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Treptichnus pedum, a paleontological Geosite, in at central alborz, Iran

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Abstract
Paleontological sites and fossil discoveries are types of geosites that have a high potential to be introduced as paleontological tourism sites and can be defined as geological tourism and places of geological heritage value. One of the exciting places is Soltanieh Formation which is an opportunity for those interested in geological history to visit. The lower and upper shale members of the Soltanieh Formation in Garmab region, due to the presence of various trace fossils such as the *Teriptichnus Pedum* index Ichnofossil is considered one of the paleontological sites with high potential for tourism in Central Alborz also, the spectacular exposure of the Precambrian sediments on the Cenozoic sediments by the operation of the Mosha fault has added to the value of this site. This site is an open-air paleontological site that should be subject to earth protection measures. In Iran, Geological Survey and Mineral Explorations of Iran (GSI), has a high potential to preserve Iran's geological heritage, which can have a practical activity in this basin.

Keywords: Geotourism; Central Alborz; Paleontological tourism; Trace fossil; *Treptichnus pedum*.

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1. Introduction

Geotourism is a form of nature-based tourism with a specific focus on the geosystem (Newsome, 1112) and geological features (Dowling,). This science is essentially 'geological8ourism' (Dowling,). It follows from these definitions that the aim of the "geo" or geology part of geotourism is the geological features that are attractive to tourists. Like the unique geology and raw nature of some countries (Ólafsdóttir,) Landscapes of high relief (Newsome, 2222) Land scapes, Coasts,Mountain ranges and Mountains, Weathered landforms, Rock outcrops (jointing, strata, folding, faulting), Meteori te impact sites, Site fossils, (Newsome,), and many Geological Formations, that have attracted the attention of many tourists (Ólafsdóttir, 1118). The insight that geotourism provides to understand the environment and Geology Fig (1), indicates the importance of information ,(Dowling, 1111) and important factors such as like Fossils,Type of rocks, stratigraphic type sections, biostratigraphy, Lithostratigraphy, tectonic features, mineralizations and etc., which is also effective in dividing geosites and Based on them, different geological geosites are determined, such as Paleontological site, Paleoenvironmental site, Petrographical site, Stratigraphical site, Mineralogical site, Tectonical site, Economical site and etc.are determined (Raveloson, 8888). Most geological tourists are professional or amateur geologists who travel with a focus on geology, and a percentage are general tourists who are interested in geology and its phenomena (Dowling,).Geotourism can be a powerful tool for sustainable development but, if not managed effectively, can constitute a direct threat to Geoheritage resources (Newsome, 2222).

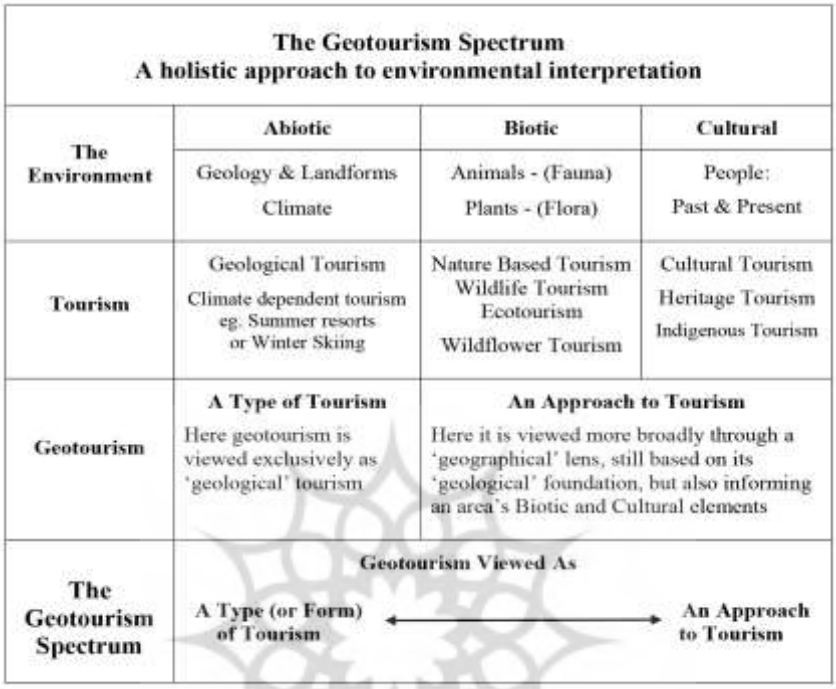

Figure 1. Geotourism spectrum (Dowling, 1111)

111. Paleontological site

Paleontological site, Places are defined where fossils can be seen and studied, these places, which are the stratigraphic units and geological formations, are one of the most popular geotourism which their protection has many complications (Blasi, 1111). Fossil sites, in addition to being interesting places for recreation and tourism, a valuable basis for the development of local tourism (Antczak, 0000), a natural cultural monuments (Carvalho, 8888) and often places are introduced for scientific tourism. Paleontological scientific tourism is type of geological tourism and Paleontological geosites are Educational sites for schools, researcher and scientists (Avila et al., 00). They the scene of education, display and dissemination of scientific results and extensive research (Constabel,) which offer clarity perception the history of life on Earth (Tomić et al., 5555). Most of the Paleontological sites are located in Open-air paleontological sites which make their protection difficult. Since geosites are places of special geological importance, rarity or beauty that represent the

geological history, geological events and processes of the region (Santangelo,) they can also be studied in the scope of Geoheritage. Undoubtedly, paleontological sites are classified according to the importance of the genus and species of fossils, and this value and prestige is equal to the value of the fossils that can be seen in the area, such as Treptichnus pedum, which has global value and attracts the attention of tourists and paleontologists all over the world. The world attracts.

222 Paleontological tourism

Paleontological tourism is a type of geotourism that is defined based on the presence of animal and plant fossils. Visiting fossil collections as one of the geological attractions has long been the main focus of Geotourists. Based on its activity and importance, the development of scientific geographical heritage tourism or creative paleontological tourism has been considered in modeling, geotourism planning and tourist branding (Staneva,). Paleontological tourism has three categories: the simple visit to a museum, or Classic Paleontological Tourism (CPT); the visit of site museums, or Externai Paleontological Tourism (EPT) and the Alternative Paleontological Tourism (APT) That In the site, direct participation in paleontological activities are carried out between visitors and paleontologists (Perini and Calco, 8888).

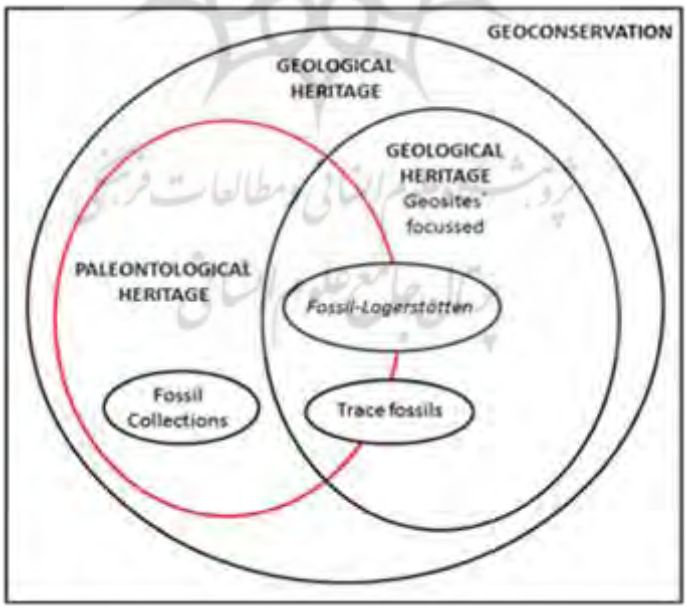

Figure 2. Educational communication Geoconservation (Henriques, 5555)

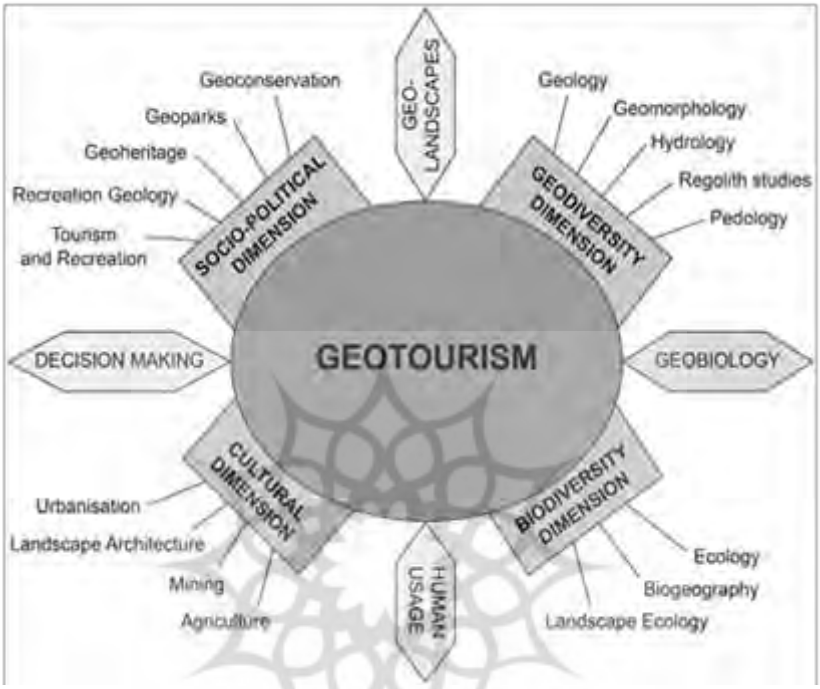

Figure 3. The four major dimensions of geotourism (Newsome, 2222)

2. Literature review

The land of Iran is in the middle part of the Alpine-Himalaya mountain range, which starts from Western Europe and continues after passing through Turkey, Iran, Afghanistan to Tibet and near Burma and Indonesia (Aghanabati, 6666). Iran has diverse sedimentary, igneous and metamorphic geological structures of different ages, such as Alborz and Zagros, etc., which are the result of fundamental forces that continuously affect it (Ghorbani, 3333). However the geological position and crustal structure of Iran during the Precambrian period have always been of interest to Iranian geologists. So far, the Archean and lower and middle Proterozoic lands have not been observed in Iran, but there are Upper Precambrian or Neoproterozoic outcrops in Iran (Ghorbani, 4444). In the meantime, one of the formations attributed to the Precambrian and Cambrian is the Soltanieh formation. Soltanieh Formation with numerous fossils like, Acritarchs, Small

Shelly fauna and Trace fossils (Hamdi, 5555) and ECT. the a diachronous Formation attributed to the Precambrian - Cambrian and is one of the most extensive rock units that has numerous outcrops in various sedimentary structural zones of Iran, such as Alborz - Azerbaijan, Central Iran, Fig, 4 (Aghanabati, 8888).

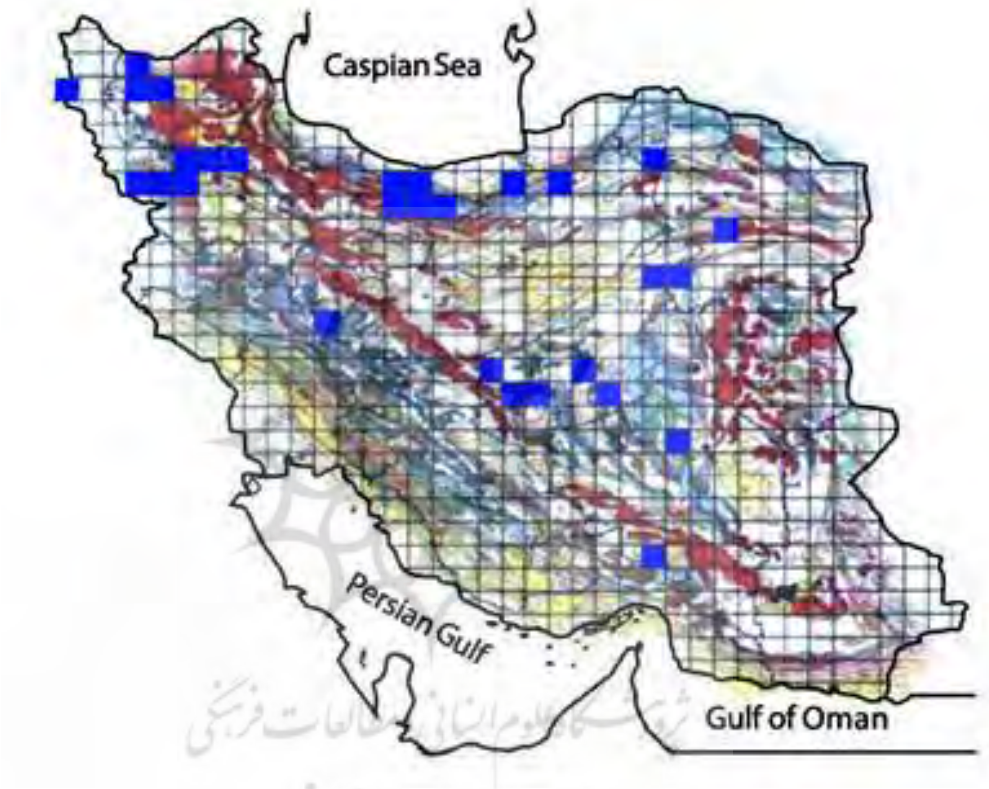

Figure 4. Geographical distribution of Soltanieh Formation in the scale of geological maps :: 000,000, Aghanabati (8888)

111. The Soltanieh Formation

Type section of the Soltanieh Formation with millions of years old is located ridges east of the village of Chapoghlu in the Soltanieh Mountains (Stocklin et al. 2222). Soltanieh Formation is widely distributed in the Alborz Mountains and parts of east and central Iran Fig (3), and was subdivided by (Stocklin et al., 4444) Into the following three prominent Members: Lower Dolomite Member, Lower shale Member and Upper Dolomite Member

(Hamdi, 9999). But then with more detailed studies by (Hamdi, 3333). This organization was divided into five distinct Members: Lower Dolomite Member, Lower Shale Member, Middle Dolomite Member, Upper Shale Member and Upper Dolomite Member. This Formation has Trace fossils especially the fossil assemblage *Treptichnus Pedum*, one of the world-famous trace fossils, (Hamdi, 5555); (Ciabeghodsi, 6666); (Tashayoei, 2222); (Shahkarami, 7777); (Famarini Bozchalouei, 0000).

222 Fossil and Paleontology

Fossils are a familiar name for the general public and the basis of fossil geosites. Fossils are non-renewable resources obtained from the ancient history of Earth's life over billions of years and recorded in sedimentary deposits (Henriques, 5555). They are the remains and effects of plants and animals that lived in the past geological time (Neuendorf, 5555). The important role of fossils for understanding the origin of the earth, investigating life in geological time, climate change, biodiversity, evolution and extinction of organisms, and identifying oil and gas reservoirs (Benton, 9999). It has made many scientists interested in studying them in the field of paleontology, which is a path between biology and geology (Zavarei, 7777).

333 Ichnology and Ichnofossil

Ichnology is the study of vital trace of living organisms (animals and plants) such as: burrows, track ways and boring substrate. This science related to paleontology, biology, sedimentology and Stratigraphy (Buatois, 1111). Ichnofossils or Trace fossils are sedimentary structures that a series of fossilized track, trails, burrows, tube, boring, tunnels resulting from the life activities (other than growth) of an animal, and Signs and marks made by an invertebrate moving such as creeping, feeding, hiding, browsing and running which are formed on or in sediments (Neuendorf, 5555).

444 Treptichnus pedum

Treptichnus pedum, as index fossil for the base of Cambrian (Gougeon, 1111) and Precambrian–Cambrian boundary (Narbon, 7777); (Seilacher, 5555); (Buatois, 3333). The role of this fossil in the topics of ichnotaxonomy, behavioral significance, facies controls and stratigraphic occurrence (Buatois, 8888) which It has made it a well-known fossil around the world. This feeding burrow (Crimes, 7777) is division into modular segments, Figure (5), that look like buds along a branch (Seilacher, 7777). This burrow system probably produced by priapulid worms (Vannier, 0000).

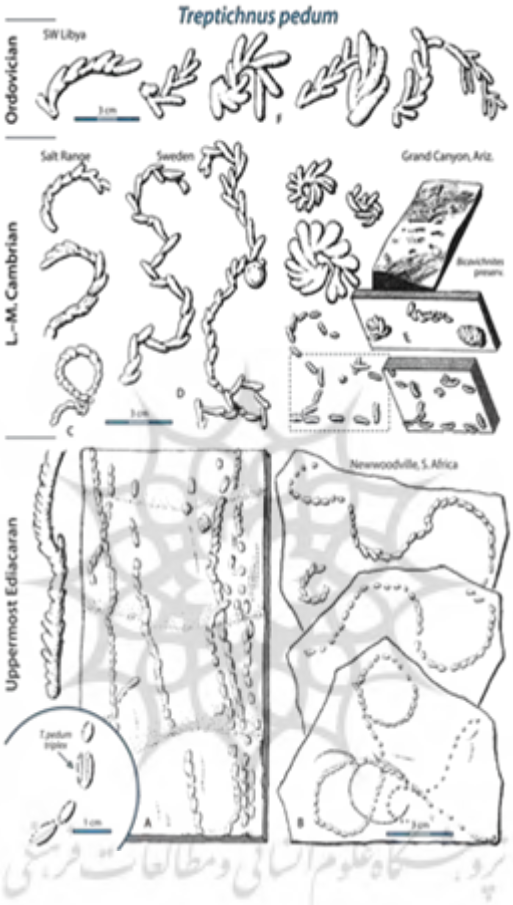

Figure . Treptichnus pedum at a glance (Seilacher,).

. Research methods

In order to study biostratigraphic studies and introduce a paleontology Geosite in the Soltanieh Formation Fig ( ) located in Garmab region, 444 samples of Trace fossils with 00 slabs containing 33 specimens of Treptichnus pedum from Lower and Upper Shale Members Fig (8, 9) of Soltanieh Formation was gathered and after washing and photography prepared for paleontological studies, and the final results were extracted after library studies and several field studies. In this research, our research approach has been formed in the development of a particular attitude toward the place of fossils in the field of Geotourism, Palaeontological scientific

tourism and also their protection. It has been tried to organize the specialized material of paleontology in simple scientific language (Constabel,) for introduction in the Paleotourism field.

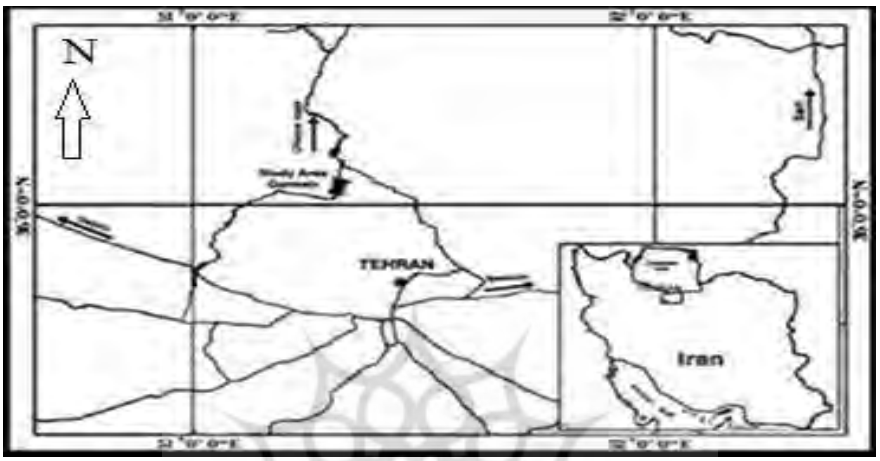

Figure 6. Road Map of study area

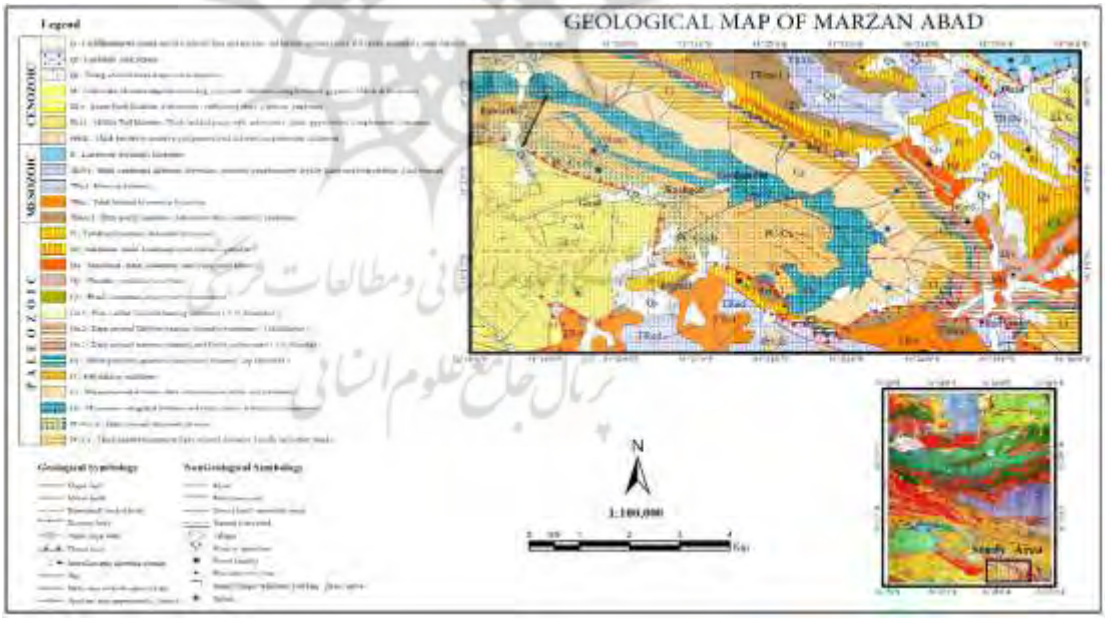

Figure 7. Map of study area (Vahdati Daneshmand, 1111)

4. Result

Significant deposits of the Soltanieh formation Fig (8) are exposed in the Garmab region, located on the Chalus road, and are easily accessible for visiting and studying. This outcrop is along Tehran-Chalus road with geographical location (E°°° ′′′′′ ′ and N000333333) in Alborz Province. From the fossils examined at site, the following can be mentioned:

Small Shelly Fossils (SSFs): *Anabarites tripartitus*, *Anabarites latus, Anabarites rectus, Conotheca subcurvata, Cambrotublus* sp., *Obtusoconus rostriptutea, Hyolithellus vladimirovae, Jakutiochrea lenta, Siphogonuchites triangularis, Latouchella korobkovi, Yunnanodus dolerus, Drepanochites dilatatus, Protohertzina anabatic, Protohertzina ungulifrmis, Protohertzina siciformis and etc*. and Trace Fossils*: Treptichnus pedum, Gordia mariana, Planolites annularius, Neonereites uniserialis, Trichophycus venosus Hormosiroidea* isp. *Trichophycus venosus, Palaephycus* isp. *Treptichnus palmatum, Planolites aunularis*, *Helminthopsis* isp. And etc. (Tashayoei, 9999, 7777).Among the ichnofossil found in this fossil site, the study of the *Triptychnus Pedum* Ichnofossil was prioritized due to its importance in stratigraphic and sedimentary environment interpretation and studies.

Figure 8. Soltanieh Formation View of Southeastside

Figure . Upper Shale member

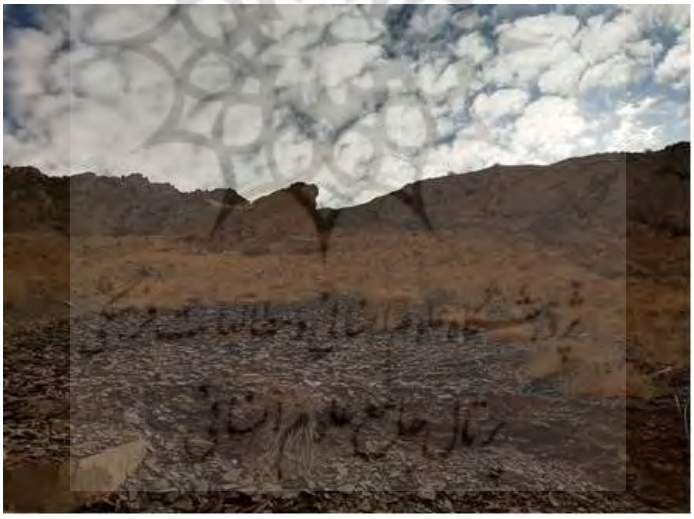

Figure . Upper Shale member, View of Southside

Figure 11. Lower Shale member, Eastside

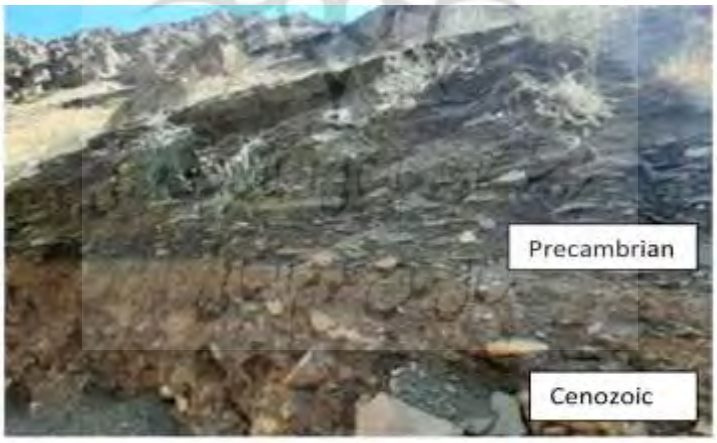

Figure 22. Contact Lower Shale member (Precambrian) with Cenozoic, View of South eastside

Based on the following influential factors, the studied open space paleontological site was introduced as paleontological geosite within the scope of geological heritage.

1-The presence of Trace fossils, especially the presence of the Index Ichnospecies *Treptichnus pedum*, Fig (33), as fossil in the introduction of Precambrian-Cambrian boundary (Narbon et al., 7777; Brasier et al., 4444; Landing, 4444).

2- A dramatic scene of two layers being placed on top of each other with millions of years' difference: due to the action of the Mosha fault in area the Soltanieh Formation, with Precambrian - Cambrian age (Black Shale, Silty shale, siltstone and Massive Dolomite) is situated on top of the Quaternary deposits, Fig (22), (undifferentiated young and old alluvial fans and terraces, Colluvium, residual soils, fill valley sediments, Lake deposits (Vahdati Daneshmand, 1111).

3- Location of the investigated area on Chalus tourist road: Chalus Road is an ideal road for geologists and nature lovers such as Different Geological Formations from Precambrian to Cenozoic, Amirkabir dam, Sepahsalar Waterfall, Yakh Morad Cave, Historical attractions of Shahristanak Village, Garmab tulips garden, Haft Cheshmeh Waterfall Etc.

In addition, walking on Precambrian (about 666 billion years ago) and Cambrian (888-111 million years ago) sediments is the most exciting part of the adventure like time travel earth history.

Figure 33. Ichnofossils *Treptichnus pedum*

5. Discussion and Conclusion

Places where exciting fossils are found are highlighted as places with high research potential for geologists' education and research (Hose, 2222) and tourist area for Geotourists and non-geologists. Today, the interest in fossils and the history of life on Earth has made paleontological sites more interesting than ever but these valuable resources are rapidly disappearing due to various reasons (Tomic, 4444).Therefore, paleontological sites have been introduced as one of the most important recreational-scientific places to visit, which should receive special attention and be included in the geological heritage collection, because the discussion of land protection in the territory of geological areas is a vital issue which has been the focus of paleontologists and earth science thinkers. Considering the important position of fossil sites in the discussion of earth protection, Figure ( ) the lack of proper management of the geotourism industry, which is a powerful

tool for sustainable development, can be a threat to geographic resources (Newsome, 2222) and geological heritage. But Fortunately, the relationship between humans and the earth and the mutual influence of each in the life of the other has set a common future for them in the wide area of geological science in which concepts such as economy and society can also be traced which makes her take a broad and deep view Fig (3) of the subject of geotourism in this regard However Factor that constitutes the centrality of this interaction is human capital and its proper training. , in understanding and expanding the concept, Geoconservation, geotourism and sustainable development using effectively implement the potential of the created network. But Fortunately, the relationship between humans and the earth and the mutual influence of each in the life of the other has set a common future for them in the wide area of geological science in which concepts such as economy and society can also be traced which makes her take a broad and deep view Fig (3) of the subject of geotourism in this regard However Factor that constitutes the centrality of this interaction is human capital and its proper training. Undoubtedly, institutionalizing the teaching of the main principles and identifiers of earth sciences along with tourism interests in formal and informal education centers and tourism with special attention to factors such as political goals, intergenerational and intragenerational justice in the exploitation of land resources, initiates positive changes in the processes of preservation and Protecting the earth's resources and preventing its destruction and further improving the geological and environmental management systems, will make it more effective. The activity of earth science experts with support of the governing force, in designing the idea of reality and then the model of sustainable universities, can be a step towards creating new methods of education and laying the groundwork for publishing, culture building and creating skills to apply teachings in the people, as be the most important protectors of the earth. In order to educate the general public and familiarize them with the earth, in addition to providing an easy, understandable definition and away from any complexity of geology, environment, the importance of biological resources, management of the earth's resources such as water and its resources, it is possible to use the effective power of geotourism in changing the type of Their attitude to the land was effective. In today's world, with the progress of science, understanding and explaining the attractive features of the earth and nature with more precision, planning and an intelligent plan for scientific tourism has been formed, which is always subject to change in the direction of more communication with the planet earth in this realm of strengths, weaknesses, Opportunities and threats can help us in the accurate assessment of tourism land situations and its proper management. The

methods of introducing the earth and its capacities to different sections of the society should be accompanied by activities aimed at the targeted training of earth science specialists continuously from education (schools) to higher education centers and related organizations. Centers such as the Geological Organization and Geological Associations, etc. can be determined as the most prominent effective space in strategic planning, knowledge promotion, supporting the elite community of geosciences, so that geologists and geoscience specialists, with the help of global experiences and support systems, in understanding and expanding the concept, Geoconservation, geotourism and sustainable development using Effectively implement the potential of the created network. Geological Survey of Iran, can be useful for geological tourists to form geological thinking in tourism to understand the importance of geological knowledge and geological heritage; in addition this important center can, to determine the basic, main and fundamental criteria for the introduction of geological sites for geological tourists and to have an effective activity in the field of preserving the geological heritage of Iran.

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