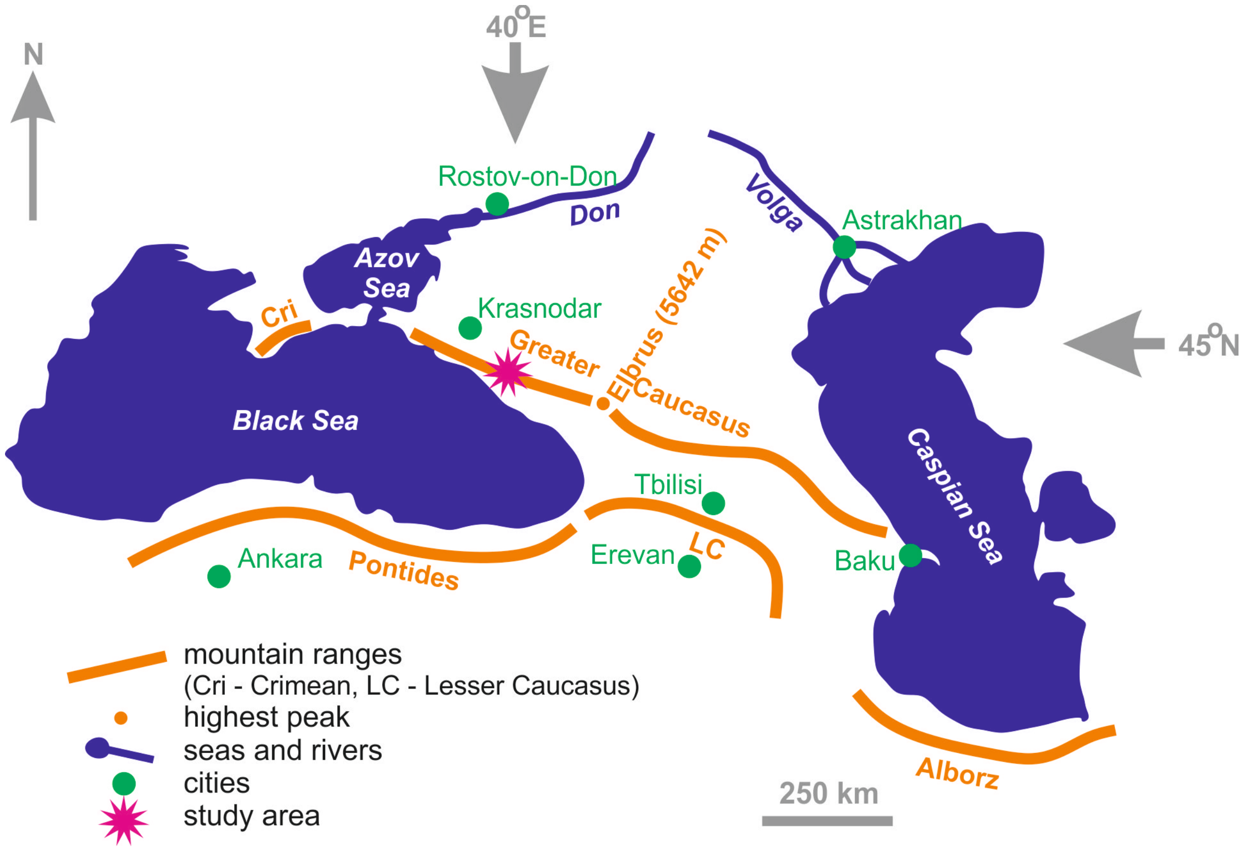

Figure 1. Geographical location of the study area.

The geographical characteristics of the study area were summarized by Bedanokov et al. [24], Lozovoy [25], and Nazarenko et al. [26]. Mountains dominate it, with their height ranging from 700 m to over 2500 m. Cuesta-type ranges with an asymmetrical profile (the Stonesea, Azish-Tau, Skalisty, and Una-Koz ranges) bound it from the west and the north, and lower, fairly symmetrical ranges (Burelom, Dudugush, Inzhenerny, and Skazhenny) cross it from the northwest to the southeast (Figure 2). The highest part is the Lagonaki Highland in the southwestern corner of the area, where the elevations exceed 2000 m. The Belaya River, a left tributary of the larger Kuban River flowing to the Azov Sea, crosses the study area from the south to the north. Its drainage network is very dense. The climate is temperate but mild, with annual precipitation up to 3000 mm. Snowfields and small glaciers are common in the Lagonaki Highland. The vegetation cover is represented by coniferous, deciduous, and mixed forests, with relatively large meadows in river valleys and Alpine meadows in the most elevated domains. The area is not densely populated but hosts a small town and several villages (Figure 2). The road infrastructure is relatively well developed. From May to October, Mountainous Adygeya is overcrowded by tourists.

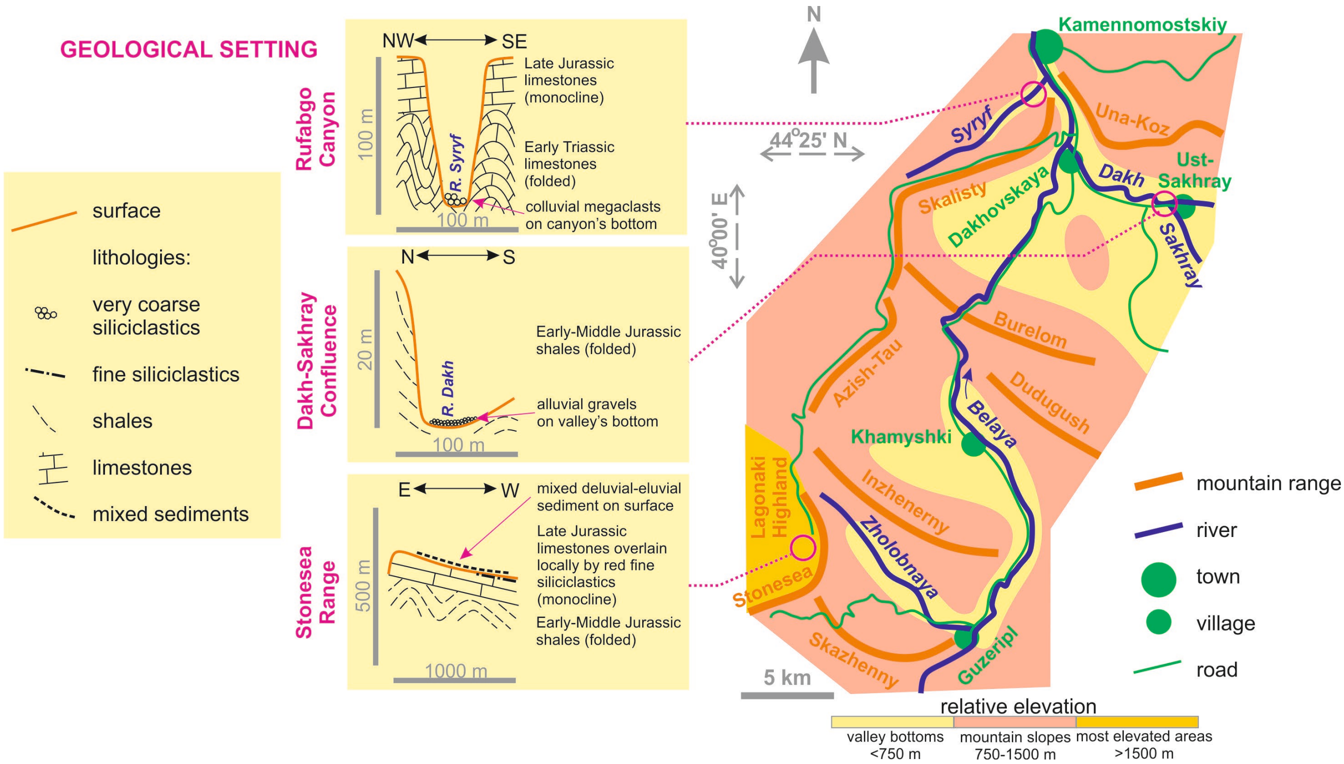

Figure 2. The study area and the considered localities. A geological scheme of the area can be found in [27].

The Western Caucasus is a part of the Late Cenozoic orogen of the Greater Caucasus [28–30]. It has grown in the compressed domain between the Eurasian lithospheric plate in the north and the Arabian plate in the south (some smaller plates and terranes are also involved in their interaction). The orogen inherits the Mesozoic–Early Cenozoic back-arc basins and island arcs [31], and its Paleozoic history reflects large-distance shifts of the Greater Caucasus terrane between Laurussia and Gondwana [32]. The geological setting of Mountainous Adygeya is described by Plyusnina et al. [33] and Ruban [34]. To avoid repetition of these descriptions, it is sufficient to state that the study area is dominated by thick (several kilometers) Early–Middle Jurassic sandstones and shales overlain by Late Jurassic limestones and dolostones; variegated sabkha siliciclastics of the latest Jurassic age cap the latter. In addition, Late Paleozoic granitoids, Permian molassic sequences, Triassic limestones, and Early Cretaceous mixed lithologies crop out locally. The area is intensively folded and faulted. More details of the geological setting are provided below, with a description of the considered localities. Nonetheless, it is important to stress that the Late Cenozoic orogeny and the related Pliocene–Quaternary uplifts and erosion intensification were responsible for the development of the above-mentioned landforms. The cuesta-type ranges reflect uplifts strengthened to the south and the east, due to which thick and hard carbonates of the Late Jurassic age became inclined to the north and the west. The symmetrical ranges formed where relatively soft, shale-dominated packages of the Early–Middle Jurassic age were exposed due to the total erosion of the carbonates. The diversity of the local geology determines the existence of rich, world-class geoheritage resources, which are quite well documented [23]. Notably, fifteen geosites of all ranks (including global) have been established, the largest and most important of which corresponds to the Lagonaki Highland [23].

The Quaternary cover of Mountainous Adygeya is yet to be described systematically. Nevertheless, it can be characterized briefly based on the author's observations during more than two decades of field research. The Belaya River and its numerous tributaries, such as the Dakh, Syryf, Zholobnaya, and many others (as well as their own tributaries), have more-or-less developed valleys. The width of the valleys of the Belaya and Dakh rivers is several kilometers, and they have several levels of terraces. These valleys are covered with alluvial deposits, usually mixed gravels and sands. The gravel particles are chiefly well-rounded. Gentle slopes of cuestas and some other landforms are covered by deluvial sediments, which are washed down by rainwater. These sediments (often fine siliciclastics) are distributed widely and are especially extensive where shales crop out. Steep slopes, such as cuesta scarps, host colluvial sediments (on the slopes and at the toes), which may form lengthy (up to several hundreds of meters) tongues of angular gravels. In some places, colluvial and deluvial sediments are mixed. Finally, eluvial sediments produced by the weathering of parent rocks are found locally. For instance, these occur on slopes of cuestas where the intense karstification of carbonates leads to the destruction and disintegration of their upper horizons. The presence of glacial or fluvioglacial sediments cannot be excluded because the Western Caucasus hosted ephemeral glaciers in the Pleistocene [35], but more investigations are required to document such sediments. Generally, Quaternary sediments encompass a significant part of the study area and are very typical for mountainous domains. Their composition and facies reflect the study area's active mountain building coupled with intense river erosion. However, many details of the Quaternary evolution of the study area are yet to be elucidated.

2.2. Approach

The materials for the present study were collected in three localities (the Rubago Canyon, the Dakh–Sakhray Confluence, and the Stonesea Range (Figure 2)) over the course of more than ten years of field investigations. These localities represent portions of the larger geosites, the establishment of which was not linked to studies of Quaternary sediments [23]. A variety of more or less peculiar Quaternary features were found. Therefore, attention is paid to these features, as well as to some properties of the localities themselves. The parameters for the description of the localities are summarized in Table 1.

Table 1. Template for the description of the considered localities.

Parameter	Essence	Special Notes
Location	Where is the locality, and how does it look physically?	-
Geological setting	Composition and age of "parent" rocks	The ICS's developments [36] are followed.
Quaternary feature	General view of sediments (with an emphasis on their composition and distribution)	See classifications by Blair and McPherson [37], Blott and Pye [38], Bruno and Ruban [39], and Terry and Goff [40], from which [39] is derived.
Origin	Genesis of sediments	Old-fashioned but still suitable terms such as "alluvium", "colluvium", "deluvium", and "eluvium" are used.
Possible age	When did sediments start to form?	Only very approximate judgments are possible.
Significance	Why should this locality be interesting to specialists?	-
Accessibility	How easy is to access the locality and to move within it?	-

These parameters characterize each locality. The three main steps include a general description of the locality by the first and second parameters, a description of the sediments according to the third, fourth, and fifth parameters, and making preliminary geoheritage-related notes using the sixth and seventh parameters. Such characteristics constitute the results of the present study, and they will facilitate further geoheritage investigations. Although procedures for such research are not standardized, the implemented approach follows some general principles of sedimentary geoheritage investigations (e.g., [41,42]).

The proposed approach is rather descriptive, but it matches the objective of this study, i.e., the preliminary reporting of Quaternary sediments as elements of geoheritage from the territory, where many other unique geological and geomorphological phenomena have already been registered. Some additional explanations are necessary. First, this paper focuses specifically on Quaternary sediments from small-sized localities, and not from geosites. As such, it is unreasonable to undertake a full-scale, score-based (semi-quantitative) geoheritage assessment, because the latter had already been conducted [23]. Nonetheless, some general principles of geoheritage studies as explained by Brilha [43], Bruschi et al. [44], Mucivuna et al. [45,46], Quesada-Valverde and Quesada-Román [47], Reynard and Brilha [8], and Štrba et al. [48] are taken into account. Second, a parameter as tentative as significance is considered. Indeed, scientists constitute the main target audience, who may be interested in Quaternary sediments. Scientific value is essential to geosites [43,46,49–53]. The considered localities are only parts of larger geosites with known scientific value [23], and, thus, the potential interest of a given locality to specialists should be explained qualitatively. Third, accessibility is characterized by understanding how easily the localities can be reached for direct examination. The general accessibility of the related geosites [23] may differ from the accessibility of Quaternary sediments, which can be found at the bottoms of turbulent rivers or on steep slopes.

3. Results

3.1. Rufabgo Canyon

The Rufabgo Canyon is located in the northern part of the study area near Kamennomostskiy town (Figure 2). It is a part of the Khadzhokh canyon system formed by the Belaya River and its right and left tributaries. The Rufabgo Canyon is divided by the Syryf River (a left tributary of the Belaya River) (Figure 3). It hosts the famous Rufabgo waterfalls, the main tourist attraction of Mountainous Adygeya. The depth of the Rufabgo Canyon reaches 100 m, whereas its width is a few dozen meters. It is cut in the hard although strongly deformed limestones of the Yatyrgvarta Formation (Early Triassic), capped by a northward-dipping monocline of karstified carbonates of the Gerpegem Formation (Late Jurassic) (Figure 2). This locality is a part of the large geosite known as the Khadzhokh canyon system and Rufabgo waterfalls (its particular value is determined by the presence of the Triassic sequence, waterfalls, and notable landforms) [23].

The bottom of the Rufabgo Canyon is covered by alluvial deposits, composed of clasts (chiefly carbonate) with sizes ranging from <1 mm to 10–20 cm. However, numerous clasts have irregular shapes and diameters exceeding 1 m (Figure 4). Essentially, these are megaclasts (particularly fine, medium, and coarse blocks of sensu [39]), which are entirely detached from the parent rocks (carbonates of the Gerpegem Formation). Some of them reach 5 m in diameter. They occur individually or in groups consisting of ten or more megaclasts. Their distribution in the canyon is sporadical, and they generally fill the canyon "above" the noted alluvial deposits. They look like huge, free-lying stones, which differ lithologically from the rocks exposed in the lower part of the canyon's walls. In some places, their accumulations are so extensive that they look like natural barriers across the canyon's bottom. This megaclast sediment was previously investigated by Lubova et al. [54], who noted their colluvial origin. These megaclasts become detached from Late Jurassic carbonates weakened by karstification, move down the canyon's steep slopes (via sliding, rolling, and falling), and accumulate at the bottom. The energy of the Syryf River is not enough to transport them. The age of this megaclast sediment is challenging to establish, but, considering the depth of the canyon and the fact that the river has insufficient energy for rapid valley incision, it is possible to hypothesize that it started to form before the Holocene. However, some megaclasts are very young and formed after slope collapses only a few years or decades ago.

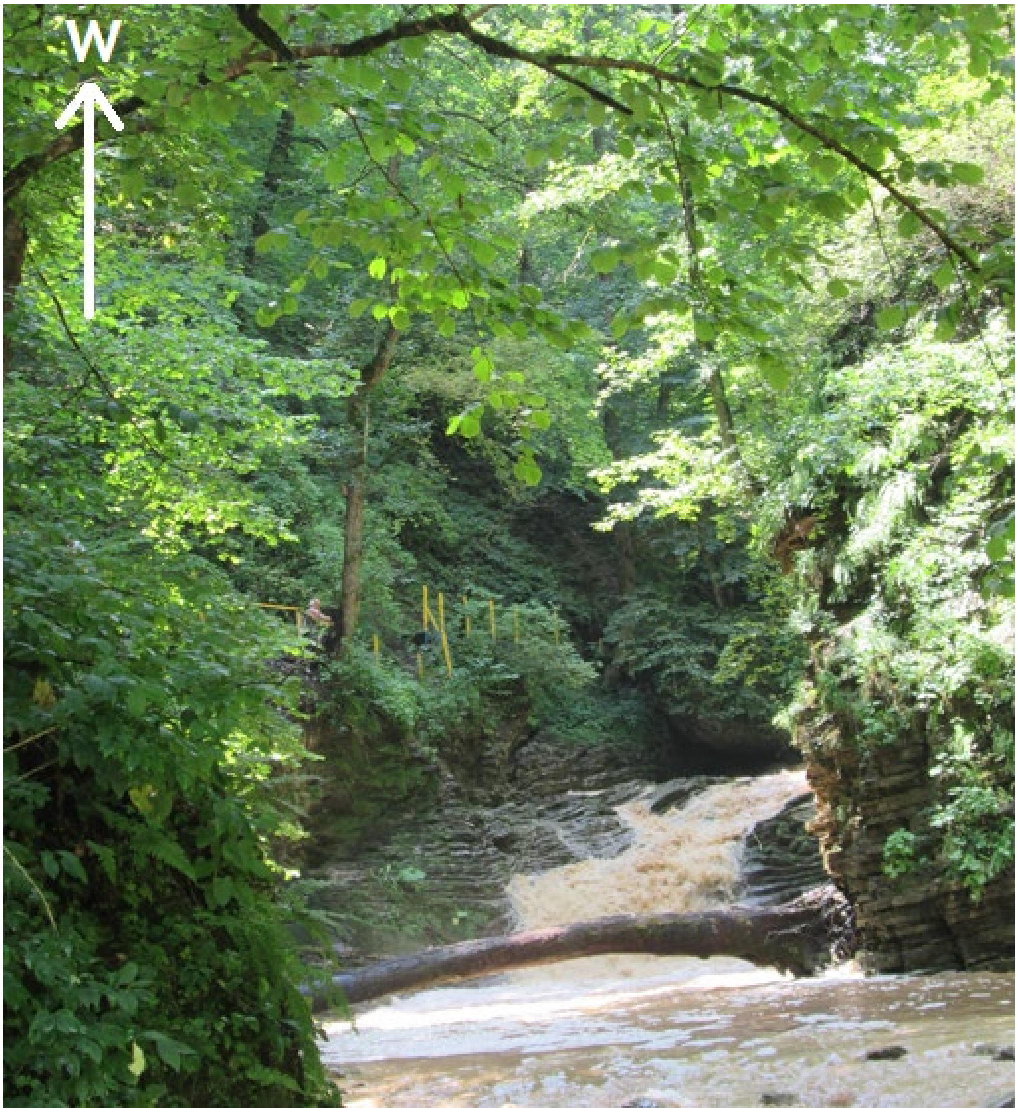

Figure 3. General view of the Rufabgo Canyon. The arrow shows west.

The colluvial megaclast sediment from the Rufabgo Canyon should attract the attention of many specialists. On the one hand, such sediments have already been used to develop the idea of megaclasts [54]. On the other hand, such huge accumulations of megaclasts are unique, at least on the national scale. Although colluvial megaclasts have been known since the Precambrian period [55], coastal megaclasts are the main focus of the present research [56]. Moreover, voluminous alluvial megaclast sediments are rare geological features. Aside from the Rufabgo Canyon, they have been reported in Fiji [57]. The studied locality has good accessibility. A private (entrance fee required) metallic bridge above the Belaya River leads to the Rufabgo Canyon from the principal road southward of Kamennomostsky town (Figure 2). A trail with some metallic bridges and stairs totaling ~2 km is located at the bottom of the canyon. It allows for the comfortable examination of all megaclasts available there.

Figure 4. A typical megaclast from the Rufabgo Canyon (this huge sedimentary particle is fully detached from the parent rock, which is exposed dozens of meters higher).

3.2. Dakh–Sakhray Confluence

The Dakh–Sahray Confluence is a small locality in the eastern part of the study area near Ust-Sakhray village (Figure 2). The Dakh River is the right tributary of the Belaya River, and the Sakhray River is the left and largest tributary of the former. The Dakh River before the confluence and the Sakhray River are equal streams, and, thus, the confluence is an important hydrological point (Figure 5). In this locality, the valley of the Dakh River has a high, steep right bank with natural outcrops of Early–Middle Jurassic, dark-colored, folded, and faulted shales and a gentle left bank with small terraces (Figure 2). This locality is a part of the large geosite known as the Sakhray canyon (its value is determined, in particular, by the presence of Triassic sequences with reefal limestones) [23].

The valley's bottom near the confluence of the rivers is relatively flat (Figure 5) and covered by alluvial gravels (up to 20–30 cm in size) mixed with sand in different proportions. These clasts are products of the erosion of different parent rocks cropping out in the valleys of the Dakh and Sakhray rivers above their confluence. There are clasts of Precambrian metamorphic rocks, Late Paleozoic granitoids, Triassic limestones (including Late Triassic pink reefal limestones), and Jurassic shales, sandstones, and limestones. Besides these detrital particles, one can observe brown clasts with markedly different shapes (from spherical or brick-like to irregular, but often flat and with rounded angles); their size also differs and ranges from 1–3 cm to 15–20 cm (Figure 6). Such clasts constitute up to 1% of the entire sediment. They are mixed with gravels of other compositions and are distributed relatively homogeneously within the locality. Essentially, these are Fe-rich concretions with mixed clayey and siderite cores and crusts consisting of the mineral products of iron oxidation. Imprints of smaller concretions and calcite veins are found in some of them (Figure 6). The original, pre-detachment morphology determines their flatness and more or less perfect rounding. Such concretions of mixed fine clayey and siderite material are common in Early–Middle Jurassic deposits, which dominate the study area [58,59]. The amount of siderite in the concretions varies, and there are concretions consisting almost entirely of this mineral. In some cases, iron oxides compose a significant part of the concretions.

Figure 5. General view of the Dakh–Sakhray Confluence. The Dakh River flows from the left, the Sakhray River flows from the right, and the joint stream is visible in the lower left corner of the image. The author is present for scale. The arrow shows east.

Figure 6. Examples of Fe-rich concretions collected at the Dakh–Sakhray Confluence (scale in cm).

The origin of these concretions is linked to diagenetic processes in initially Fe- and C-enriched shales [59,60]. Importantly, concretions from the Early–Middle Jurassic shales are the same as those found in the modern sediment at the Dakh–Sakhray Confluence. It appears that the erosion of relatively soft shales by rivers, streams, and slope processes leads to washing out hard and heavy concretions, which accumulate together with detrital clasts in alluvium. These processes started with the development of the modern hydrological network in the Pleistocene, and they are still operating.

Although modern river sediment from the Dakh–Sakhray Confluence looks like very ordinary alluvium, the presence of the noted concretions makes it somewhat peculiar. Although most clasts were shaped in the process of the parent rock destruction, some of them (concretions) were shaped by diagenetic processes far before this destruction. Similar sediments can be found at several other localities of Mountainous Adygeya. However, the Dakh–Sakhray Confluence provides a highly representative example where the amount of concretions in the deposit is high. The information about this alluvial sediment may be important for re-vitalizing the development of the classification of modern clastic sediments. Sediments enriched in weathered concretions can be found in some other locations around the world, including Egyptian deserts [61] and Californian coasts [62]. Concretions from these sediments differ from "normal" clasts due to their formation mechanism; therefore, sedimentologists may be interested in visiting the localities. Moreover, the Early–Middle Jurassic shales crop out directly at the considered locality; thus, it is possible to compare concretions found in situ and ex situ. The accessibility of this locality is perfect. An unpaved but good-quality road connects Dakhovskaya and Ust-Sakhray (Figure 2). A well-established trail along the gentle slope of the Dakh River's valley leads to the beach (quite a popular place for local recreation) near the confluence. The rivers are shallow (except for limited periods after heavy rainfall), and one can cross them and collect sedimentary material directly from the channels.

3.3. Stonesea Range

The Stonesea Range is situated in the southwestern part of the study area (Figure 2). This is a cuesta-type range, which belongs to the Lagonaki Highland and borders the latter from the southeast. The locality corresponds to the eastern, gentle slope of the cuesta, with elevations of ~2000 m. This slope is affected by intense karst processes, and epikarst features such as depressions, grike fields, and furrows are common there (Figure 7). The upper part of this cuesta is composed of relatively hard Late Jurassic (Oxfordian–Kimmeridgian) carbonates of the Gerpegem Formation, which form a kind of monocline dipping to the northwest with an angle of ~10°; the Mezmay Formation consisting of Tithonian red fine siliciclastics (siltstones and shales) overlays the noted carbonates in the study area [58], although these deposits remained only locally after significant erosion at the considered locality (Figure 2). The red color of fine siliciclastics is explained by the high content of iron oxides. The monocline generally dips in the same direction as the gentle slope of the cuesta. This locality is a part of the very large geosite known as the Lagonaki Highland (its value is determined by abundant karst features and Late Jurassic carbonate buildups) [23].

Although the locality is covered by grass (so-called "Alpine meadows"), red sediment is exposed in many places. It occurs beneath the very thin (no more than a few centimeters) soil cover. The best exposures are available near karst depressions covered by small, permanent snowfields, the discharge of meltwater from which created long (up to several hundreds of meters) and relatively shallow (<0.5 m) furrows that are incised into the surface sediments and trended down (Figure 8). This sediment consists of structureless silty–clayey material with light-grey inclusions of boulders and megaclasts (fine blocks of sensu [39]). These clasts are angular and irregular in shape, and they consist of Late Jurassic carbonates that are widely exposed (particularly on the borders of karst depressions and near the cuesta's edge). The clasts occur chiefly individually, although they form dense groups. The whole sediment looks like mélange overwhelmed by "crushed stones". The fine siliciclastic material, which serves as a kind of matrix for the noted clasts, can be related to the Mezmay Formation (see above), which covered the locality in the geological past (possibly in the Pleistocene).

Figure 7. General view of the gentle slope of the Stonesea Range. The arrow shows south.

Figure 8. Example of eluvial–deluvial sediments from the Stonesea Range. The author is shown for scale.

The origin of the sediment can be explained by the joint action of weathering and deluvial processes. On the one hand, red siliciclastic deposits of the Mezmay Formation have permanently been washed out by melt- and rainwater and temporary streams and, thus, re-sedimented on the gentle cuesta's slope and in local topographical lows (for instance, karst furrows). On the other hand, the karstification of exposed carbonates of the Gerpegem Formation has led to the destruction of their upper layers, and the disintegrated rock looks like an accumulation of free-lying clasts, which either remain in situ or are washed down the slope. These materials are mixed, thus forming eluvial–deluvial sediment. Indeed, fine siliciclastics are relatively soft and prone to erosion; therefore, voluminous amounts of them were washed out from what was the thick Mezmay Formation. Hypothetically, these processes may have started after the deglaciation of the Lagonaki Highland near the Pleistocene–Holocene transition (see some lines of evidence in [35]). They are inactive because the Mezmay Formation has been eroded almost entirely on the gentle slope of the Stonesea Range.

The Stonesea Range locality representing karst-related, eluvial–deluvial sediment is interesting to specialists because it sheds light on the complexity of sedimentary processes in some peculiar geological and geomorphological domains. Similar complexity was recorded in karst studies of other "classical" areas [63]. One should also note that the origin of the considered sediment is related to understanding the evolution of cuesta-type landforms, which is the focus of contemporary research [64]. This locality has ideal accessibility. A principal paved road leads to the Lagonaki Highland from Dakhovskaya (Figure 2). Then, visitors must enter the Caucasian State Natural Biosphere Reserve (entrance fee required) and follow the well-established (often overcrowded) tourist trail to reach the edge of the Stonesea Range. The locality itself has an almost flat, slightly inclined surface; from here, there are no limitations to surveying the outcrops of the sediment.

4. Discussion

4.1. General Geoheritage Interpretations

The three considered localities represent different Quaternary sediments of the study area with few unique peculiarities (see the descriptions given above). Indeed, the value of these localities is incomparable to that of the scientifically important and spectacular geosites of Mountainous Adygeya, such as Raskol Cliff (latest Permian reef) or the Polkovnitskaya Valley (mid-Cretaceous ammonite locality) [23]. However, it should be explained that uniqueness, which is essential to geoheritage value, is a relational characteristic. It should not be considered only in global or national terms. The rarity of any phenomenon within any given area also constitutes uniqueness (local, in such cases). The considered localities do not form separate geosites, but they are found within large geosites that are already established in Mountainous Adygeya on the basis of other (pre-Quaternary) geological properties [23]. As such, these localities can contribute to our understanding of the overall geoheritage value and the geological diversity of the study area. Importantly, all three localities are parts of larger geosites (Table 2), and, thus, they can be referred to as geoheritage points [65]. In essence, geosites are individual, isolated localities hosting unique geological features and boasting integrity, whereas geoheritage points are small parts within larger geosites and constitute manifestations of integrated geoheritage landscapes. The latter correspond, to a certain degree, to geofeatures [53,66] and geotopes [67–69]. The characterized sediments contribute to the value of the noted geosites established earlier by Ruban et al. [23].

A specific parameter can be used to discuss the contribution of geoheritage points semi-quantitatively, namely relative uniqueness (UR). Three criteria score each kind of sediment: rarity in the study area (R, scores: 1—occurs everywhere, 2—typical to small parts of the area, 3—restricted to the given geosite), geological complexity (C, scores: 1—simple origin, 2—somewhat complex origin, 3—highly-complex origin), and temporal frame (T, scores: 1—formed in the past and accumulating presently, 2—formed in the past as a result of long-term processes, 3—formed in the past as single episode). The UR is a simple sum of these scores, and it can be classified as low (<5 total scores), moderate (5–7 total scores), or high (>7 total scores).

Table 2. Characteristics of the considered localities of Quaternary sediments.

Characteristic	Geoheritage Points		
	Rufabgo Canyon	Dakh–Sakhray Confluence	Stonesea Range
Spatial correspondence to geosite (parent Geosite) *	Khadzhokh canyon system and Rufabgo waterfalls	Sakhray canyon	Lagonaki Highland
Portion of geosite *	~25%	<5%	<5%
Relative uniqueness **	High	Low	High
Degree of scientific investigation **	High	Moderate	Low
Accessibility *	High (entrance fee required)	High (unpaved road)	High (hiking, entrance fee required)
Vulnerability **	Absent	Absent	Minimal
Aesthetic value **	High	Minimal	High

Notes: * evaluated for the entire locality; ** evaluated for Quaternary sediments, not the entire locality.

The descriptions given above allow us to establish the UR of the studied sediments. For the Rufabgo Canyon, R = 3, C = 2, T = 1, and, thus, U = 8. For the Dakh–Sakhray Confluence, R = 1, C = 2, T = 1, and, thus, UR = 4. For the Stonesea Range, R = 3, C = 3, T = 2, and, thus, UR = 8. Therefore, two localities boast high relative uniqueness, and one locality is only moderately unique (Table 2). In any case, all three geoheritage points contribute to the value of their parent geosites by emphasizing their intrinsic diversity. It should be stressed that all unique features constitute geoheritage, irrespective of whether they are more or less unique. Only features without uniqueness are excluded from geoheritage, but this is not the case for the sediments considered herein.

The three geoheritage points differ with regards to the degree of scientific investigation (Table 2). Colluvial megaclast sediments of the Rufabgo Canyon were investigated and described by Lubova et al. [54]. Alluvial sediments with concretions from the Dakh–Sakhray Confluence are in the process of being investigated. Red eluvial–deluvial sediments from the Stonesea Range are yet to be studied. The accessibility of these localities is high (Table 2), although it is decreased slightly either by the absence of paved roads or by the necessity of paying entrance fees. Vulnerability is absent in two cases and minimal in the third case (Table 2). Planned tourist infrastructure development can affect the exposure of red sediments, although these risks seem low. One should also note the area's aesthetic properties (Table 2). The sediment from the Rufabgo Canyon seems attractive because megaclasts change the meaning of the local landscape to visitors and appeal to their sense of beauty [54]. The red color of the sediment from the Stonesea Range, which contrasts the dominating green (grass in summer), white (snowfields), and blue (sky) colors of the local landscape, is linked to some widespread perceptions of beauty by visitors [70], even though red is perceived differently in different cultural frameworks [71]. Alluvium from the Dakh–Sakhray Confluence does not exhibit any evident aesthetic attractiveness and looks very ordinary. Nonetheless, this locality itself is highly scenic.

Irrespective of their uniqueness, the Quaternary sediments reported from the three geoheritage points of Mountainous Adygeya seem to be notable. These geoheritage points contribute to the overall value of Mountainous Adygeya, which is an area with world-class geoheritage resources and significant potential as a geotourist destination [23]. Additionally, the potential of being classified as geoheritage has already been proven for somewhat similar sediments in East Europe [20,72–74]. These inferences may enable the construction of a "bridge" between local and international geoheritage.

4.2. Geoheritage Utility

The previous research on the Quaternary geoheritage in different parts of the world [17–22] has proven that the unique features of this age can be used in science, education, and tourism. Therefore, the three considered geoheritage points provide exciting lines of evidence for in-depth scientific investigations (see above). Moreover, they were not the subject of intense studies (except for the Rufabgo Canyon [54]); thus, they offer opportunities for further research.

The considered geoheritage points represent some peculiarities of Quaternary sediments and their genetic diversity (alluvial, colluvial, and eluvial–deluvial sediments), as well as the ongoing processes of their formation. Therefore, the educational potential of these localities is linked to the possibility of using them to develop knowledge and skills in sedimentology of the geosciences students of several Russian universities that organize their summer educational field trips in Mountainous Adygeya. These include the Southern Federal University and the Voronezh State University, which have geoscience departments that specialize in sedimentology (among other subjects). The present work allows for us to establish the presence of educational potential. However, developing a framework for its effective exploitation will require special studies, which is task for the future.

As for the perspective of tourism, one should note the aesthetic properties of megaclasts in the Rufabgo Canyon and red siliciclastics on the slope of the Stonesea Range (Table 2). The relationship between Quaternary sedimentary archives, geotourism potential, and geoaesthetics has been established in other countries around the world [75–77]. In isolation, the considered geoheritage points cannot attract geotourists, but they are part of larger and highly important geosites (Table 2). Thus, the established Quaternary sediments can be used, together with many other notable features, during excursions. Moreover, one should note the picturesque landscapes of the considered localities, their biodiversity and wilderness, and some cultural value. Moreover, the Dakh–Sakhray Confluence boasts outstanding views of the entire locality, the Stonesea Range is famous for its diversity of plants (including endemics), and the Rufabgo Canyon is located close to the historical trade route connecting the Middle East and Eastern Europe and played an important role in the development of the local cultures before the 19th century.

The localities correspond to existing educational sites and tourist attractions (Figure 9). Crowds of tourists visit the Rufabgo Waterfalls throughout the year, although the excursions with an educational component are limited there. The same is true for the Stonesea Range. However, one should note that educational excursions are more common there, and the Caucasian State Natural Biosphere Reserve offers some educational services. The Dakh–Sakhray Confluence is a relatively popular site for outdoor recreation among locals, even if educational excursions are infrequent there. Nonetheless, the interests of educators and the tourism industry in the plots to which the geoheritage points belong (Figure 9) generates significant potential for using these Quaternary sediments as geoheritage features via their educational and touristic exploitation.

It is necessary to address another aspect of the considered localities with Quaternary sediments. Two of them, namely the Dakh–Sakhray Confluence and the Stonesea Range, host another kind of natural heritage. The former is home to the Sakhray River, which is one of the most important hydrological objects in the study of Telonemia found in the bottom sediments of the stream [78] (although these are microorganisms, they determine the uniqueness of the local ecosystem, a fact that may stimulate the interest of visitors). The latter is a part of the Lagonaki Highland, which is known not only as an important center of phytodiversity, but also a habitat of endemic and subendemic plant species, including representatives of *Campanula*, *Euphorbia*, and *Scutellaria* [79,80]. As such, the full (not only geological) uniqueness of these localities and the adjacent areas may extend beyond the local. Their biotic value may also attract scientists and tourists.

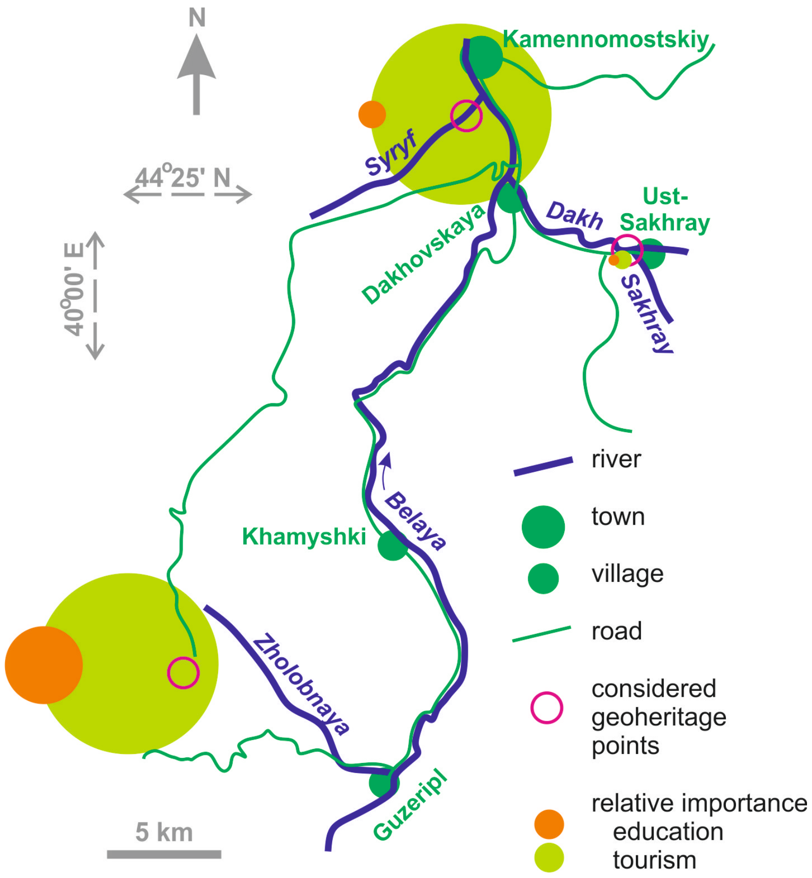

Figure 9. Educational and touristic activities in the considered localities.

5. Conclusions

The present examination of potential Quaternary geoheritage in Mountainous Adygeya in the Western Caucasus leads to three general conclusions:

(1) the three localities exhibit notable peculiarities of Late Quaternary alluvial, colluvial, and eluvial–deluvial sediments;
(2) these localities are geoheritage points within larger geosites, and the knowledge about Quaternary sediments from the former contributes to the value of the latter;
(3) Quaternary sediments with geoheritage value can be used for research, education, and tourism.

The present paper offers preliminary results for interpreting Quaternary sediments as geoheritage and highlights important directions for future investigations. Although Mountainous Adygeya is famous for its pre-Quaternary geoheritage, the recognition of even locally important Quaternary features helps to improve and deepen our knowledge of the geological uniqueness of this area, which is necessary for the successful exploitation of the geoheritage resources available there. In addition to more detailed investigations of the already considered sediments and an examination of their educational and touristic potential, new field research should focus on identifying other sedimentary features of the Quaternary age with geoheritage value in the study area. Tentatively established Quaternary-related geoheritage points (not only those characterized for the purposes of the present study) would facilitate improvements in our understanding of the local Quaternary geology, which remains incomplete (or, more accurately, fragmentary). More generally, Quaternary sediments must be conceptualized as geoheritage, which requires information from many places around the world and from different geological contexts.

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References

1. Bentivenga, M.; Cavalcante, F.; Mastronuzzi, G.; Palladino, G.; Prosser, G. Geoheritage: The Foundation for Sustainable Geotourism. *Geoheritage* **2019**, *11*, 1367–1369. [CrossRef]
2. Guilbaud, M.-N.; Ortega-Larrocea, M.P.; Cram, S.; van Wyk de Vries, B. Xitle Volcano Geoheritage, Mexico City: Raising Awareness of Natural Hazards and Environmental Sustainability in Active Volcanic Areas. *Geoheritage* **2021**, *13*, 6.
3. Herrera-Franco, G.; Carrión-Mero, P.; Montalván-Burbano, N.; Caicedo-Potosí, J.; Berrezueta, E. Geoheritage and Geosites: A Bibliometric Analysis and Literature Review. *Geosciences* **2022**, *12*, 169. [CrossRef]
4. Jácome Paz, M.P.; Gómez Piña, V.M.; Prol Ledesma, R.M.; Gonzalez Romo, I.; Estrada Murillo, A.; Hernandez Hernandez, M.A.; González Alfaro, A.; Gómez Torres, M. Geoheritage in Thermal Springs of Puruándiro, Michoacán, México. *Geoheritage* **2021**, *13*, 68. [CrossRef]
5. Neto, K.; Henriques, M.H. Geoconservation in Africa: State of the art and future challenges. *Gondwana Res.* **2022**, *110*, 107–113. [CrossRef]
6. Quesada-Román, A.; Torres-Bernhard, L.; Ruiz-Alvarez, M.A.; Rodriguez-Maradiaga, M.; Velazquez-Espinoza, G.; Espinosa-Vega, C.; Toral, J.; Rodríguez-Bolaños, H. Geodiversity, Geoconservation, and Geotourism in Central America. *Land* **2022**, *11*, 48.
7. Quesada-Román, A.; Zangmo, G.T.; Pérez-Umaña, D. Geomorphosite Comparative Analysis in Costa Rica and Cameroon Volcanoes. *Geoheritage* **2020**, *12*, 90. [CrossRef]
8. Reynard, E.; Brilha, J. (Eds.) *Geoheritage: Assessment, Protection, and Management*; Elsevier: Amsterdam, The Netherlands, 2018.
9. Urban, J.; Radwanek-Bąk, B.; Margielewski, W. Geoheritage Concept in a Context of Abiotic Ecosystem Services (Geosystem Services)—How to Argue the Geoconservation Better? *Geoheritage* **2022**, *14*, 54. [CrossRef]
10. Corvea, J.L.; Gutiérrez, R.; Pascual-Aguilar, J.A.; de Bustamante, I.; Blanco, A. Geoheritage Integration in the Management of the Cuban Protected Areas. *Geoheritage* **2020**, *12*, 67. [CrossRef]
11. Dowling, R.; Newsome, D. *Handbook of Geotourism*; Edward Elgar: Cheltenham, UK, 2018.
12. Herrera-Franco, G.; Montalván-Burbano, N.; Carrión-Mero, P.; Apolo-Masache, B.; Jaya-Montalvo, M. Research trends in geotourism: A bibliometric analysis using the Scopus database. *Geosciences* **2020**, *10*, 379. [CrossRef]
13. Pérez-Umaña, D.; Quesada-Román, A.; Zangmo Tefogoum, G. Geomorphological heritage inventory of Irazú Volcano, Costa Rica. *Int. J. Geoheritage Park.* **2020**, *8*, 31–47. [CrossRef]
14. Quesada-Román, A.; Pérez-Umaña, D. Tropical Paleoglacial Geoheritage Inventory for Geotourism Management of Chirripó National Park, Costa Rica. *Geoheritage* **2020**, *12*, 58. [CrossRef]
15. Reyes, C.A.R.; Amorocho-Parra, R.; Villarreal-Jaimes, C.A.; Meza-Ortiz, J.A.; Castallanos-Alarcon, O.M.; Madero-Pinzon, H.D.; Casadiego-Quintero, E.; Carvajal-Díaz, J.D. Geotourism in Regions with Influence from the Oil Industry: A Study Case of the Middle Magdalena Valley Basin (Colombia). *Geoheritage* **2021**, *13*, 107. [CrossRef]
16. Tiago, F.; Correia, P.; Briciu, V.-A.; Borges-Tiago, T. Geotourism destinations online branding co-creation. *Sustainability* **2021**, *13*, 8874. [CrossRef]
17. Clifford, P.; Semeniuk, V. Sedimentary processes, stratigraphic sequences and middens: The link between archaeology and geoheritage—A case study from the Quaternary of the Broome region, Western Australia. *Aust. J. Earth Sci.* **2019**, *66*, 955–972. [CrossRef]
18. Dempster, M.; Enlander, I.J. Conserving Quaternary geoheritage in Northern Ireland. *Proc. Geol. Assoc.* **2022**. [CrossRef]
19. Duan, Z.; Zhang, X.; Zhou, C.; Yu, M.-G.; Chu, P.-L.; Hong, W.-T. Characteristics and Geological Significance of Quaternary Volcanic Geoheritages in Northern Hainan Island. *Acta Geosci. Sin.* **2021**, *42*, 111–123.
20. Górska-Zabielska, M.; Wieczorek, D.; Zabielski, R.; Stoiński, A. Erratic boulders from the Przedbórz Region as objects important for Quaternary geology and geoheritage. *Prz. Geol.* **2022**, *70*, 34–49.
21. Németh, K.; Wu, J.; Sun, C.; Liu, J. Update on the Volcanic Geoheritage Values of the Pliocene to Quaternary Arxan–Chaihe Volcanic Field, Inner Mongolia, China. *Geoheritage* **2017**, *9*, 279–297. [CrossRef]
22. Niculiță, M. The Need for Protecting, Promoting, and Managing a Quaternary Geoheritage Site: Bahluieț Valley at Costești Village (Moldavian Plateau, North-Eastern Romania). *Geoheritage* **2022**, *14*, 21. [CrossRef]
23. Ruban, D.A.; Mikhailenko, A.V.; Yashalova, N.N. Valuable geoheritage resources: Potential versus exploitation. *Resour. Policy* **2022**, *77*, 102665. [CrossRef]
24. Bedanokov, M.K.; Chich, S.K.; Chetyz, D.Y.; Trepet, S.A.; Lebedev, S.A.; Kostianoy, A.G. Physicogeographical characteristics of the Republic of Adygea. *Handb. Environ. Chem.* **2020**, *106*, 19–55.
25. Lozovoy, S.P. *Lagonaki Highland*; Krasnodarskoe Knizhnoe Izdatel'stvo: Krasnodar, Russia, 1984; p. 160. (In Russian)

26. Nazarenko, O.V.; Mikhailenko, A.V.; Smagina, T.A.; Kutilin, V.S. *Natural Conditions of Mountainous Adygeya*; SFU: Rostov-on-Don, Russia, 2020. (In Russian)
27. Ruban, D.A.; Mikhailenko, A.V.; Ermolaev, V.A. Inverted Landforms of the Western Caucasus: Implications for Geoheritage, Geotourism, and Geobranding. *Heritage* **2022**, *5*, 2315–2331. [CrossRef]
28. Adamia, S.; Zakariadze, G.; Chkhotua, T.; Sadradze, N.; Tsereteli, N.; Chabukiani, A.; Gventsadze, A. Geology of the Caucasus: A review. *Turk. J. Earth Sci.* **2011**, *20*, 489–544. [CrossRef]
29. Mosar, J.; Mauvilly, J.; Koiava, K.; Gamkrelidae, I.; Enna, N.; Lavrishev, V.; Kalberguenova, V. Tectonics in the Greater Caucasus (Georgia—Russia): From an intracontinental rifted basin to a doubly verging fold-and-thrust belt. *Mar. Pet. Geol.* **2022**, *140*, 105630. [CrossRef]
30. Rolland, Y. Caucasus collisional history: Review of data from East Anatolia to West Iran. *Gondwana Res.* **2017**, *49*, 130–146. [CrossRef]
31. Adamia, S.; Alania, V.; Chabukiani, A.; Kutelia, Z.; Sadradze, N. Great Caucasus (Cavcasioni): A long-lived north-tethyan back-arc basin. *Turk. J. Earth Sci.* **2011**, *20*, 611–628. [CrossRef]
32. Ruban, D.A. The Greater Caucasus—A Galatian or Hanseatic terrane? Comment on "The formation of Pangea" by GM Stampfli, C. Hochard, C. Vérard, C. Wilhem and J. von Raumer [Tectonophysics 593 (2013) 1–19]. *Tectonophysics* **2013**, *608*, 1442–1444.
33. Plyusnina, E.E.; Ruban, D.A.; Zayats, P.P. Thematic dimension of geological heritage: An evidence from the Western Caucasus. *J. Geogr. Inst. "Jovan Cvijic" SASA* **2015**, *65*, 59–76. [CrossRef]
34. Ruban, D.A. Islands in the Caucasian Sea in Three Mesozoic Time Slices: Novel Dimension of Geoheriatge and Geotourism. *J. Mar. Sci. Eng.* **2022**, *10*, 1300. [CrossRef]
35. Scherbakova, E.M. *Ancient Glaciation of the Greater Caucasus*; Moscow University Press: Moscow, Russia, 1973. (In Russian)
36. International Commission on Stratigraphy (ICS). International Chronostratigraphic Chart v2022/02. Available online: https://stratigraphy.org/chart (accessed on 23 September 2022).
37. Blair, T.C.; McPherson, J.G. Grain-size and textural classification of coarse sedimentary particles. *J. Sediment. Res.* **1999**, *69*, 6–19. [CrossRef]
38. Blott, S.J.; Pye, K. Particle size scales and classification of sediment types based on particle size distributions: Review and recommended procedures. *Sedimentology* **2012**, *59*, 2071–2096. [CrossRef]
39. Bruno, D.E.; Ruban, D.A. Something more than boulders: A geological comment on the nomenclature of megaclasts on extraterrestrial bodies. *Planet. Space Sci.* **2017**, *135*, 37–42. [CrossRef]
40. Terry, J.P.; Goff, J. Megaclasts: Proposed revised nomenclature at the coarse end of the Udden-Wentworth gain-size scale for sedimentary particles. *J. Sediment. Res.* **2014**, *84*, 192–197. [CrossRef]
41. Chauhan, G.; Biswas, S.K.; Thakkar, M.G.; Page, K.N. The Unique Geoheritage of the Kachchh (Kutch) Basin, Western India, and its Conservation. *Geoheritage* **2021**, *13*, 23. [CrossRef]
42. Woo, K.S.; Chun, S.S.; Moon, K.O. Outstanding Geoheritage Values of the Island-Type Tidal Flats in Korea. *Geoheritage* **2020**, *12*, 8. [CrossRef]
43. Brilha, J. Inventory and quantitative assessment of geosites and geodiversity sites: A review. *Geoheritage* **2016**, *8*, 119–134. [CrossRef]
44. Bruschi, V.M.; Cendrero, A.; Albertos, J.A.C. A statistical approach to the validation and optimisation of geoheritage assessment procedures. *Geoheritage* **2011**, *3*, 131–149. [CrossRef]
45. Mucivuna, V.C.; Reynard, E.; Garcia, M.G.M. Geomorphosites Assessment Methods: Comparative Analysis and Typology. *Geoheritage* **2019**, *11*, 1799–1815. [CrossRef]
46. Mucivuna, V.C.; Motta Garcia, M.D.G.; Reynard, E. Comparing quantitative methods on the evaluation of scientific value in geosites: Analysis from the Itatiaia National Park, Brazil. *Geomorphology* **2022**, *396*, 107988. [CrossRef]
47. Quesada-Valverde, M.E.; Quesada-Román, A. Worldwide Trends in Methods and Resources Promoting Geoconservation, Geotourism, and Geoheritage. *Geosciences* **2023**, *13*, 39. [CrossRef]
48. Štrba, L.; Rybar, P.; Balaz, B.; Molokac, M.; Hvizdak, L.; Krsak, B.; Lukac, M.; Muchova, L.; Tometzova, D.; Ferencikova, J. Geosite assessments: Comparison of methods and results. *Curr. Issues Tour.* **2015**, *18*, 496–510. [CrossRef]
49. Corbí, H.; Fierro, I.; Aberasturi, A.; Sánchez Ferris, E.J. Potential Use of a Significant Scientific Geosite: The Messinian Coral Reef of Santa Pola (SE Spain). *Geoheritage* **2018**, *10*, 427–441. [CrossRef]
50. Fernández, M.P.; Timón, D.L.; Marín, R.G. Geosites Inventory in the Geopark Villuercas-Ibores-Jara (Extremadura, Spain): A Proposal for a New Classification. *Geoheritage* **2014**, *6*, 17–27. [CrossRef]
51. Pereira, D.I.; Pereira, P.; Brilha, J.; Cunha, P.P. The Iberian Massif Landscape and Fluvial Network in Portugal: A geoheritage inventory based on the scientific value. *Proc. Geol. Assoc.* **2015**, *126*, 252–265. [CrossRef]
52. Reynard, E.; Perret, A.; Bussard, J.; Grangier, L.; Martin, S. Integrated Approach for the Inventory and Management of Geomorphological Heritage at the Regional Scale. *Geoheritage* **2016**, *8*, 43–60. [CrossRef]
53. Yusry, M.; Simon, N.; Unjah, T. Geodiversity and geoheritage assessment in Hulu Langat district, Selangor, Malaysia. *Geoj. Tour. Geosites* **2018**, *23*, 861–872.
54. Lubova, K.A.; Zayats, P.P.; Ruban, D.A.; Tiess, G. Megaclasts in geoconservation: Sedimentological questions, anthropogenic influence, and geotourism potential. *Geologos* **2013**, *19*, 321–335. [CrossRef]

55. Killingback, Z.; Holdsworth, R.E.; Walker, R.J.; Nielsen, S.; Dempsey, E.; Hardman, K. A Bigger Splat: The Catastrophic Geology of a 1.2-b.y.-old Terrestrial Megaclast, Northwest Scotland. *Geology* **2021**, *49*, 180–184. [CrossRef]
56. Lorang, M.S. A wave-competence approach to distinguish between boulder and megaclast deposits due to storm waves versus tsunamis. *Mar. Geol.* **2011**, *283*, 90–97. [CrossRef]
57. Gale, S.J.; Ibrahim, Z.Z.; Lal, J.; Sicinilawa, U.B.T. Downstream fining in a megaclast-dominated fluvial system: The Sabeto River of western Viti Levu, Fiji. *Geomorphology* **2019**, *330*, 151–162. [CrossRef]
58. Rostovtsev, K.O.; Agaev, V.B.; Azarian, N.R.; Babaev, R.G.; Besnosov, N.V.; Hassanov, N.A.; Zesashvili, V.I.; Lomize, M.G.; Paitschadze, T.A.; Panov, D.I.; et al. *Jurassic of the Caucasus*; Nauka: St. Petersburg, Russia, 1992. (In Russian)
59. Teodorovitch, G.I.; Pokhvisneva, E.A. *Lithology and Diagenesis of the Jurassic Deposits of the North-Western Caucasus*; Nauka: Moscow, Russia, 1964. (In Russian)
60. Gavrilov, Y.O. *Dynamics of Formation of the Jurassic Terrigeneous Complex of the Greater Caucasus*; GEOS: Moskva, Russia, 2004. (In Russian)
61. Al-Dhwadi, Z.; Sallam, E.S. Spheroidal "Cannonballs" calcite-cemented concretions from the Faiyum and Bahariya depressions, Egypt: Evidence of differential erosion by sand storms. *Int. J. Earth Sci.* **2019**, *108*, 2291–2293. [CrossRef]
62. Konigsmark, T. *Geologic Trips, Sea Ranch and Bowling Ball Beach*; GeoPress: Medford, MA, USA, 2005.
63. Posilović, H.; Galović, L.; Stejić, P.; Pandurov, M.; Gajić, R. Quaternary depositional environments in the Vrgoračko Polje/Lake (SE Croatia). *Geol. Croat.* **2018**, *71*, 147–162. [CrossRef]
64. Duszyński, F.; Migoń, P.; Strzelecki, M.C. Escarpment retreat in sedimentary tablelands and cuesta landscapes—Landforms, mechanisms and patterns. *Earth-Sci. Rev.* **2019**, *196*, 102890. [CrossRef]
65. Ruban, D.A.; Zorina, S.O.; Rebezov, M.B. Dispersed geoheritage points of the Lagonaki Highland, SW Russia: Contribution to local geoheritage resource. *Geosciences* **2019**, *9*, 367. [CrossRef]
66. Hjort, J.; Tukiainen, H.; Salminen, H.; Kemppinen, J.; Kiilunen, P.; Snåre, H.; Alahuhta, J.; Maliniemi, T. A methodological guide to observe local-scale geodiversity for biodiversity research and management. *J. Appl. Ecol.* **2022**, *59*, 1756–1768. [CrossRef]
67. Frost, W.; Steingötter, K. Geotrope survey of Rheinland-Palatinate. *Mainz. Geowiss. Mitt.* **2001**, *30*, 271–302.
68. Šilhán, K.; Feher, R. Geotope of boulder accumulations: Possible source of noise in the dendrogeomorphic dating of landslides. *Catena* **2022**, *213*, 106142. [CrossRef]
69. Zafeiropoulos, G.; Drinia, H. Kalymnos island, SE Aegean Sea: From fishing sponges and rock climbing to geotourism perspective. *Heritage* **2021**, *4*, 3126–3146. [CrossRef]
70. Kirillova, K.; Fu, X.; Lehto, X.; Cai, L. What makes a destination beautiful? Dimensions of tourist aesthetic judgment. *Tour. Manag.* **2014**, *42*, 282–293. [CrossRef]
71. Jonauskaite, D.; Abu-Akel, A.; Dael, N.; Oberfeld, D.; Abdel-Khalek, A.M.; Al-Rasheed, A.S.; Antonietti, J.-P.; Bogushevskaya, V.; Chamseddine, A.; Chkonia, E.; et al. Universal patterns in color-emotion associations are further shaped by linguistic and geographic proximity. *Psychol. Sci.* **2020**, *31*, 1245–1260. [CrossRef]
72. Górska-Zabielska, M. The most valuable erratic boulders in the Wielkopolska region of western Poland and their potential to promote geotourism. *Geoj. Tour. Geosites* **2020**, *29*, 694–714. [CrossRef]
73. Górska-Zabielska, M. Geoheritage in a Forest: Traces of Ice Sheets in Pałuki, Western Poland. *Sustainability* **2022**, *14*, 7190. [CrossRef]
74. Górska-Zabielska, M.; Witkowska, K.; Pisarska, M.; Musiał, R.; Jońca, B. The Selected Erratic Boulders in the Świętokrzyskie Province (Central Poland) and Their Potential to Promote Geotourism. *Geoheritage* **2020**, *12*, 30. [CrossRef]
75. De Waele, J.; Di Gregorio, F.; Gasmi, N.; Melis, M.T.; Talbi, M. Geomorphosites of Tozeur region (south-west Tunisia). *Alp. Mediterr. Quat.* **2005**, *18*, 223–232.
76. Lokier, S.W. Coastal Sabkha Preservation in the Arabian Gulf. *Geoheritage* **2013**, *5*, 11–22. [CrossRef]
77. Pérez-Hernández, E.; Peña-Alonso, C.; Fernández-Cabrera, E.; Hernández-Calvento, L. Assessing the scenic quality of transgressive dune systems on volcanic islands. The case of Corralejo (Fuerteventura island, Spain). *Sci. Total Environ.* **2021**, *784*, 147050. [CrossRef] [PubMed]
78. Tikhonenkov, D.V.; Jamy, M.; Borodina, A.S.; Belyaev, A.O.; Zagumyonnyi, D.G.; Prokina, K.I.; Mylnikov, A.P.; Burki, F.; Karpov, S.A. On the origin of TSAR: Morphology, diversity and phylogeny of Telonemia. *Open Biol.* **2022**, *12*, 210325. [CrossRef]
79. Bibin, A.S.; Trepet, S.A.; Grabenko, E.A.; Akatov, T.V. Shaposhnikov Caucasian State Nature Biosphere Reserve. *Handb. Environ. Chem.* **2020**, *106*, 603–631.
80. Litvinskaya, S.A. Florophytocenotic diversity of the Western Caucasus. *South Russ. Ecol. Dev.* **2020**, *15*, 37–48. [CrossRef]

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