

Development of Haraz Road geotourism as a key to increasing tourism industry and promoting geoconservation

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Abstract

The purpose of this research is to introduce road tourist attractions. Geotrial attractions of Haraz Road (Haraz Valley), located in the Alborz Mountain, are presented in this article. The Haraz Road (Road 77) is one of the most beautiful roads in the world that connects the capital of Iran (Tehran) to Mazandaran province. In this research, the geodiversity attractions of the area outside the urban context, in the Jajrud Neck to the Filband zone have been investigated. There are 17 stops along the road. The basis of this research has been the transfer of knowledge and experience of over 20 years of field visits to this road. This research was conducted due to the various interests in the Haraz road, such as geodiversity, cultural, historical, religious, and ecological attractions. The most attractive tourist sites along the Haraz road include Lar plain, Qal'e Dokhtar, Shahandasht waterfalls, Imamzadeh Hashem, Damavand peak Gol-e Zard cave, Damavand Icy waterfall, Basaltic prisms, kafer-Keli crypts, and Shahi Bridge. This road is the cheapest road geotourism option for middle to low-income people.

Keywords: Haraz Road (Road 77), Geotrial, Geodiversity, Geotourism, Geosite, Geoheritage, Alborz Region.

Introduction

The mountains and plains on a road have long been fascinating to publics, and people are unwittingly using these attractions along the way to the destination. Roadside geotourism has attracted the attention of enthusiasts, experts and researchers. Site watching of these spectacular spots, while crossing the road or getting off the car and touching these divine attractions is considered as a tourist activity. Presently, with increasing population growth and pollution of cities, natural areas with a clean and quiet environment are welcoming large numbers of travelers who leave their homes for vacation. Iran has a beautiful nature, diverse climate and areas rich in unique geological phenomena. Investigating natural attractions is essential for understanding these and geotourism development (Beigi & Beigi, 2016). Geotourism is a subset of sustainable tourism that aims to conserve tourism resources at the destination and guiding tourists in a way that the location remains untouched for future generations to use (Dowling & Newsome, 2006; Dowling, 2010). We introduce geotrial concept by connecting the values of each geosite in Haraz Road (Ginting & Siregar, 2018).

Geosites and geoparks are good tools for extensive education with a simple approach to environmental and geosciences. In addition, it is essential to record the history of the land for aesthetic, cultural, scientific reasons, its importance and potential for production through

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sustainable economic development (Newsome & Dowling, 2010). Geotourism has made it possible for researchers and users to improve the environment and quality of their visit. Therefore, human interference on the earth leads to a new and distinctive vision of nature. The tourism industry introduces geological phenomena to tourists by preserving the environment and its prospects (McKeever & Zouros, 2005; Zouros, 2007; McKeever et al., 2010). Geotourism is the third generation of industries and an integral part that will stimulate other industries such as transportation, services, catering, hotels, travel agencies, and will play an important role in sustainable economic development. Geosites are the most basic core of geotourism. These places should have aesthetic and scientific value and should be accessible to all. According to previous studies (e.g. Cowie & Wimbledon, 1994; Panizza & Piacente, 2003; Reynard et al., 2007; Zwoliński, 2012; Kubalikova, 2013; Panizza & Piacente, 2013; Pelfini, & Bollati, 2014; Bartus, 2015), geosites are places with examples of conspicuous history and geological prominent processes that have contributed to the development of landforms and are of global value.

The territory of Iran is very diverse in terms of geomorphological and geological structures and represents new areas in the country's tourism industry (Amrikazemi & Mehrpooya, 2006). In addition to geological attractions in the Haraz Road area, there are also a number of natural, cultural, artistic, religious and historical attractions that will affect the economic development of the region. In the meantime, any country with more ancient history and additional geological complexities will have positive potential for the development of this industry (Amiri et al., 2018). This road has always been of interest to tourists due to the variety of climate, caves, and beautiful water-filled rivers and has favorable conditions of roads for tourism and with the actual and potential tourism capabilities; it can be one of the most important axes of tourism in the country.

This route is of great interest to all groups of geosciences, including geologists, geomorphologists, and civil engineers, given the diversity of geological formations from the Paleozoic to Quaternary (Feiznia, 1990; Emami, 1992; Majidinia, 2012; Ehteshami-Moinabadi & Nasiri, 2017). The reason for the importance of this route for engineering geologists is the existence of landslides zones, bridges, tunnels, snowplows and avalanches. Also, for those who are interested in mountaineering considering the high peaks, including the Damavand Volcanic Peak, there are good conditions to enjoy. Along the Haraz road, there are excellent facilities for winter sports lovers, such as suitable infrastructures, as well as proper shelters for a stay to reach Damavand Peak. The main features of this route include diverse ecosystems ideal for botanical research considering the diversity of vegetation, protected parks, and Hyrcanian forests. The tourist attractions that most family travelers enjoy are the variety of waterfalls, hot springs, historical, cultural and religious centers that host millions of tourists from all over the world during all four seasons. This study aims to directly study the processes and also discover how important geological phenomena occur in geosites, together with a general acquaintance with the geology of Iran in the route of the Central Alborz area. It also introduces a variety of geological, ecological phenomena, as well as religious, historical, and cultural sites under the geotourism of Road 77. Regarding these potentials, we would like to propose that this road should be included in the list of UNESCO Geoparks.

Materials and Methods

This research has used geotourism development strategies along the Haraz road, using a descriptive and analytical approach. Our data collection method was library, documentary and field studies. This work was based on a bibliographical research, field visits, and surveys. (Errami et al., 2013; Ginting & Siregar, 2018; Palacio Prieto et al., 2019). The study includes the interpretation of the general geology of the study area in Haraz Road as shown in figure 1.

During the outcrop survey, the study was emphasized in the description of general geological characteristics such as lithology, texture, succession characteristic and identification of structural features that requires details observation. Additionally, observation on tourist attraction, recreational activities, and how it affects local people social-economic have also been taken into account. The data was used in interpreting the geomorphological characteristic of the sites and capture the beautiful scenery (Dzulkafli et al., 2019). The Haraz road area is of great importance due to its pristine nature and interesting geotourism phenomena and proximity to the Iranian capital city, Tehran. For this visit, the Haraz road (from Jajrud Neck to Filband and Forest) has been directly field-surveyed and data were collected from the nature.

Geographical Location of the Road 77 Geotrial

The road 77, now known as Haraz, was put into operation in 1963 and took 23 years to complete and passes through the Haraz River, dividing the two cities of Boomehen and Rudehen from the Firouzkuh road, crossing Abali, Imamzadeh Hashem, Polour, Abusk, Rine and Larijan rivers, and eventually joins the city of Amol. This road is one of the most important roads from Tehran to the northern mountains of Iran, and the Iranian coast on the southern Caspian Sea.

The road's route travels through Tehran Province and Mazandaran Province. It crosses the Alborz mountain range and then descends northwards down the Haraz River Valley. The road is the shortest route from Tehran to the north (180 km) and in recent years some parts of the road has been widened and the safety has been improved. It passes through the towns of Amol and Rudehen. This road is the nearest road to Mount Damavand, the highest peak in Iran and Middle East. Lar Dam, Lar National Park, which Mount Damavand is within, is easily accessible from Road 77 (Fig. 1). Among the activities on this trip are education, fun and a touch of these attractions (Robinson, 2016). The Haraz road has been recognized as Iran's most newsworthy road since its inception, due to landslides, floods, avalanches, Damavand volcano secondary activity and its subsequent earthquakes. The Alborz Mountains, which stretches almost east-west in the northern part of Iran, from Imamzadeh Hashem onwards to Amol city intersects the Road 77 in Alborz heights (Allenbach, 1970).

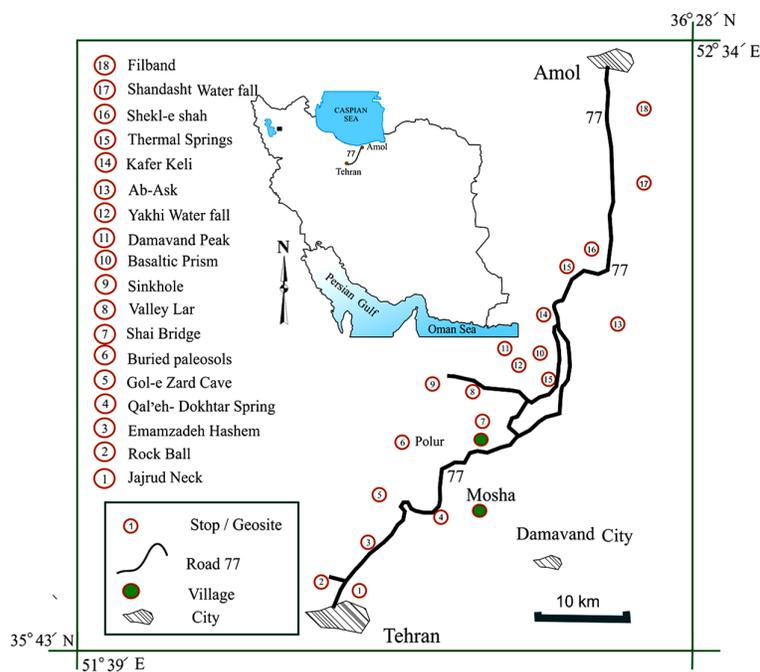


Figure 1. Haraz Road (Road 77) with the location map of identified geosites explained in this paper.

Therefore, different geological structures and Paleozoic and later periods formations can be observed and studied. Along the Haraz road, the Haraz River flows, causing numerous erosional forms and beautiful landscapes. The Haraz River originates from the Lar valley in the south of Damavand volcano peak. The river flows in a relatively wide valley to the north and eventually runs to the Caspian Sea.

The geotourism of Haraz road is well-suited to encourage travelers to use the road by its fascinating, spectacular, geomorphological and geological, climatic, ancient, cultural and religious phenomena. Numerous geosites such as various forms of rocky outcrops, cliff, and mass wasting movements such as landslides, debris and rock falls, different eroded faces and natural landscapes are among many areas that can contribute to the development of tourism and geotourism in Haraz road basin. Amrikazemi (2002, 2004, 2009, & 2013) has published some atlas books on capacities of geoparks and geotourism in Iran and has continued his extensive research on the introduction of indigenous geosites and landforms in Iran. Below, considering the variety of tectonic features, climatic characteristics, altitude, and road distance to major faults, the different attractions of the Haraz Road tourism will be examined with particular attention to the Damavand Volcanic Zone and surrounding areas. Geotourism, according to its diversity, is divided into seven main subdivisions (Ginting & Siregar, 2018 & Table 1).

The target audience for geotourism is not just geologists and geomorphologists, but ordinary tourists and nature lovers. During geotourism activities, visitors are introduced to the geological and geomorphological phenomena of this road, the history of Alborz and Damavand, Amol and Iran. There are numerous historical, natural, and religious tourist attractions along this route that have encouraged more travelers to use the road. These capabilities prompted the researchers to introduce the geotourism capabilities of this attractive route. Due to the variety of attractions on Road 77, this collection can be organized into four categories: 1- Geomorphological and Geological Attractions, 2- Cultural and Historical Attractions, 3- Eco-Tourism Attractions, 4- Religious attractions. The following is an outline on each of the tourism categories as we begin to navigate the route from the Jajrud Neck to Amol.

Geomorphological and Geological Attractions

The Haraz Road is based on a range of Cambrian to Quaternary rocks. Due to the diversity of the materials of the underlying rocks, some features have caused a large number of geosites. The most important geological attraction of this route is the Damavand volcano and about one-third of the Haraz road is built on alluvial sediments and volcanic ashes of the Damavand. The Damavand volcano, the highest active volcano in Asia, is located in the Alborz range in central part of northern Iran (Lü & Chen, 2017). Also, erosional valleys, large faults and thrusts, landslides, springs and waterfalls are of features of this road (Fig. 2).

Table 1. A diagram of the prominent branches of geotourism

Kind of geotourism	
1	Adventure with sporting approaches: mountains, caves, rivers, lakes, and deserts
2	Road outcrops
3	Geology and Geomorphology: Earth processes like volcanoes, earth forms like meander river
4	Rock, Stone and Handmade Buildings: Used Materials or New Stone Formations
5	Mining: Today mines, contemporary abandoned mines and their reconstruction, the legacy of intense mining and ancient metal mining
6	Anthropology
7	Exploratory geotourism; geology, jewelry and precious metals exploration

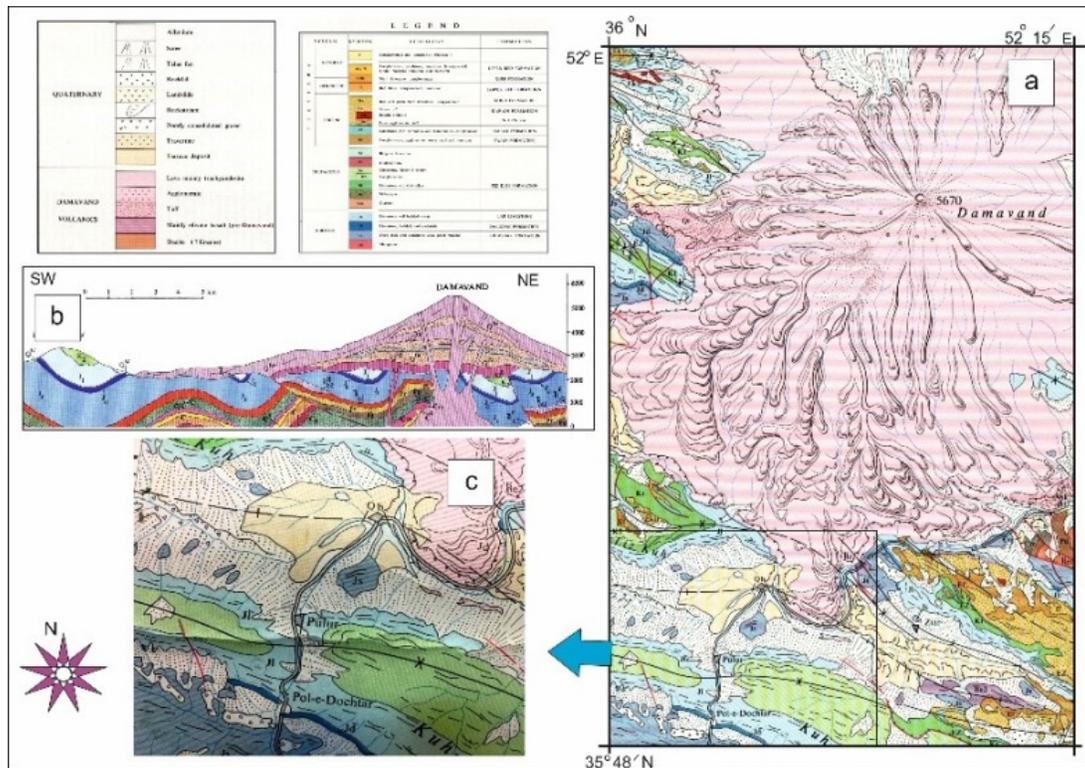


Figure 2. Part of the geological map of the Haraz Road (Allenbach & Steiger, 1972)

Cultural and Historical Attractions

The Sassanid Haraz road, with its millennial history, is a precious heritage that holds a piece of its history and identity. Along this road, there are bridges and hand-carved houses on the volcanic ash walls as well as carved stone inscriptions which are the cultural and historical attractions of the area.

Ecotourism Attractions

The Haraz Road has many ecotourism attractions (Eskandari, 2013; Yazarlou, 2015; Amiri et al., 2018). Along with the biodiversity of the Polur region, there are good opportunities for tourists. The utmost of biodiversity is related to the area of the Poppy flowers of Lar plain and the remaining of the Hyrcanian Forests.

Religious Attractions

Religious tourism is one of the most common forms of tourism around the world the history of which goes back to the past centuries; in general it includes trips and sightings, the main purpose of which is a religious experience (Shinde, 2010; Zamani-Farahani & Henderson, 2010; Zamani-Farahani, 2010; Henderson, 2011; Zamani-Farahani & Musa, 2011; Egresi et al., 2012). Religious attractions, shrines and sacred places attract a large number of tourists each year. One of these attractions is described in this section. Religious tourism is the only form of tourism that overcomes climate barriers. The following is a brief description of the geotourism attractions moving from Jajrud Neck to Amol. This geotrial is 180 km long. It first stop is starts from the Tehran City in north of Iran.

Stop 1. Jajrud Neck (35°44'6.58"N - 51°40'34.34"E)

On the way to Amol (Fig. 1), the road passes through a steep slope in alluvial sediments. These sediments are the result of the Alborz Mountains rise peaks and erosion of older formations that nowadays appears as alluvial fans on the southern slopes of Alborz. The name of this formation (Hezardarreh Formation) originates from the geomorphic nature of outcrops of the formation. "Hezar" means "thousand" and "darreh" means "valley" (Stöcklin & Setudehnia, 1991)

Hezardarreh Formation, literally "Badland morphology" has been inspired by the geomorphologic properties of its surface and the existence of the multitude of its erosional valleys of great density. Its alluvial substances mainly consist of alluvial sediment, alluvial talus, and volcanic rocks from Eocene age. The type section of Hezardarreh Formation is situated in the east of Tehran (Khaksar & Khaksar, 2012). The alluvial deposits of Hezardarreh Formation have been formed by joining the mentioned collection; there are many valleys, resulted from weathering. The composition of this formation is mainly coarse gravel and sand size, with pyroclastic origin (Fig. 3). Currently, in Tehran, alluviums are used in the construction of concrete and asphalt.

Stop 2. Rock ball tuff of Karaj Formation (35°45'35.98"N - 51°41'57.89"E)

In the Jajroud Valley route (Fig. 1), on the route branched from Road 77, the first outcrops of the Karaj Formation are visible. The Karaj Formation is a volcanoclastic sequence cropping out in a very large area in Central Alborz. This formation is middle Eocene in age and mainly formed of green-tuffites and marine shales and mainly formed in a deep to the semi-deep environment (Amini & Bolourian, 2005). This formation is seen in southern Alborz and its central part is several hundred kilometers wide and 3,000 meters thick. Its greatest thickness is in the Chalus Road area (Fig. 4a). One of the features of this formation in the Haraz road outcrop is the presence of rock balls. These rock balls have a core and a coating around the core. The core consists of a very fine-grained tuff containing radiolarian. During the middle Eocene, submarine volcanic eruptions were active, pyroclastic debris poured out and were mixed with marine sediments and planktonic organisms and deposited. Due to the accumulation of excessive amounts of sediments on existing slopes and subsequent slumping, the cores formed and rolled over the soft tuffaceous mud (Fig. 4b). The pyroclastic debris wrapped around the core, making the tuff balls (similar to the formation of an avalanche) (Feiznia, 1990; Hosseinzadeh & Ranjbaran, 2018).



Figure 3. A close-up Hezardarreh Formation, east of Tehran

Stop 3. Imamzadeh Hashem ($35^{\circ}46'48.96''\text{N}$ - $52^{\circ}2'21.85''\text{E}$)

Another tourist attraction is the religious attraction. This site is the most important religious attraction on the road. This is located on the highest part of the road and on a hill of the same name. The Imamzadeh Hashem shrine is built over a foothill about 60 kilometers northwest of Tehran. Mosha valley in Damavand city, which created by a fault, is at the foothill of this neck. The main building of Imamzadeh is built in the Safavid era. The Damavand volcanic rocks have been used for reconstruction of this shrine. Imamzadeh Hashem neck has been one of the most popular paths, both in the past and present time (Fig. 5a, b & c).

The Mosha and North Tehran faults correspond to two major structures in the southern border of the Central Alborz, the active mountain range surrounding the southern margin of the South Caspian basin. These faults are located in the immediate vicinity of the highly-populated region of Tehran, where more than 15 million people are living (Solaymani Azad et al., 2011).

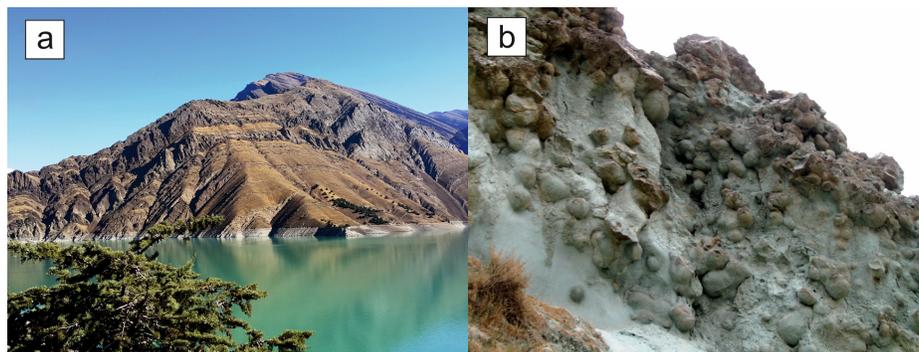


Figure 4. a) Karaj Formation in the vicinity of Amir Kabir Dam (Karaj Dam) and b) rock balls of Karaj Formation with an average diameter of 20 cm is located on the bank of the Jajroud River

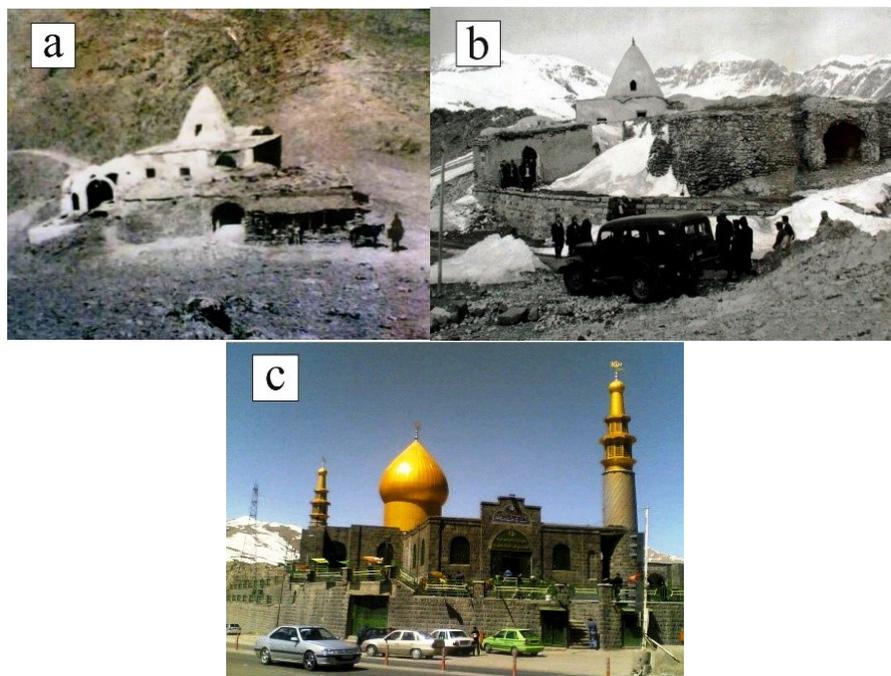


Figure 5. The shrine of Imamzadeh Hashem. a) The early building of Imamzadeh Hashem, which lacks solidity and appearance, and at that time the means of transportation was cattle, b) a bit of reconstruction, figures a and b show the old status of Imamzadeh in the Qajar period and c) the current view of Imamzadeh Hashem after reconstruction.

Stop 4. Pol-e-Dokhtar waterfall (35°48'51.30"N - 52° 1'50.59"E)

Most of Iran's waterfalls are in the Zagros and Alborz Mountains (Dowling & Newsome, 2006). There are numerous waterfalls along this tourist route. The first waterfall we encounter on the route is the Pol-e-Dokhtar waterfall. This waterfall is located near the village of Polur. It originates from the limestone rocks of the Late Jurassic age (Fig. 6). The Polur mineral water plant is currently supplied with water from this karstic waterfall.

Stop 5. Gol-e Zard Cave (35°50'32.09"N - 52° 0'7.03"E)

There are many types of caves such as limestone (karstic), salt, ancient and human-made ones. Limestone caves have various multi-store forms (Dowling & Newsome, 2010). Gol-e Zard Cave is located on the southeastern slope of Gol-e Zard Mountain, which is one of the highest peaks of Mount Damavand. This cave is located in the Polur area and in the northern pastures of the village of Manzarieh. The lane road leading to the Gol-e Zard Cave, 65 kilometers after Tehran, is separated from Haraz Road and is 4 kilometers long. This road is just after the famous avalanches down the Imamzadeh Hashem and before Manzarieh gatehouse and the end of road reaches a mountain hut. Next to the hut, it is a 30-minute walk to the cave. The mouth of the cave is very narrow and the beginning of the cave should be passed in a crawling position. The horizontal length of the cave is 594 meters (Fig. 7a). The Gol-e Zard Cave has been visited by many Iranian and foreign climbers and Cavemen from June to September each year. Other than this time, the cave's small opening closes due to flooding. During the rainy months, there is a high probability of landslides in the entrance of the cave. The surface of the cave is covered with a variety of cave deposits and beautiful calcareous columns and candlesticks are found alongside the pools of cold water. This cave contains simple and composite types of beautiful stalactites and stalagmites. It has fungal-shaped calcareous columns, sediments, and band-shaped deposits. Also, in this cave, there are water ponds that emerge from the water flow at the bottom of the cave (Fig. 7 b).

Stop 6- Buried paleosols under Damavand Lava and pyroclastics (35°50'32.84"N - 52° 2'46.31"E)

This stop is the first point where Damavand volcano activity is visible. At this site, old Paleosol layers beneath the ashes and lava flows are clearly visible and separable on the roadside. More than one-third of the Haraz road is built on unstable Damavand river sediments, lava flows on volcanic ash (Fig. 8a & b). Deposits of lava and ash, which are the product of Damavand volcano, are highly susceptible to climate change and weathering.



Figure 6. a) The outflow of springs from the Lar limestones and creation of Pol-e-Dokhtar waterfall; b) the Polur mineral water plant is located near Pol-e-Dokhtar waterfall

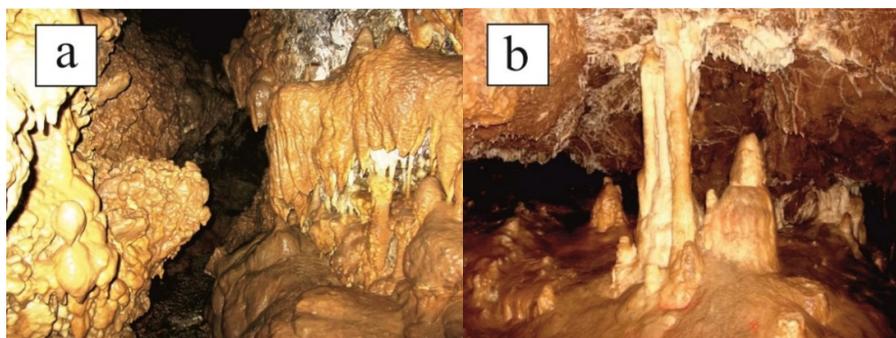


Figure 7. a and b) Gol-e Zard cave deposits in the form of stalactites and stalagmites



Figure 8. a) Onion skin weathering in Polur lava flows at Haraz Roadside, and b) burial of sediments and river deposits and the creation of old soils (Paleosols) beneath the Polur lava flows. Due to the high temperature of the lava, the sediments have been discolored and oxidized

The Haraz River is, in fact, an intersection for all Damavand volcanic activity and older sedimentary units in the Haraz Road area (Pandamouz, 1998; Majidinia, 2012; Solleiro-Rebolledo et al., 2016).

Due to the nature of the volcanic deposits, this river crosses the boundary of volcanic ash and other sedimentary rocks in the region and deepens its bed continuously (Fig. 9). Past extensive activities of the Damavand Volcano, periodically from lava flows to volcanic ash, cover about 400 km². The Damavand volcano is a composite cone phenomenon since it alternates with lava and pyroclastic material. However, the total amount of lava material exceeds pyroclastic materials (Mortazavi, 2017; Moradi, 1996; Darvishzadeh & Moradi, 1997). This volcano has a large variety of pyroclastic materials and has been spread mainly in the form of tuffs, agglomerates and volcanic breccia extending from the Polur village of to Gazanak city (Fig. 9b). The total ash and lava from multiple craters were formed in less than 1.5 million years ago (Davidson et al., 2004; Solleiro-Rebolledo, et al., 2015). The base of the Damavand volcanic peak is mainly related to the succession of Mesozoic sedimentary rocks. Lava flows and volcanic ash on limestone, sandstone and coal cover the Shemshak, Lar and Dalichai formations from the Mesozoic (Assereto, 1966; Berzins et al., 2001; Ehteshami-Moinabadi & Nasiri, 2017). Other sections of the road, especially in the Ab-Ask area, have always been the center of the region's largest landslides; and many times large pieces of land, over several dozen meters, have been invaded by landslides and were rebuilt again.

Stop 7. Historical Shahi Bridge (35°51'18.83"N - 52° 3'23.96"E)

The historic stone bridge that connects the village of Polur to the Lar plain and the Larijan area is a stone bridge built on the Lar River that uses beautiful and arched architecture. The stone materials used in this bridge are volcanic rocks of the Damavand area. This bridge is based on

the Triassic carbonate folded rocks of the Elika Formation (Fig. 10).

Stop 8. Valley of Lar red poppies and buttercup flowers (35°52'54.01"N - 52° 2'41.87"E - 35°54'58.90"N, 51°56'55.86"E)

The Damavand Mountains slope with an altitude of 2,000-3,500 m is completely covered by seasonal and poppy flowers. This unique poppy is well-known in the world and has been recorded in the world-renowned botanical books under the name of Lar and Rineh Poppy. The Lar National Park, which has high and aquatic mountainous ecosystems, is located on the southwest slope of Damavand. This protected area, in the vicinity of 20 Km-Lar Lake, is one of the recreation centers in the area. The park covers an area of about 30,000 hectares. Hunting and shooting have been banned in the area to protect the environment's ecosystem. Plants of Lar Plain and its highlands have a considerable variety. Some of these herbs are used as herbal medicine (Fig. 11a & b).

Stop 9. Sinkholes on the margins of the Lar Lake dam (35°53'59.61"N - 51°59'5.38"E)

Karst is an erosive phenomenon that is caused by the dissolution and destruction of soluble rocks by acidic waters in the surface and underground sections. Studying karstic areas is of two important aspects.

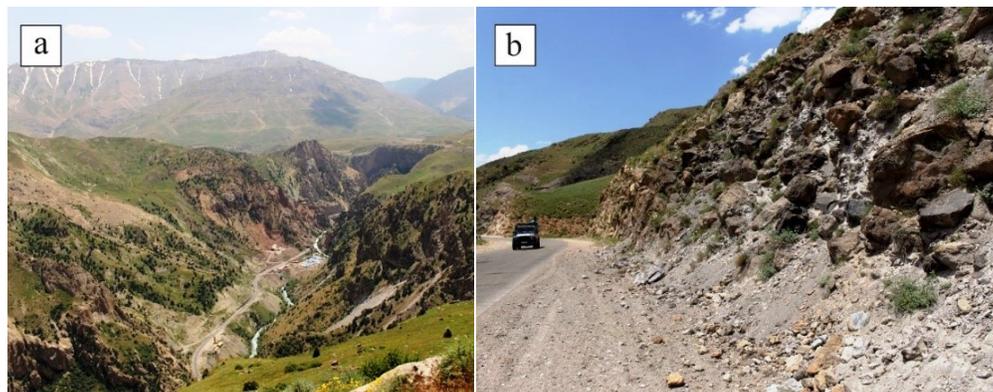


Figure 9. a) The Haraz River crossing the boundary of volcanic ash and other sedimentary rock sequences and b) a large variety of pyroclastic materials

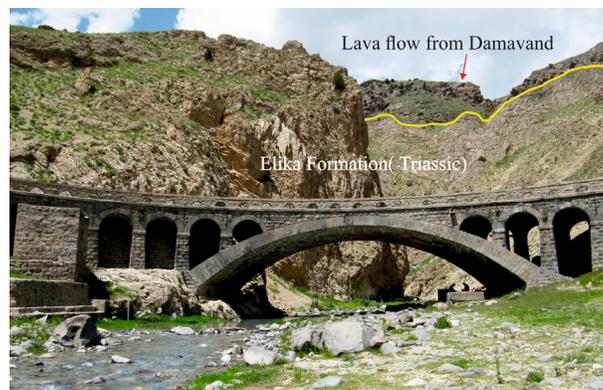


Figure 10. The Stone Bridge linking Polur to Lar Plain and Dam, with Iranian-Islamic architecture made of volcanic rocks of Damavand area.

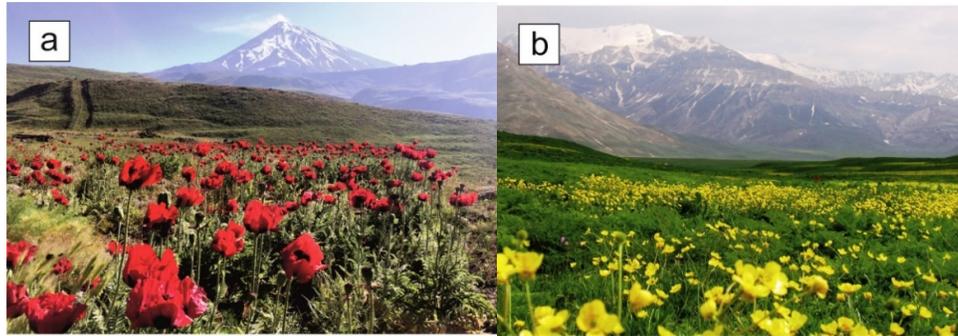


Figure 11. a) Poppies and b) buttercup flower land in the Lar valley on the slope of Damavand

Hydrogeological, these areas have significant groundwater resources and in the field of engineering geology, it raises special issues for hydraulic structures, especially dams. The Lar Dam is located on the western slope of the Damavand volcano. The Lar storage dam has been constructed on the Lar limestones to provide some of Tehran's drinking water supply and has been built near the confluence of the Lar and Dalichai Rivers. The karsting in surface sections is limited to weathering and the effect of atmospheric water whereas in deeper areas (more than 400 meters), the presence of large and numerous caves indicates that the dissolution process is formed by warmed atmospheric waters with high dissolution potential. So far regarding the water escape, in the post-flood period of the Lar Dam, various research and implementation activities have been carried out to identify water escape channels to prevent water leakage. After the dam is flooded, a large number of sinkholes are now evident in the left body of the dam, some of which are over 30 meters in diameter (Uromeihy, 2000; Mozafari & Raeisi, 2017; Fig. 12).

Stop 10. Damavand Basaltic Prisms (35°51'4.03"N - 52° 4'36.70"E)

Basaltic prisms are observed along the Haraz Road on the south-north route at the intersection of Polur and Ab-Ask. After cooling and turning into basaltic layers, joints were created in the width of lava flows and therefore, special prismatic columns were formed. Usually these prisms come in the form of a direct hexagon shape. Sometimes the height of the Damavand prismatic columns can reach up to 10 meters (Fig. 13).

Stop 11. Damavand Peak (35°57'10.43"N - 52° 6'32.27"E)

Alborz Mountain is divided into three sub-zones of eastern, central, and western. Damavand Volcano is located in the east of central Alborz sub-zone. The Damavand Volcano is located in the central part of the Alborz Range, south of the Caspian Sea and in the Larijan district of Amol city. It is 5678 meters high and the highest peak of Iran and West Asia and is one of the highest volcanic peaks in the world which annually attracts many climbers. The Peak is snow-covered and permanently frozen all the year round (Ferrigno, 1991). It is a composite stratovolcano with acidic-neutral alkaline composition. Since 10,000 years ago, its external activity has declined and it has been dormant ever since, however its internal underground activities have never stopped showing fumaroles emission from the summit (Kosari Torbehbar & Haghazari Liseroudi, 2015). It is known as the highest silent volcanic peak in Asia. The Damavand volcano is approximately oval with a diameter of about 250 meters and a depth of 20 to 30 meters. This volcano has been active from the late Pliocene to the Holocene (present age) and is in the fumarolic phase today (Emami, 1992). Sometimes when the air is clear, the vapor coming out of the top of the volcanic cone can be seen (Fig. 14a & b). The Mount Damavand is a symbol of the land of Iran and is printed on some of the country's banknotes (Fig. 14c).

Stop 12. Abshar Yakhi ($35^{\circ}56'23.33''\text{N}$ - $52^{\circ} 6'41.07''\text{E}$)

Abshar Yakhi meaning the icy waterfall is a strange waterfall located 5100 meters from the south face of the Mount Damavand. The waterfall is between 7 and 12 meters high and frozen all year round except for short periods in summer when a narrow stream of water flows along its sides. Access to this waterfall will need a diversion from the main route of the southern face (Fig. 15).

Stop 13. Ab-Ask travertine mine ($35^{\circ}51'53.90''\text{N}$ - $52^{\circ} 8'55.29''\text{E}$)

Moving on to the city of Amol, we learn about the heritage of mining. The Ab-Ask travertine mine at the southern slope of the Damavand Peak is a remnant of carbonate-bearing mineral deposits of the Quaternary time known as travertine's (Rahmani Javanmard et al., 2012).

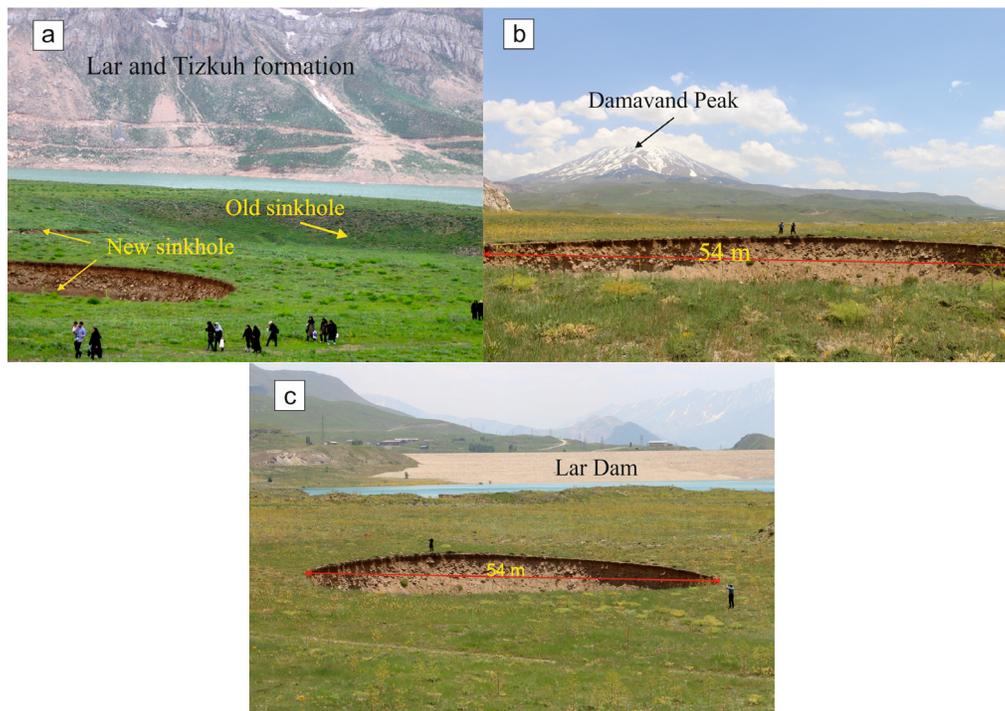


Figure 12. Location of the sinkholes in the dam's lake. a) old and new sinkholes in the part of the dam; b) the Damavand Peak and sinkhole is seen on the left lake; c) a sinkhole is located in part of lake dam



Figure 13. The Damavand basaltic columns located on the Haraz Road and the Ab-Ask area (west view)

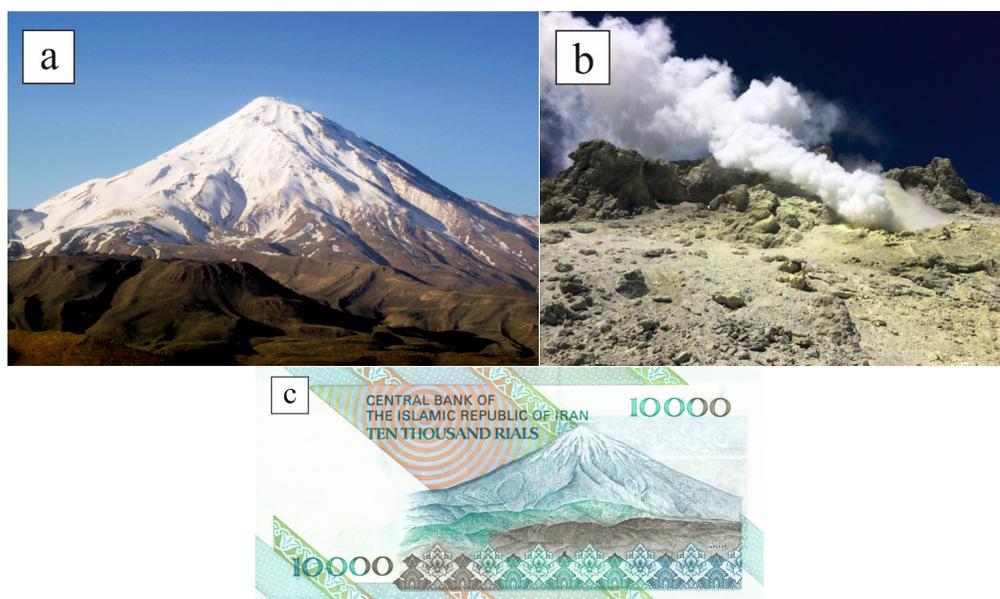


Figure 14. a) The Damavand Peak with an altitude of 5670 m is covered with snow throughout the year, b) exit of sulfur gas from the Damavand peak and c) The Damavand peak photo on back of 10000 Rials banknote



Figure 15. Icy waterfall at an altitude of 5100 meters from Damavand Peak Slope

This rock is the result of sedimentation from calcareous hot springs. The Ab-Ask travertine mine is located on the southern edge of the Damavand Mountains. The colors of this travertine are varied and include red, yellow, orange, lemon and brown. The mine features and miniature and smooth layering, which are the result of sedimentation in the region old springs, have given Travertine a special beauty (Fig. 16 a, b).

Stop 14. The stone crypt of Kafer Keli (35°53'23.87"N - 52°11'48.70"E)

Along the Haraz road from the Ab-Ask village to the Panjab village, on a way with 42 kilometers length, in heights overlooking the valley, as well as in several sub-valleys, about 250 hand-carved rooms are located in the rock. These caves have been used for temporary or permanent living or as a defense and surveillance complex. The crypts are hand-carved architectural spaces towards Amol, and were formerly built by a group of residents in the Larijan area at the rocky cliffs on the Damavand slope in volcanic ash and lahars. From the bottom of the mountain and along the road, the Kafer Keli looks like inaccessible holes. Most of these hand-carved colonies have several rooms with light entrances, surveillance locations,

restrooms in upper floors and kitchen. The traffic between the floors was made through stairs dug into the rocks and the good location of security guards and watchdogs provided security for these houses. These houses are now home to birds. They are dated as at least pre-Islamic and maximum pre-historic (Fig. 17).

Stop 15. Thermal Springs (35°54'21.01"N - 52°11'36.05"E)

Due to the specific geological conditions in the Alborz slopes, especially around the Damavand Peak, there are mineral waters with different therapeutic properties, the most important of which is in the Ab-Ask village, Larijan and Baijan. The hot mineral waters of the village of Rineh, Larijan, with a temperature of about 62 degrees, are rich in minerals and sulfur. The Larijan hot spring appears naturally located on the hillside of the Damavand. It has been used by the public for many years. This spring discharges thousands of liters per second. The melting of snow and the penetration of atmospheric water through the fractures of the volcanic rocks into the lower sections has caused hot springs in the area (Ansari, 2013; Saini et al., 2017; Fig. 18).

Stop 16. Embossed inscription of Shekl-e-Shah (35°56'50.49"N - 52°15'49.9"E)

The Shekl-e-Shah embossed inscription is a historical monument in the Larijan district of Amol city. At the Larijan district, a prominent inscription of the image of Shah Qajar and a number of Shah's companions was commissioned by Nasser al-Din Shah Qajar to represent him and a number of his companions carved along the historic Haraz road along.

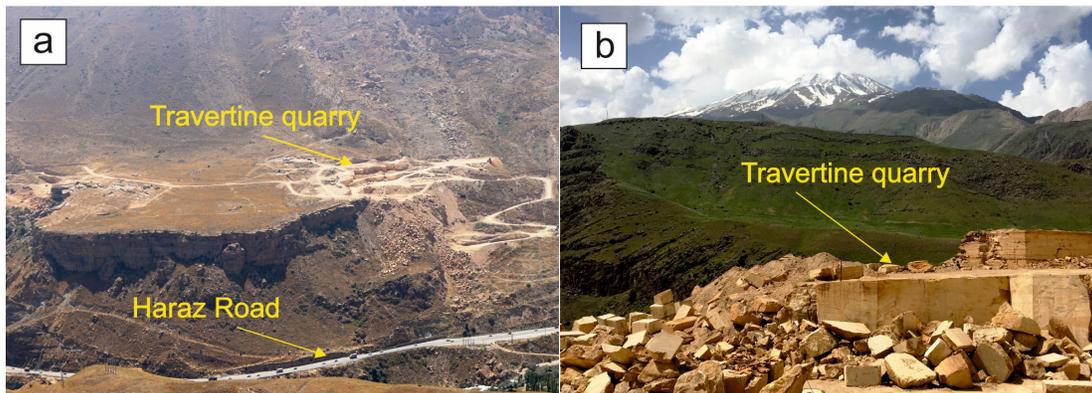


Figure 16. a) A view of travertine mine, and b) an overview of the active extraction of stone blocks at the Ab-Ask Travertine Mine (south view)



Figure 17. The Kafer Keli crypt of the Haraz road, west of Ab-Ask village

This embossed inscription is seen in a rectangular bed, in limestone adorned with poems on the frames. In this picture, Nasser al-Din Shah on horseback in the middle and ten of his companions are shown on both sides standing ministers (Fig. 19). The relief is carved within a rectangular frame 8 m long and 4 m high and with a depth of 130 cm. It is located on the Haraz road overlooking the Haraz river about 60 km from Amol in Mazandaran Province, Iran. It is close to an ancient Sassanid road. The work was ordered after the new road was built in 1879 (Yazarlou, 2015).

Stop 17. Shahdanasht Waterfall (35°54'31.67"N - 52°15'27.21"E)

The Shahdanasht waterfall is the largest waterfall in Mazandaran province. This waterfall is located in the south of Shahandasht village (waterfall is distance 65 km from Amol City) and overlooks the road. This great, permanent, and massive waterfall overlooks the magnificent south side of the Haraz road and Haraz River. The waterfall is composed of 8 waterfalls that are approximately 180 m in height (Fig. 20a).

Stop 18. Filband Forest and Mirza kocek Khan Forest Park (36°18'21.58"N - 52°21'49.90"E - 36°9'48.86"N - 52°30'38.86"E)

The end of Route 77 leads to the Caspian Hyrcanian mixed forests. It is a bio-region in the ecosystem of mixed broadleaved forests of the southern Caspian Sea, covering an area of 55.000 square kilometers, located in the southern and southwestern coasts of the Caspian Sea in some parts of five Northern Provinces of Iran and in both Iran and Azerbaijan countries. It is one of the most valuable forests in the world, dating back to 40 million years and is known as the Natural Museum. The Filband Forest is one of the most beautiful forests of the remaining Hyrcanian forests. From spring to autumn, the forest has beautiful landscapes that attract many national and international nature lovers. This forest is located near the city of Amol. Species of deciduous and evergreen trees are found in this forest (Fig. 21a.). Mirza kocek Khan Forest Park is located 20 kilometers away from the Amol city, Mazandaran province, on the Haraz road, and features camping facilities. (Fig. 21b).

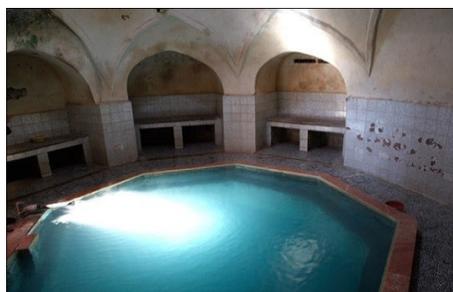


Figure 18. Water treatment basin of Rineh, Larijan fed from mineral hot springs



Figure 19. Embossed inscription of Nasser al-Din Shah



Figure 20. Two different views (a) and (b) from Shahandasht waterfall along Haraz road



Figure 21. a) Mirzakocheh Khan Forest Park and b) Filband Forest

Conclusion

The Haraz Road has abundant potential for expansion of the tourism industry, in particular, geotourism. This road is one of the most beautiful route in Iran that has interesting geological processes and phenomena. The Haraz road cuts across different geological units and formations of Iran. Along the way, the outstanding Damavand Peak can be seen from different locations.

Geotrail (roadside tourism) is one of the most refreshing tourism for different people, including families traveling to different cities. Meanwhile, the Haraz Road has one of the most beautiful and geodiversity, geography, religion, history, and ecology. Along this 180-kilometer road, we encounter various phenomena ranging from mountains, jungles, glaciers, dams, ski resorts, pilgrimage centers, and tourist sites to mines and protected wildlife parks. The beauty of the road, both the inanimate and the vibrant nature, has attracted a broad audience as roadside tourist. These attractions are for geologists, biologists, archaeologists, hikers, skiers, and others.

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