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Narman Fairy Chimneys Area as a Geotourism Example from Erzurum, NE Turkey

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Abstract
Geotourism, which was created to promote and protect geological structures, has become one of the most important tourism sectors to develop and spread rapidly in recent years. Bringing geological structures with millions of years of history to tourism ensures that these structures are preserved and passed on to future generations and provides an increase in tourism revenue at local and regional level. Our country is rich in geological structures due to its location on the active Himalayan tectonic belt. One of these riches is the Narman Fairy Chimneys located within the borders of Erzurum (NE Turkey). This geological structure, known as Narman Fairy Chimneys, is formed by rivers flowing on a volcanic-sedimentary sequence and is located on the valley slopes. The different behaviors of the hard and soft geological units in the volcanic-sedimentary sequence against erosion have been effective in the formation of this uniquely beautiful geological structure. Narman Fairy Chimneys, which are visible from the surface over a wide area, fascinate those who see them with their spectacular beauty. Developing Narman Fairy Chimneys for tourism as an example of geotourism will both preserve this geological structure and pass it on to future generations and contribute to the economic development of the region by hosting national and international tourists.

Keywords
Narman, fairy chimney, geotourism, geological formation, geomorphology

1. Introduction

The planet we live on can be seen as a dynamic mixture of water and rocks forming the landscape we look at and we walk on every day. It is usual to admire landscapes in different parts of the world, which means in areas with a different climate and different geological history, that may inspire a sense of wonder and that let the people to travel for very long distances to be in touch with these amazing portions of the globe (Brilha, 2018; Newsome and Dowling, 2018; Reynard and Brilha, 2018; Santangelo and Valente, 2020). They are places where the process responsible for Earth's dynamic and evolution is so well represented that they may be considered as temples or open-air museums to explain the history of our planet (Santangelo and Valente, 2020).

Areas with picturesque landscapes are very popular for tourists who prefer vast natural landscapes and want to escape from the unnatural boredom of city life. Such areas, termed geodiverse, are often represented by spectacular geomorphology supported by a variety of lithologies (Altenberger et al., 2000; Gray, 2019).

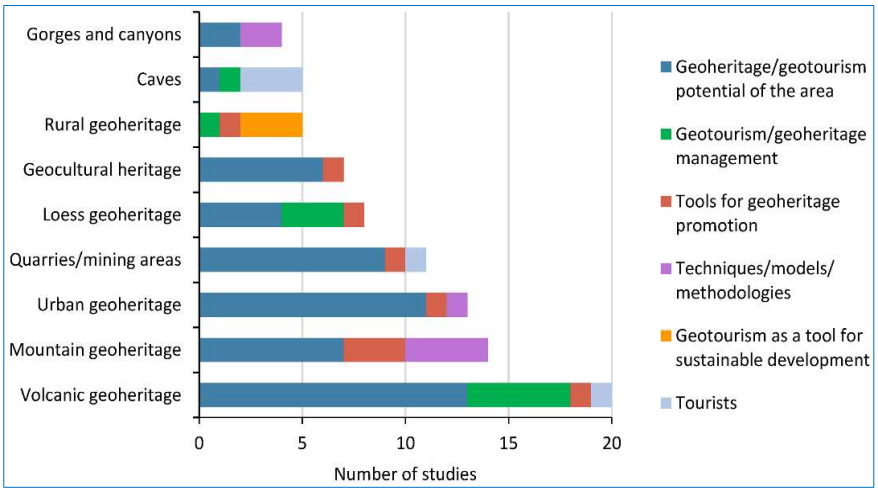
High-relief landscapes are often favored tourist destinations and also exhibit a complex geomorphology that may be the result of summarizing diverse geology into the concept of geodiversity. In contrast, areas of subdued landscape, although topographically unattractive, can also be geodiverse but need careful explanation and promotion to attract the geotourist. While beautiful landscapes are attractive to many tourists, information about their evolution presented at a relatively superficial level can add to the visitor's experience and understanding of the present and past environments in which the rocks and landscapes formed (Anderson et al.,

2006; Lane, 2017; Dowling and Newsome, 2018; Johnston and Van Kranendonk, 2018; Newsome et al., 2022; Migon, 2021; Newsome, 2022).

Geotourism is one of the newest concepts within the field of tourism and primarily focuses on promoting geological and geomorphological features in landscapes as tourist attractions (Ólafsdóttir, 2019). It is a form of sustainable tourism based on visiting the geosites and geological heritage of an area by local and/or foreign people. In this way, people get acquainted with the Earth Sciences and become closer; so that not only the concept of preservation of geological heritage can be understood and spread, but also contribution to local/regional development can be secured. Nature and culture are the common heritages of humanity and should be respected, maintained, and protected for the future generations (Kazanci et al., 2004; Kaygili et al., 2018).

Geotourism that primarily focuses on geological and geomorphological features in landscapes as tourist attractions has over the course of the past decade been one of the fastest growing market segments within tourism (Dowling and Newsome, 2018; Ólafsdóttir and Dowling, 2014; Ólafsdóttir and Tverijonaite, 2018). The expectation is that geotourism will continue to grow at a rapid pace worldwide, stressing the critical importance of increased knowledge and understanding of its various impacts from a broader perspective.

Generally speaking, geotourism addresses the theories and practicalities involved in managing attractions which have a high geological value, emphasizing the need for more integrated research in fields related to geology, geography, geomorphology and tourism. With this in mind, the goal in putting together this special issue was to gather a selection of articles on recent works and cases with a focus on understanding how geotourism has evolved over time; future challenges facing geotourism; geoconservation management; sustainable management of geotourism; geotourism spatial planning and design; tourism impact at different types of geological site; geotourism in relation to geological hazards and geomorphological changes; geotourism and public perception; geotourists as a market niche; and geotourist behavior (Ólafsdóttir, 2019).



The major areas of geoheritage focus within geotourism research (Ólafsdóttir and Tverijonaite, 2018)

The rapid increase in the annual number of tourists, growth in tourism destinations and improvements in transport have made it easier to reach previously difficult areas. This has made many areas with unique geological heritage and history more accessible today than ever before. While this attracts a large number of visitors seeking new experiences and exotic destinations, improved accessibility also provides opportunities for the tourism industry (Cságoly et al., 2016; Haraldsson and Ólafsdóttir, 2018; Tverijonaite et al., 2018; Ólafsdóttir, 2019). When the situation of geotourism is evaluated in recent years, geological and geomorphological features in landscapes come to the fore as touristic attractions and have become one of the fastest growing market segments (Ólafsdóttir and Dowling, 2014; Dowling and Newsome, 2018; Ólafsdóttir and Tverijonaite, 2018; Ólafsdóttir, 2019).

Geotourism was first used by Hose (1995) for an alternative type of tourism, referring to the UK countryside and the concepts of geosites and geoparks (Hose et al., 2011; Newsome and Dowling, 2010). Later, the scope of the geotourism concept was expanded to include geological formations with touristic value such as coasts, mountains, valleys, dunes, glaciers, waterfalls, caves and canyons, gorges and fossil resources (Dowling and Newsome, 2006a; Newsome et al., 2012; Newsome et al., 2013; Uncu and Karakoca, 2019).

It includes specific and interdependent components that must be present in order to develop geotourism, which distinguishes it as a separate form of tourism and whose basic characteristics can be identified. There are five basic principles that form the basis of geotourism (Dowling, 2011; Risteski and Kocevski, 2013). These are; 1) geologically based, based on World heritage with a focus on geological forms and/or processes, 2) sustainable, supporting economic continuity by providing benefits to local people as well as geoconservation, 3) geologically informative, with education and geo-interpretation for landforms and processes, creating

positive geotourism experiences, 4) the involvement of local communities not only generates benefits for the communities themselves and the environment, but also creates local benefits that also improve the quality of tourist experiences, and 5) the positive experiences of visitors and tourists with geotourism activities are the satisfaction of tourists, which is essential for the long-term development of this type of tourism.

Researchers in the field of geotourism emphasize the importance of limiting the definition of geotourism to geology and its conservation. Researchers also note that applying a broader approach to geotourism may reduce the impact of the concept (Dowling and Newsome, 2006b; Hose, 2008; Hose, 2011; Newsome and Dowling, 2010; Ollier, 2012; Ólafsdóttir, R., Tverijonaite, E., 2018; Fedorov et al., 2022; Drinia et al., 2023; Quesada-Valverde and Quesada-Román, 2023; Negri et al., 2024; Hadian et al., 2025; Quesada-Valverde and Quesada-Román, 2025).

Studies show that certain areas and types of geological heritage are given more attention by researchers due to their specific characteristics (Fig. 1).

Geotourism as a type of tourism focusing on the exploration of geological and natural heritage can be classified according to natural features, scientific and educational purposes, types of activities and its relationship with ecotourism. Newsome et al. (2012) proposed the first classification system of peculiar geological and geomorphological phenomena that can be considered as attractions for students, independent travellers or tourist groups (Fig. 2).

This classification system can help marketing efforts to promote the destination by maintaining and developing geotourism interest while supporting the interpretation of the site. It consists of several branches, all interconnected and sometimes overlapping, reflecting tourists' perceptions of geological attractions (Tiago et al., 2021).

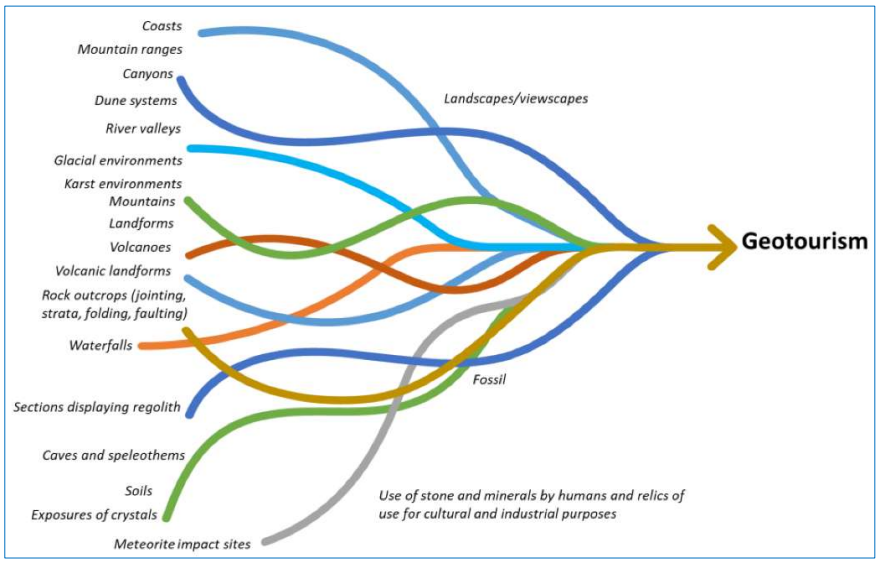


Fig. 2. Scope and focus of geotourism (Newsome et al., 2012; Tiago et al., 2021)

In addition to the classification scheme proposed by Newsome et al. (2012), Mikhailenko et al. (2017) stated that the aesthetic characteristics of the geosite should also be recognized. Fig. 2 illustrates the different types of geoattractiveness, similar to the roots of a tree that connect to the soil and support the tree, unique combinations of different landscape elements and their integration reflect the uniqueness of the geotourism destination.

Turkey, which is located on the Alpine-Himalayan Tectonic Belt, carries the traces of geological changes on the belt and is affected by them, which offers a great potential to be evaluated as an alternative tourism type (Dölek and Şaroğlu, 2017; Özer, 2021). Nevertheless, although the studies carried out at this time in Turkey are late, the recent increase in studies increases the hopes that geotourism will be carried to more advanced levels in Turkey in the future.

In Turkey, which is a part of the Alpine-Himalayan Mountain Belt, it is possible to see lands of different qualities belonging to each geological time and even each geological period. Therefore, it can be stated that Turkey has a wide potential for geotourism and a diversity of natural resources (Çeşmeci, 2023). During the ongoing collision process of the Arabian Plate with the Eurasian Plate, major fracture systems such as the North Anatolian Fault Zone and the Eastern Anatolian Fault Zone have developed, while volcanic activities and sedimentary basin formations have formed at the same time.

While active tectonic mobility has caused natural disasters such as earthquakes, it has also led to the formation of various rock types and the formation of different geological structures. Therefore, Turkey has an important geotourism potential with its rock type diversity, geological structure richness and magnificent morphological features. In recent years, although some of these geological values have been evaluated in the field of geotourism, there are places that have not yet been evaluated in terms of geotourism. With the evaluation of these values within the scope of geotourism,

both these values that we have inherited from past generations will be preserved and transferred to future generations and a sustainable geotourism resource will be built.

Turkey, a country world-famous for its natural beauties, also stands out with its fairy chimneys spread in every region of the country. Especially the fairy chimneys in the Cappadocia region (Nevşehir) are one of the unique geological formations that attract the attention of local and foreign tourists. It is not limited to Cappadocia. All around Turkey, it is possible to come across fairy chimneys as fascinating and unique as Cappadocia. Some important fairy chimneys are known as Narman Fairy Chimneys (Erzurum), Kuladokya (Manisa), Vanadokya (Van), Frig Valley Fairy Chimneys (Afyon), Selime Fairy Chimneys (Aksaray), Meşeli Village Fairy Chimneys (Artvin), and Sakaeli Gelincik Kayası Fairy Chimneys (Çankırı). Narman Fairy Chimneys, which are the subject of this study, are located within the borders of Narman district of Erzurum Province in Turkey.

Narman Fairy Chimneys, also known as the "Land of Red Fairies". Narman Fairy Chimneys Area is a very interesting area for nature lovers and photographers and has been accepted as a Geological Heritage by UNESCO Turkey National Commission.

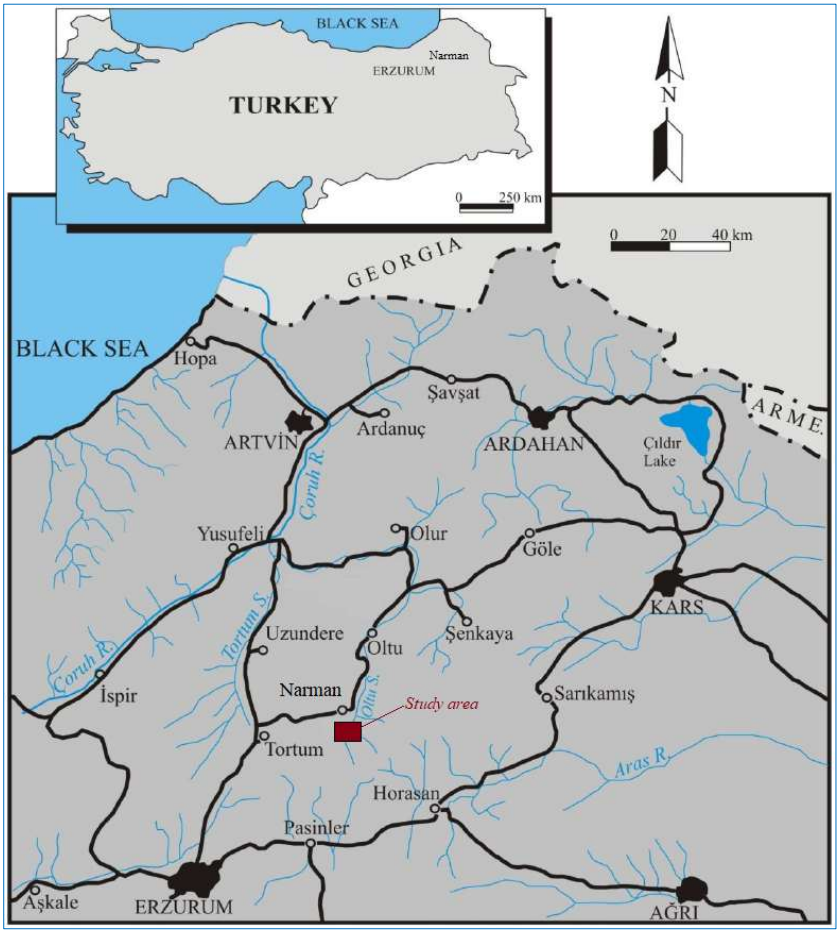


Fig. 3. Location of study area

The most prominent feature that distinguishes Narman Fairy Chimneys from the formations in Cappadocia is that they are formed from sedimentary units, which are shaped by the effect of erosion of terrestrial facies consisting of Pliocene aged red colored sandstones and pebbles due to atmospheric conditions. Although the structures in Cappadocia are of volcanic origin, Narman Fairy Chimneys are of sedimentary origin.

The Plio-Quaternary sedimentary rocks observed in the valley where Narman Fairy Chimneys are located have a red color as a result of the oxidation of the iron element in their structure (Garipağaoğlu, 1996; Yılmaz and Özer, 2003; Güngör et al., 2012; Kalkan and Alacali, 2017; Şaroğlu, F., Güngör, Y., 2019; Külekçi ve Koç, 2020; Azaz, 2021a; Azaz, 2021b).

Narman Basin (Narman, Erzurum, NE Turkey) where Narman Fairy Chimneys are in the Eastern Anatolia Region of Turkey has been the subject of studies carried out for different purposes. In these studies, geological and tectonic structure, morphological features, economic resources and tourism potential of the basin were discussed. The region in which Narman Basin is located has high geotourism potential with its rock type diversity, geological structure richness and unique morphology.

In addition to different rock types and geological structures, fairy chimneys, waterfalls, canyons, caves, valleys, lakes, floating islands, colourful clay hills, cold air areas, more studies should be carried out in terms of geotourism in the region waiting to be discovered.

The Narman Fairy Chimneys Area features fairy chimney-like structures and surface formations that emerged as erosion products within the Yoldere Formation, which was formed sedimentarily under terrestrial environmental conditions, and these are spread across a wide area. The area has high tourism potential due to its unique geological and geomorphological appearance. It is located 7 km from the district centre of Narman (Erzurum) and is accessible by asphalt road. Its proximity to national and international highways makes the area attractive for tourism. Located 90 km from Erzurum Airport, the Narman Fairy Chimneys Area is close to numerous tourist attractions in the region. The area has high tourism potential due to its rare fairy chimney-like structures and surface formations, as well as its other advantages.

With this study, it is aimed to draw attention to the geotourism potential of the region in Narman Fairy Chimneys and to address the geotourism potential of Narman Fairy Chimneys. In this context, the geology, tectonics and morphology of the Narman Basin were discussed, and the formation and formation patterns of Narman Fairy Chimneys were examined.

2. Study Area

The study area covering Narman Fairy Chimneys is located within the borders of Narman District of Erzurum (NE Turkey). The Fairy Chimneys, which were formed as a result of the erosion process on sedimentary formations, especially by water and wind, are located 7 km from Narman District Centre and 90 km from Erzurum Province. The Fairy Chimneys site, which can be reached from different directions, is on the Oltu (Erzurum, NE Turkey) - Pasinler (Erzurum, NE Turkey) Highway. The study area located in the west part of Oltu-Narman Tertiary Basin formed Oligocene-Miocene geological time interval. Oltu-Narman Tertiary Basin extending southwest- northeast has 80 km length and 10-20 km width (Harzhauser et al., 2018). Its location map and Google Earth image are seen in Figs. 3-4.

3. Geology

Turkey, which has many unique geological and geomorphological features, also bears the general characteristics of this belt due to its location on the Alpine-Himalayan Belt. Turkey, which is located between the Eurasian plate in the north and the Arabian and African plates in the south, has developed due to the continuous movements of these two plates and the geotectonic evolution of the old and new Tethys Sea between these plates (Ketin, 2007; Sönmez and Dölek, 2016). The Oligocene-early Miocene time interval corresponds to a period of tectonic stagnation and major transgression when the Eastern Anatolia Region was invaded by the sea from south to north.

During the neotectonics period beginning in the late Miocene, the depositional prism and the overlying sedimentary basement were intensely deformed, continental basins were formed and filled with fluvial sediments. This deformation caused the shortening and uplift of the region and is characterized by its unique landscape (Erinç 1953; Şengör and Kidd 1979; Şaroğlu and Güner 1981; Şaroğlu and Güngör, 2019).

Fig. 2. Google Earth image of study area

Narman Fairy Chimneys, which are the subject of the study, are in Narman District within the borders of Erzurmu Province in the Eastern Anatolia Region of Turkey. Narman Fairy Chimneys formed by the erosion of sedimentary formations are in the west of the Oltu-Narman Basin. The first geological studies in and around Oltu-Narman Basin

were carried out by Baykal (1951), Erentöz (1954) and Nebert (1964). Afterwards, many studies were carried out for general geology, sedimentology, coal geology, structural geology, economic geology, hydrogeology and geotrism (Altinli, 1969; Şaroğlu and Güner, 1981; Bayraktutan, 1982; Bulut et al., 1984; Bozkus¸ 1990; Garipağaoğlu, 1996; Kalkan, 2003; Kalkan and Bayraktutan, 2008; Konak and Hakyemez, 2008; Kara-Gülbay, 2015; Yarbaşı, 2016; Azaz and Güngör, 2017; Kalkan and Alacali, 2017; Şaroğlu and Güner, 2019; Azaz, 2021a; Azaz, 2021b).

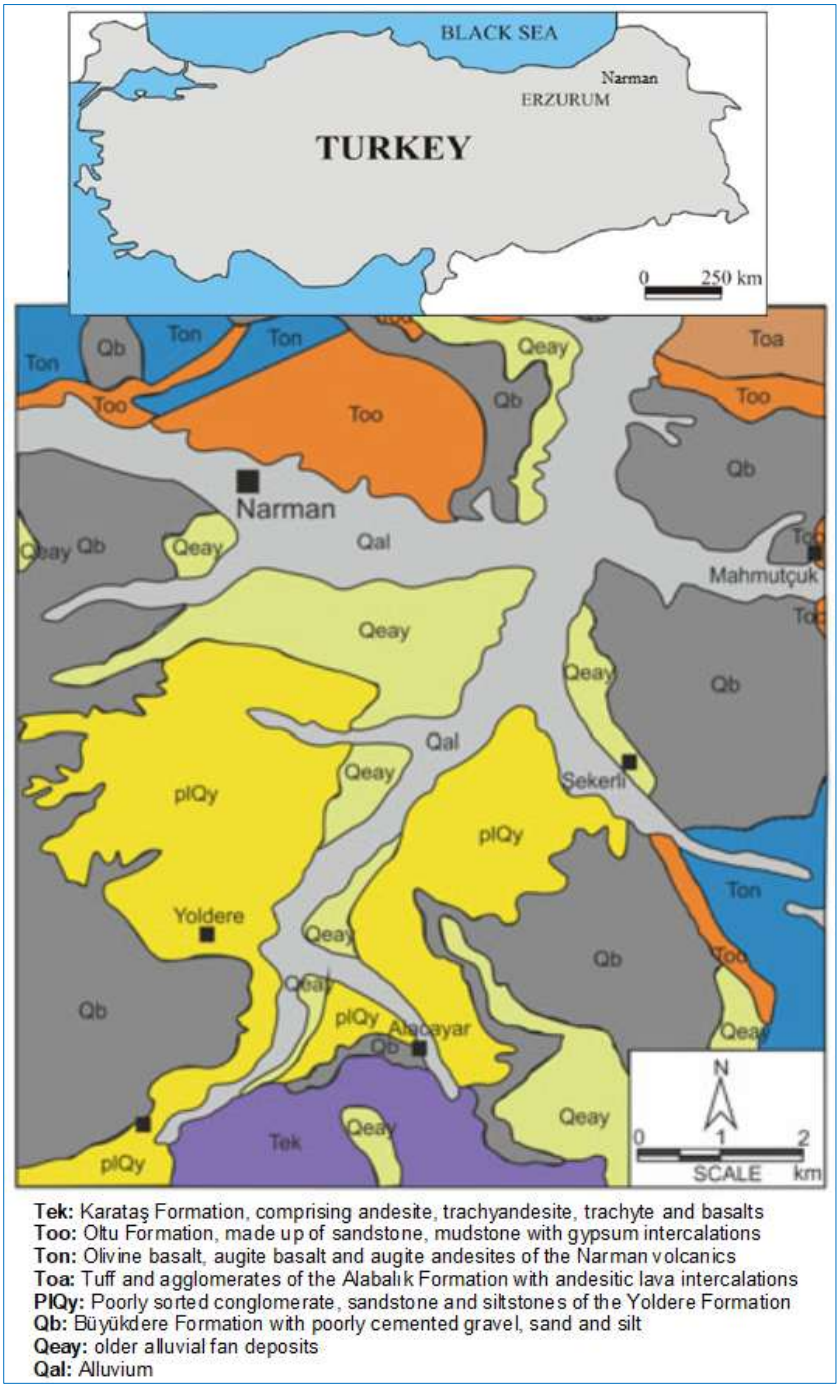


Fig. 5. Geological map of Narman and its vicinity (after Konak and Hakyemez 2008; Şaroğlu and Güngör, 2019)

The Oltu-Narman Tertiary Basin examined in detail by Bozkuş (1990) was formed Oligocene-Miocene geological time interval. The basement of Oltu-Narman Tertiary Basin is composed of Permo-Carboniferous acidic magmatic rocks and upper Cretaceous volcano-sedimentary sequence (Fig. 5). Deposits of the Tertiary Basin start at the bottom with lower-middle Eocene conglomerate, sandstone and siltstone which are conformably overlain by the upper Eocene volcano-sedimentary/shallow marine sequence. The upper Eocene unit is covered un-conformably by Oligocene-aged terrestrial and lacustrine deposits with volcanic interlayers. The sequence continues to the top with Oligo-Miocene and Miocene coaliferous units. Upper Miocene–Pliocene andesite and agglomerates (Penek Formation) conformably

set above the underlying units. This unit is conformably overlained by a volcano-sedimentary series with coal inter beddings. The uppermost part of the basin is composed of Plio-Quaternary basalts (Kara-Gülbay, 2015).

4. Geomorphology

The Narman Basin, where Pliocene-Quaternary sediments are exposed, is divided into two parts by the Narman River. The Narman Fairy Chimneys Area, which contains formations of visual and geological interest, is located north of the Narman River and features plains, hills, ridges and valleys. These erosion formations within the Yoldere Formation have been shaped by water and wind erosion, controlled by the lithological characteristics of the units forming the formation, their joint systems, and the geographical location and slope of the slopes. The Kırmızı Dere, Kovuk Dere, Bulanık Dere, Gön Dere, Büyük Dere and Yol Dere valleys are the main valleys in this area. The main hills in the area are Büyükdereninbaşı Hill, Boz Hill, Büyüksırt Hill, Büyükkuzey Hill, Karagüney Hill and Sivri Hill. The erosion structures formed by the erosional activities observed in an area of approximately 26 km² represent a surface shape generation resulting from the interaction of the region's structural geomorphology and geomorphological factors and processes (Fig. 6). This characteristic geomorphological development is directly related to the region's overall structural geomorphology (Garipağaoğlu, 1996; Güngör et al., 2012; Kalkan and Alacali, 2017; Çelik, 2018; Şaroğlu and Güner, 2019; Azaz, 2021a).

4. Typical Landforms of the Narman Fairy Chimneys Area

Both lithology and the structure of rock complexes control the evolution of landforms at various scales, from microscopic erosion aspects to regional landscapes (Yatsu, 1966; Twidale, 1971; Gerrard, 1986; Migoń and Duszyński, 2022). One of the most effective factors in shaping the terrain in a region is the geological structure of the region. Geologically, the presence of different rock types in the region allows for contrasting landforms and landscapes to develop. In particular, rock types with different strength characteristics respond differently to external influences and atmospheric conditions, resulting in varying erosion characteristics. Therefore, higher strength and more durable rocks tend to form landscapes and landforms in higher elevations. Conversely, weaker rocks tend to have the ability to form landscapes and landforms in lower elevations.

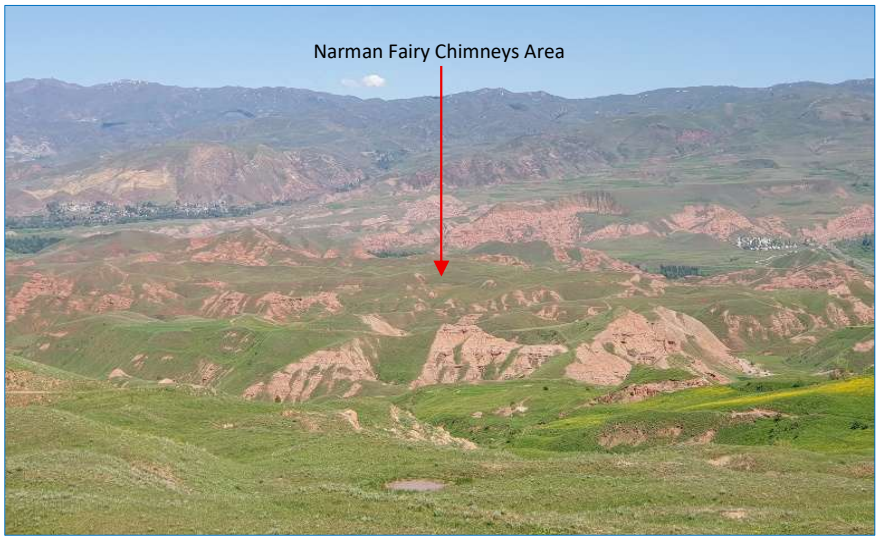


Fig. 6. Surface view of the Narman Fairy Chimneys Area

The Narman Fairy Chimneys area is located within the area where the Yoldere Formation outcrops. Çelik (2018) states that the Yoldere Formation consists mainly of active areas of water flow, mass flow beds and debris flow, fluid flow and sieve deposits. This formation is characterized by inner alluvial fan, middle alluvial fan and distal fan deposits, but there are also alluvial plains. Inner alluvial fan sediments consist of massive, matrix-supported blocky gravel and massive or coarse-bedded gravel facies. Middle fan deposits consist of interwoven channels represented by matrix-supported gravelstone, grain-supported gravelstone, boat-shaped cross-bedded sandstone, and horizontally bedded sandstone facies. Red mudstones containing calcareous levels and fine-grained sandstone facies characterize the outer fan facies assemblage. Narman Fairy Chimneys were shaped as a result of strong erosion of the units within the Yoldere Formation (PlQy). Plio-Quaternary reddish brown and greenish sandstone-conglomerate succession forms the younger rock units. These deposits are weakly deformed and preserved their original horizontality. The youngest unit in the region is the Upper Pleistocene and Holocene River deposits labelled as older alluvial fan deposits and alluvium, respectively (Konak and Hakyemez 2008; Şaroğlu and Güner, 2019) (Fig. 5)

The volcano-sedimentary stack forming the region where the Narman Fairy Chimneys Area is located in Narman District of Erzurum shows a stratified structure with a slope of 2-5 degrees close to the horizontal. The strata forming the stack exhibit different resistance to external influences, especially to water and wind erosion effects due to their different strength characteristics.

Especially the pebble and sandstone layers dominated by coarse grains have high resistance against erosion and the mudstone layers consisting of finer grains have very low resistance against erosion. On the deep valley slopes eroded by rivers, the repeated position of the layers with different resistance to erosion creates a unique morphological structure. Especially on the steep slopes of the valleys, the morphological beauty becomes even more unique.

The Narman Fairy Chimneys Area, which contains visually and geologically interesting formations, has developed entirely within the Yoldere Formation and has a monoclinal structure. Structures in which resistant and less resistant strata are stacked on top of each other and inclined to one side are defined as monoclinal structures, and in the advanced stages of erosion of such structures, visually and geologically interesting structural shapes called cuestas emerge. In the Narman Fairy Chimneys Area, the strength of the strata forming the terrestrial sediments has been instrumental in shaping the valley topography. Valley slopes with a higher density of more resistant strata exhibit steeper, more undulating, stepped, and more interesting formations, while slopes with less or no more resistant strata present a smoother topography.

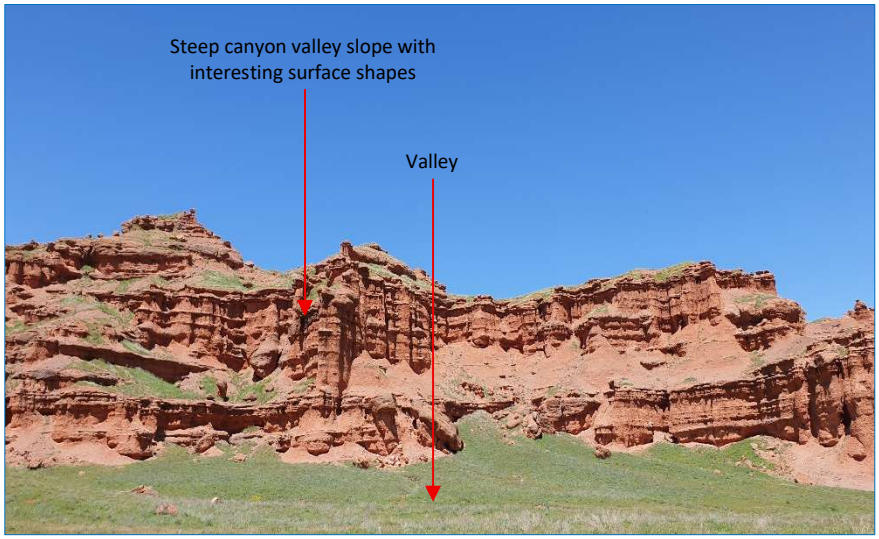


Fig. 7. In the Narman Fairy Chimneys Area, an interesting landform appears on the steep canyon valley slope where more resistant layers are concentrated

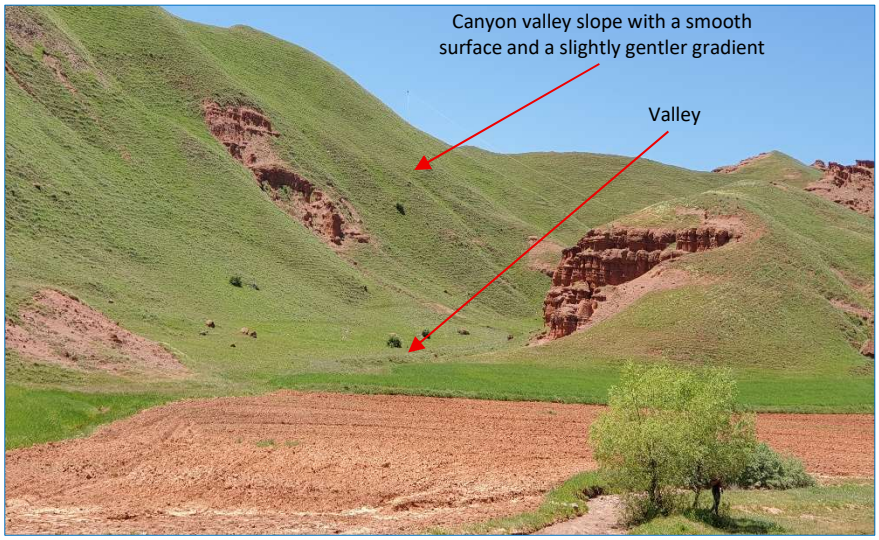


Fig. 8. In the Narman Fairy Chimneys Area, steep canyon valley slope with a smooth surface and low gradient, where more resistant layers are not concentrated

Depending on their geological characteristics, the less resistant layer (mudstone layer) beneath the more resistant layer (conglomerate layer) at the cap of the fairy chimney undergoes very rapid weathering. Rapid surface water erosion of the neck and body of the fairy chimney causes the neck and body to become increasingly thin. As erosion of the fairy chimney cap is slower, the neck and body, which have become thinner over time, can no longer support the cap. Thus, the fairy chimney cap falls, and the fairy chimney disappears (Fig. 12).

In the formation and development of the Narman Basin,

within which the Narman Fairy Chimneys Area is located, internal factors and processes such as tectonic and volcanic activity, as well as external factors and processes such as climatic conditions, surface waters and wind, are significant. The uplift that occurred in the region as a result of tectonic activity led to the development of the drainage system and the intensification of the deep excavation process. The terrestrial sediments forming the Yoldere Formation, consisting of poorly consolidated, red-coloured gravelly, sandy, silty materials of varying grain sizes, are not very resistant to surface water erosion (Garipağaoğlu, 1996; Şaroğlu and Güner, 2019; Azaz, 2021a).

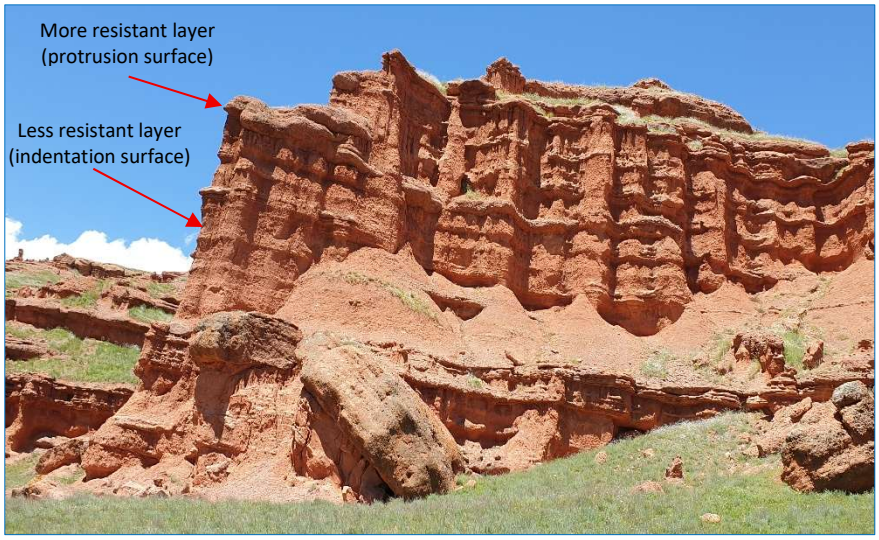


Fig. 9. In the Narman Fairy Chimneys Area, an interesting landform that appears on the valley slope as a result of the different erosion behavior of successive layers of highly resistant and less resistant terrestrial deposits that form the Yodere Formation

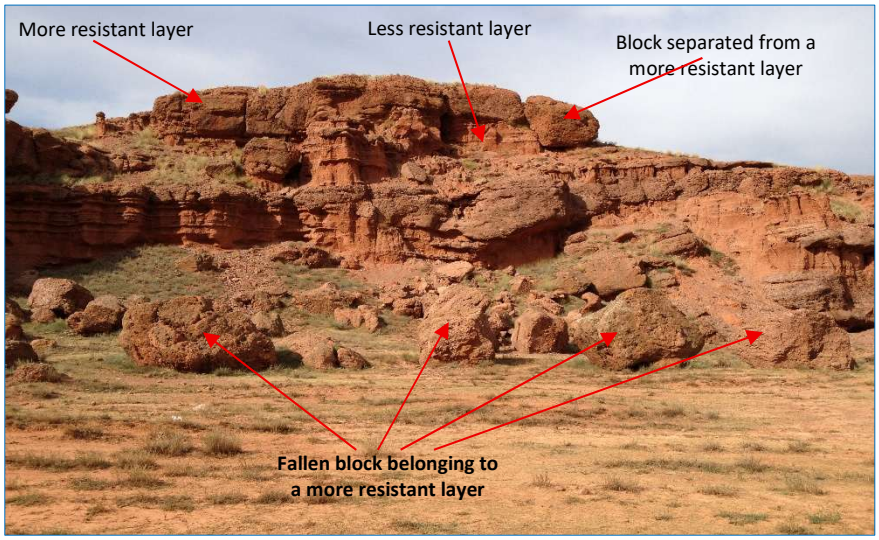


Fig. 10. In the Narman Fairy Chimneys Area, blocks that have broken off from a more resistant layer on a steep canyon valley slope and fallen downhill

Consequently, they have been rapidly eroded by surface waters, forming canyon valleys. Different erosion patterns are observed in levels with varying degrees of erosion resistance that form the terrestrial sedimentary sequence. Canyon valley slopes, where more resistant layers are concentrated and levels with different resistances are observed, have a steeper structure and exhibit interesting surface shapes formed by surface water erosion (Fig. 7).

The slopes of the canyon valley, where highly resistant layers are less concentrated, are less steep and have a smoother surface shape (Fig. 8)

Levels that are less resistant to surface water erosion have exhibited more abrasive behaviour compared to the more resistant levels above and below them. As a result, an inward collapse has occurred due to the retreat of the less resistant levels, while an outward protrusion has formed due to the advance of the more resistant levels (Figs. 9).

As the less resistant layer beneath the more resistant layer continues to erode and retreat, the resistant layers eventually lose their ability to support their own weight, break apart, and detach from the bedrock, falling down the slope (Fig. 10). Since these fragments are not very strong or resistant, they

easily break apart and disappear. This continuous erosion of valley slopes allows new formations to develop and gradually widens canyon valleys (Garipağaoğlu, 1996; Şaroğlu and Güner, 2019; Azaz, 2021a)

In the Narman Fairy Chimneys Area, tectonic activity plays a significant role in the formation of the valley and the separation of the main rock, leading to the formation of fairy chimneys. The uplift caused by tectonic activity in the region has led to the revitalisation of the drainage system here and intensified deep excavation. The tectonic activity that took place in the Narman Basin led to the formation of fracture and crack systems in the units located there. The tectonic and geomorphological developments that took place in the Narman Basin led to the formation of red terrestrial sediments on the Pliocene-Quaternary drainage system, which have taken their present form. In the region, which has been ongoing since the end of the Miocene, the erosion of the rising parts has created fairy chimney-like shapes and other interesting surface shapes.

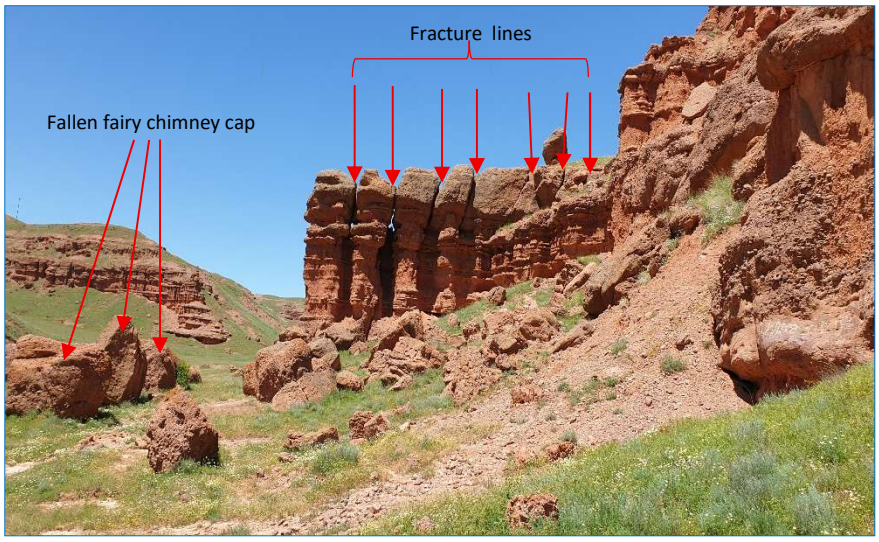


Fig. 11. In the Narman Fairy Chimneys Area, fairy chimney-like formations developed along fracture lines on the steep valley slope

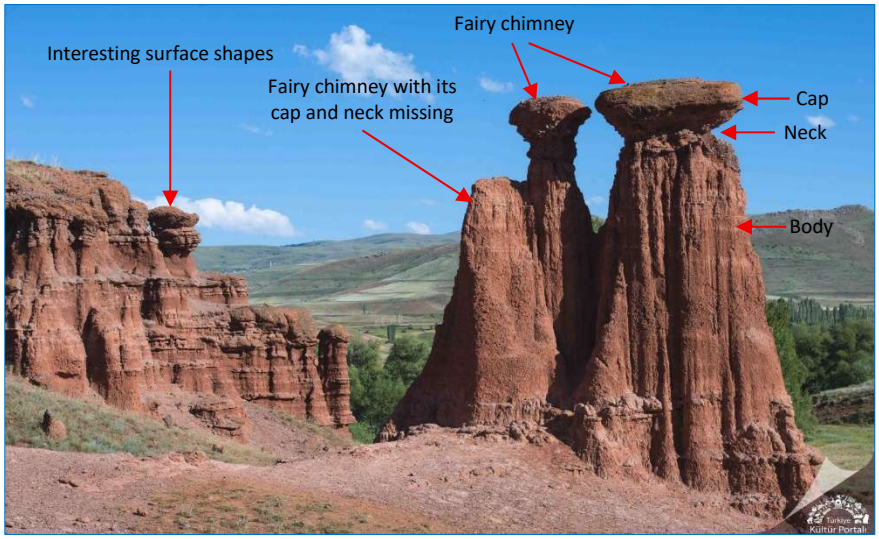


Fig. 12. In the Narman Fairy Chimneys Area, interesting surface shapes and fairy chimneys (Web 1, 2025)

Fracture lines play an important role in the erosion of surface waters in terrestrial sediments. Surface waters moving along fracture lines cause faster erosion along these lines and cause masses of different sizes to separate from the bedrock. Fracture lines parallel to valleys, in particular, facilitate the separation of masses from the bedrock and, as a result of the weathering of the separated masses by surface water and wind, lead to the formation of fairy chimney-like structures (Fig. 11).

In the Narman Fairy Chimneys Area, fairy chimneys and fairy chimney-like structures are short-lived due to the very rapid erosion of lower-resistance layers by surface water. For this reason, this area generally features more interesting indented and protruding surface shapes than fairy chimneys and fairy chimney-like structures. These interesting surface shapes in the Narman Fairy Chimneys Area have been defined by Garipağaoğlu (1996) as cuestas developed due to surface water erosion in a monocline structure formed by

hard and soft layers inclined in one direction and lying on top of each other (Fig. 13).

Although various fairy chimneys and fairy chimney-like structures are found in the Narman Fairy Chimneys area, interesting landforms formed on steep and stepped valley slopes are much more common. Valley slopes with a higher density of less resistant stratification are particularly suitable locations for the formation of interesting landforms and steps (Fig. 14). In the Narman Fairy Chimneys Area, the formation of fairy chimneys, fairy chimney-like structures, and other interesting erosion shapes is largely due to the superimposition of layers of varying resistance, as well as the role of fracture systems developed as a result of the region's tectonic activity. The weathering of different resistant layers in the terrestrial sedimentary sequence creates interesting surface shapes, such as indentations and protrusions, on the vertical valley slope surface. Similarly, the fracture systems to which the terrestrial sequence is exposed allow for horizontal erosion within the sequence, thereby enabling the formation of fairy chimney-like structures from the masses separated from the main rock mass (Figs. 11-13).

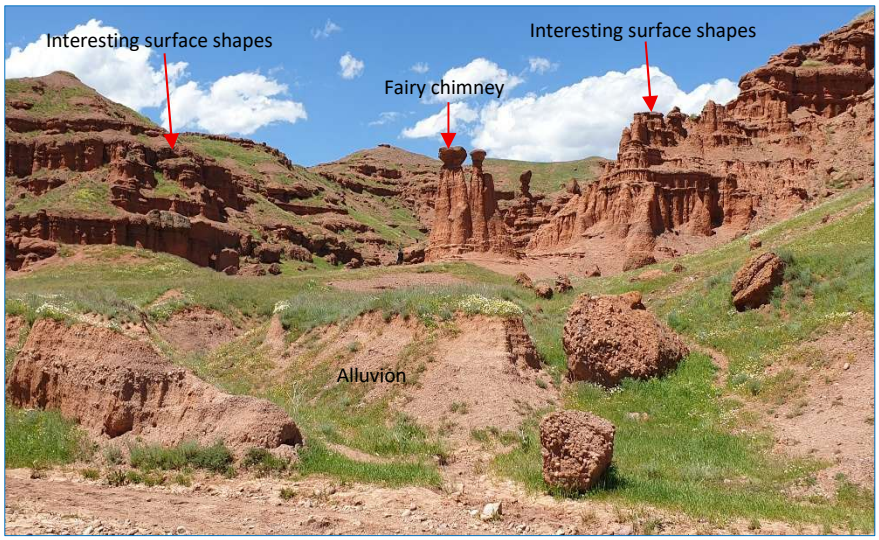


Fig. 13. In the Narman Fairy Chimneys Area, interesting surface shapes and fairy chimneys

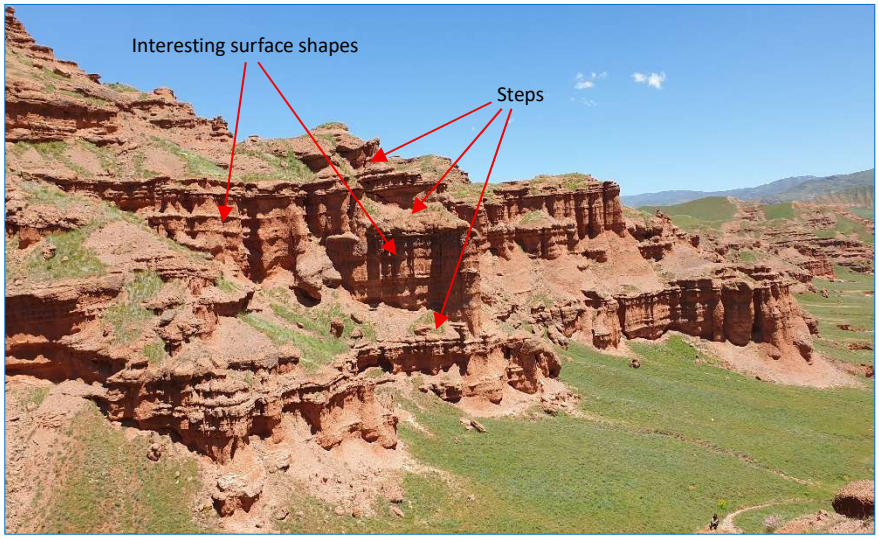


Fig. 14. In the Narman Fairy Chimneys Area, interesting surface shapes and steps

Some examples of fairy chimneys and fairy chimney-like structures, as well as other interesting surface shapes, which are unidentified erosion products in the Narman Fairy Chimneys Area, are shown in Fig. 15.

The Narman Fairy Chimneys Area, which is rarely seen elsewhere, offers interesting geological and geomorphological structures. The terrestrial sediments that form the area have a geologically fragile structure. In particular, after the more resistant cap section at the top of fairy chimney-like structures falls, the structures erode rapidly and disappear very easily. For this reason, the Narman Fairy Chimneys Area, which is a rare natural monument, needs to be better protected. This area attracts nature lovers and photography enthusiasts in particular due to its visual appeal and unique geological structure.

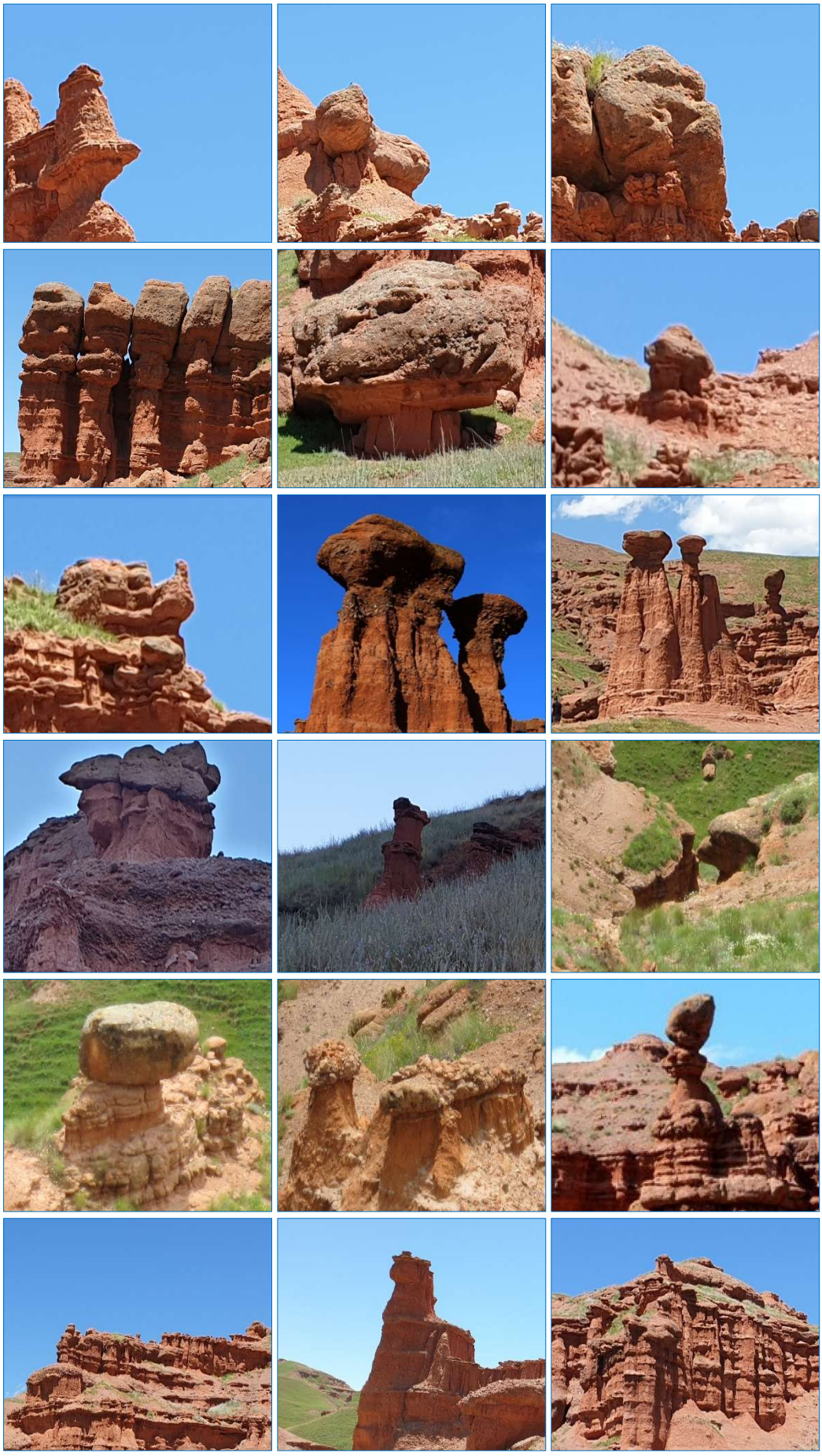


Fig. 15. Some interesting surface shapes in the Narman Fairy Chimneys Area

Although the area is significantly underpromoted, there has been a slight increase in the number of foreign visitors, in addition to local visitors. The Narman Fairy Chimneys Area, which has high tourism potential, was added to the UNESCO World Heritage Tentative List by the Turkish National Committee in 2012.

However, no significant progress has been made since then. Formed in a sedimentary environment under terrestrial conditions, the Narman Fairy Chimneys Area has the potential to be included in the World Heritage List due to its unique geological and geomorphological features.

To achieve this, greater efforts are required not only from local and public authorities but also from scientists. This will increase the region's visibility and enable it to host more tourists and visitors nationally and internationally. The increased activity of the Narman Fairy Chimneys Area in terms of tourism will also stimulate other sectors. Furthermore, the success achieved in tourism in this area will trigger efforts to promote the numerous geological structures in the immediate vicinity for tourism.

As emphasised by Azaz (2021a), who conducted a detailed geosite study in the region, some structures in this area are in a fragile state and require urgent protection. Action must be taken immediately to preserve these natural beauties for future generations and to ensure sustainable geotourism activities.

5. Conclusion

Today, the importance of interesting geological structures that have formed over millions of years is increasing. There is growing sensitivity towards preserving these structures for future generations, and awareness is developing about generating economic gains by promoting tourism. The concept of geotourism, which has recently begun to be researched as a new field in tourism, is attracting attention as an increasingly popular type of tourism. Research on geotourism is extremely important in terms of revealing geological formations and thus contributing to tourism. Geotourism, which is considered a sustainable form of tourism, makes it possible to preserve natural geological structures and pass them on to future generations. The Narman Fairy Chimneys Area, one of Turkey's important geological formations, is located within the borders of Erzurum (northeastern Turkey). Fairy chimney-like structures formed in the Yodere Formation, dominated by terrestrial sediments, and erosion-produced surface shapes present a magnificent view. The preservation and transmission of these structures, which enchant visitors, to future generations is of great importance. The area in question has not yet reached its rightful place in terms of tourism. However, if it is fully evaluated within the scope of geotourism, it will make a significant contribution to the regional and national economy.

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