



The Geotourism Potential Investigations in Kashmar Area, Khorasan-e-Razavi Province, NE Iran

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Abstract

The remains of the natural and human activities in some parts of the earth register as geopark. Actually, geopark is one or more geological phenomenon which is important from ecology, history, culture and archeological view. The aim of the geotourism description in an area and creating a geopark is trying to keep the earth's inheritance and locality the economic of the area. Iran with an old history, diversity of the environment and a lot of geological phenomenon has a great potential in creating geoparks. From this point of view, we can divide it into the five geotourism areas which are as follows: North, South, East, West and Central part of Iran. The Kashmar township is an area which is located in the south part of the Khorasan-e-Razavi province in the Northeast of Iran. This area because of the nearness into the desert, is hot and dry. The area is rich of mines, hot-water springs and geological landscapes. In this research, we tried to introduce some examples of the geotourism features in the study area such as faults, mines, hot-water springs, Bejestan playa, Asyab-e-Khooshab valley, Kavir-e-Lut salt desert, Bijvard entrance, Sar-e-Borj waterfall, Sir and Ahoor Bam caves and Natural glacier.

Keywords: Geotourism, Kashmar township, Geoparks, Iran.

1. Introduction

The term Geotourism is essentially taken to mean 'geological tourism'. It encompasses tourists looking at natural landscapes including the landforms and rocks, as well as processes that shaped them over time. The earth's geological wonders have always fascinated people and are a fundamental part of a culture's identity. Many also form the basis for the establishment of protected areas and world heritage sites. The main aim of establishing geoparks is to preserve and protect of the earth's heritages against menaces made by diverse human activities [5].

It is not just spectacular landform either, but also the processes which have shaped the earth. So tourists also visit sites where glaciers are in action, volcanoes are active, sand dunes are sculpted and rivers are causing erosion and etc. It is the understanding of this "form-process relationship" that is important in geology and by extension of geotourism. Through geotourism, the relationship is explored and the consequences of geological landforms and activities on our lives are more fully understood [4]. Tourism sector is among the most successful industries in the world, since it involves considerable results and achievements

among which one can name: making the scientific-cultural development, earning great incomes, direct and indirect employment rate increase. In the world today, tourism has adopted a broad approach towards the issue of ecotourism. In some cases, some tourism experts mention this industry as a factory with no smoke. The people tired of urban and mechanical life are always looking for a way out till they may spend a moment far from all the fuss and day-to-day living of the modern life. Due to the great geodiversity, biodiversity and also many historical and cultural attractions, Iran has suitable condition which when used properly would help to establish and develop geoparks [5]. Iran is one of a few countries in the world that due to its geographically superior status enjoys a wide variety of beautiful natural and geological graces and therein Kashmar can be considered as the gate to Iran's geotourism as well as Qeshm island that is introduced as the first for the this aim [7] & [14]. The main items in geotourism potential investigations are described as follow on the case study of Kashmar township.

- Previous geotourism studies in Iran

The previous works and activities in introducing the Iran's geotourism potential are done on the Qeshm Island [7], Chabahar region [14], Damavand region [9]. Also, general investigations in the great Khorasan are

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carried out by the Geological Survey of Iran (GSI), Northeast Territory in 2001. Nowadays, new investigations on each provinces of Iran is introducing and describing by the National Geosciences Database of Iran (NGDIR) with accompany with the Geological Survey of Iran (GSI) in the North, Central and the South parts of Iran as well as in the East and the West parts [7], [12] & [5].

2. Geological Setting of the Studied Area

Kashmar township is located 220km far from Mashhad city. This township linked to the Neishabour township from the North, to the Torbat-e-Heydarieh township from the East, to the Gonabad township from the South and to the Sabzevar township from the West. Its height from the sea level is 1052m. The north parts of this township are mild because of the mountains and the atmospheric condition, although the South parts are in desert condition. The related towns into the Kashmar township are the Bardaskan township and Khalil Abad township from the west, Kooch Sorkh township from the north.

The studied area is located in the northeast of Iran. The mountains chains are limited this area from the north and also the South part and are continued to Afghanistan border. The strike of mountains is from the southwest to the northeast in this region. The shape of mountains is like convex shape which is formed according to general strike of Darouneh fault. The tectonic units of the Kashmar area are as follows [1] & [2]:

The Lut block in the south of Darouneh fault, the Taknar zone which is located between the Darouneh and Taknar faults, the Sabzevar zone which is located between the north of Darouneh and Taknar faults, the Binalood zone which is located in the North of Sabzevar zone.

The most important outcrops and formations in the area are described as follows: the Taknar tectonical inlier, the Taknar Formation, the Soltanieh Formation, the Lalun Formation, the Milla group, the Sibzar and the Bahram formations, the Shishtu, Sardar and Jamal formations. Also, from Triassic to Cretaceous and Tertiary deposits are developed in the area as well. From the stratigraphic and structural zone's view, these formations are belonged to the Central Iran structural zone [8] & [11]. A brief description of each part is explained bellow.

3. Material and Methods

For the investigations and introducing the area from the geotourism potentials point of views, the field excursions and sampling (from rock units, Hot-water springs and etc.) are done in the different seasons in three years from 2007 to 2010.

- The stratigraphy of the Formations in Kashmar area

3.1. The Taknar Formation

The outcrops of the Taknar Formation is located in the Taknar tectonical inlier and composed of rhyolite, Precambrian tuffs with accompany of sandstone and dolomite. These rocks are affected by a low metamorphism which a granitic and diuretic complex intruded into it. The age of this formation is considered as Precambrian (Riphean-Vendian). This formation divided into three members [1] & [3].

3.2. The Soltanieh Formation

The Soltanieh Formation is composed of dolomite and shale with alternations of cherts, white to yellow limestones, dolomitic and sandy shales. The motioned formation is located in the west of the Taknar tectonical inlier between the Dahan Ghaleh and the Darouneh area. The total thickness of this formation is measured about 200-250m. According to the macro and micro fauna, the age of this formation is considered as Early Cambrian [2] & [3].

3.3. The Lalun Formation

There are a few sandstones in the Taknar tectonical inlier between the Dahan Ghaleh and the Darouneh area and the outcrops are located in the Northeast of the Rivash village. The lithology of this formation is only composed of sandstone. The age of this formation is considered as the upper part of Early Cambrian [2] & [3].

3.4. The Milla group

There are series of rocks in the west of the Taknar tectonical inlier as well as in Northeast of the Rivash village which are comparable with the Milla group. This group is composed of the thick-bedded dolomite and red to green marls. The age of this formation is considered as the Middle to the Late Cambrian [1] & [3].

3.5. The Sibzar and Bahram Formations

There is a big amount of the Devonian deposits in the South of Kashmar area and also there are same deposits (dolomite and limestones) with the same stratigraphical position in the South of Kalateh Jomeh village. But some geologists believe that there are no Devonian deposits in this area [1] & [11] with the latest stratigraphic and paleontological investigations which have been done in the recent years, it became clear that there are Devonian deposits in the mentioned area [2] & [3].

3.6. The Shishtu, Sardar and the Jamal Formations

There are some layers which composed of shales and sandstones that are comparable with the Shishtu Formation (Frasnian-Visean) and the Sardar Formation

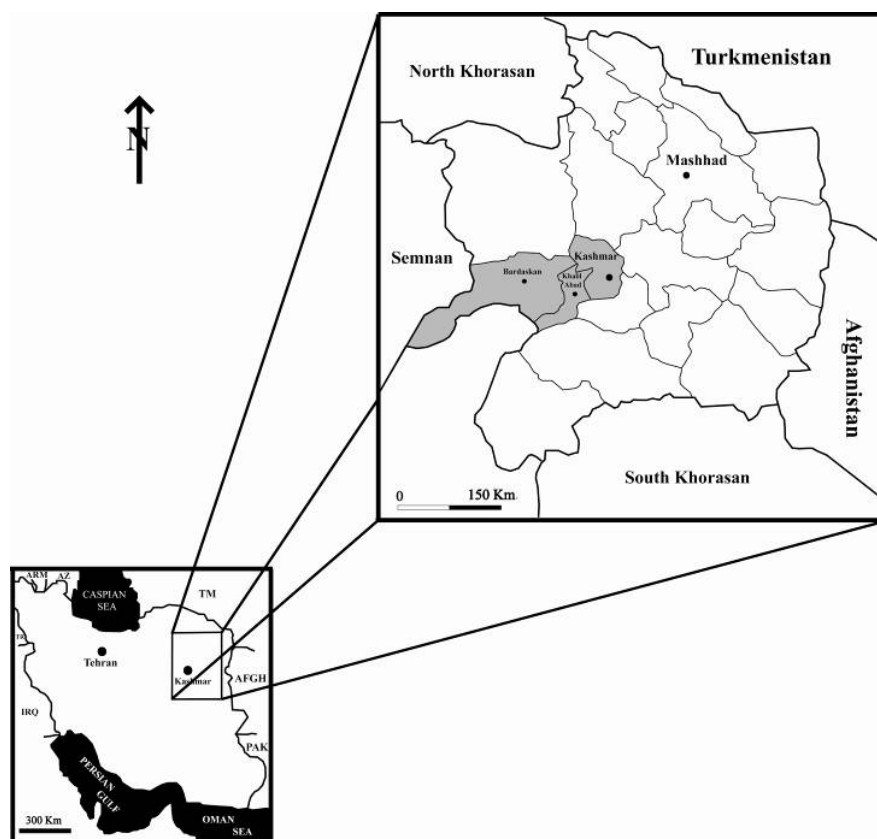


Fig.1. The location map of the studied area.

(Lower Carboniferous to the Upper Permian) near to the Kalateh Jomeh and in the Southwest of Sir villages. The thickness of these deposits near the Kalateh Jomeh village is 26m and near Sir Village is 130m. A carbonate sediment series of the Jamal Formation has created a range of mountains in the South border of Precambrian uplifted Taknar tectonical inlier as well as in the South part of Sir Village. The thickness of these sediments is over 100m. The stratigraphic and paleontological boundary between the Sardar Formation into the Jamal Formation is considered as continued in spite of the Hercinian orogeny between the Carboniferous-Permian boundary [2], [3] & [11].

3.7. Triassic and Jurassic deposits

In spite of the other parts of Central Iran, there are no Triassic depositions in this area and sediments aren't developed in the mentioned area as well. The Jurassic deposits which are included of shales and sandstone and are located between the Dahan Ghaleh and the Darouneh area. Also, there are green shales in the South of Kalateh Jomeh which are related to the Jurassic as well as in the South of Bardaskan township [2].

3.8. Cretaceous deposits

The Cretaceous deposits have composed the main parts of the area. Big amount of these parts related to

the Sabzevar zone. The Lower Cretaceous sediments include massive limestones, marls and sandstones that created heights in the Taknar and Darouneh zones as well as Shesh Taraz region. By the way, there are Cretaceous sediments in the North of Rivash village. The Upper Cretaceous sediments include the benthic facies with volcanic rocks which consist of fine-grain pyroclastic, andesitic and dasitic lava. Also, there is an Ophiolite mélangé which is located in this area and includes radiolarite, cherts and *Globotruncana* limestone [2].

3.9. Tertiary sediments

The most parts of the area are covered by the Tertiary sediments. These sediments include of green marls, sandstones, conglomerates, tuff and volcanic rocks [1] & [2].

4. The Main Geotourism Potentials in the Area

4.1. Taknar tectonical Zone

It is introduced as the Taknar inlier and is a narrow uplifted of Precambrian, Paleozoic and Mesozoic as well as Cenozoic rocks. The structure of this zone is Anticlinorium from the West to the Southwest and from the East to the Northeast direction with over 80 km length and over 10 km width [3].



1. Garmab Hot-water spring (Northeast of Khalil Abad township)



4. Waterfall (Northeast of Khalil Abad township)



2. The first pathway to the Garam Hot-water spring through the Igneous rocks (Northeast of Khalil Abad township)



5. Geomorphological phenomena (Kooch Sorkh township, provided by GSINET)



3. Ankolitic limestones in the Early Permian (North of Bardaskan township, provided by GSINET)



6. Iron bodies (North of Khalil Abad township)



7. Sandstone layers which are intruded and cutted by Dyke (North of Kashmar township, provided by GSINET)



10. Soorakh Sang area (Kooch Sorkh township, provided by GSINET)



8. Red Castle (Kooch Sorkh road, provided by GSINET)



11. Two windows entrance of Sir Cave (Bardaskan-Sabzevar road, provided by GSINET)



9. Entrance view of Sir Cave (Bardaskan-Sabzevar road, provided by GSINET)



12. The transition between the Sardar and the Jamal Formations (Bardaskan-Sabzevar road, provided by GSINET)



13. Cliffy limestones of the Jamal Formation and the entrance of Aho Bam Cave (Bardaskan-Sabzevar road)



16. Limy samples in Aho-Bam Cave (Bardaskan-Sabzevar road)



14. Stalactites in Sir Cave (Bardaskan-Sabzevar road)



17. Folding in the Cenozoic deposits (Kooh Sorkh road)



15. Shahr Abad Desert (Near to the Bardaskan township)



18. Pyroxene-Andezite with Shear joints (Shamkan, North of Kashmar township, provided by GSINET)

4.2. Darouneh Fault

Darouneh fault or big desert fault has about 700km length and is located in the Darouneh area which is on the Southwest of Kashmar region and it is extended till Afghanistan boarder. Darouneh Fault is the biggest Quaternary Fault in Iran. The displacement of Darouneh Fault is about 100km as well as Harat Fault. Along this fault, the blocks have a dextral and senestral displacement and one of the latest movements of Darouneh fault is dextral movement. This fault is named as "Darouneh" before Torbat-e-Heidarieh town and after this town till Mashhad city it is named as Sangbast Fault. After Zagros Fault, Darouneh Fault is one of the important linear structures in Persia. A lot of earthquakes have occurred along the Darouneh Fault and caused the huge destruction near the Kashmar township in the winter of 1998 and also in the spring of 1999. These earthquakes had a magnitude between 3.5–5.4. The most important earthquake in this area had occurred in 1998 between Kashmar and Bardaskan townships. Darouneh Fault has a big role in changing of crust's structure in the Iran plateau. According to the evidences, the activity of Darouneh Fault is aseismic and has creep and swarm activity. The biggest activities of Darouneh Fault are occurred in the central and eastern blocks [11].

The shape of water ways around Darouneh Fault especially in the West and the East of this fault is Sigmoidal (like S and Z), The east side of this fault is (Z) shape. With becoming near to the center of Darouneh Fault its system turns to reverse system. The evidences of this event are changing the shape of the water ways. According to the latest data we can recognize that the tectonic of the area is active [8].

4.3. Alluvial fan deposits

The alluvial fan deposits have covered the most parts of the area. According to the size and the rate of distribution, this is the main morphologic shape of the area which consists of rocks, gravel, sand, silt and clay. The thickness of alluvial fan is changing from few meters (near to the mountains) to hundred meters (in the central parts) [11].

4.4. Erosional forms and statues

Abundance of weak and not resisting beds and their alternation with more resisting ones, results in the formation of erosional forms. In other words, intense erosion in some parts and the survival of more resisting parts is the main cause of such formations [6]. Of course, these phenomena can be observed in the homogeneous layers as well and the cause behind this is the direction in which erosion factors work such as wind, sunshine, slope and flow of rain water.

4.5. Hot-water springs

The other phenomena which are so important in tourist aspect and also from the economical view are

hot-water springs. We can consider them as the main geological phenomenon which is distributed mainly in the North part of the area. These springs are created by active tectonic of the area which includes of the ancient volcanic and quaternary active fault (Darouneh Fault). There are a lot of hot-water springs along Darouneh Fault in granitic mountain ranges. We can recognize some of them in the North of Khalil Abad township (Garmab), in the North of Kashmar and also in the North of Kooh Sorkh township which are used by the residents of the area and not reported for the public usage. These springs could be introduced as the best source of curing skin diseases. It is for a long time that such springs are used because of their importance in curing diseases which is called "Balneology" in the world. In order to determine the main elements and probable contaminants, sampling was done from the Garmab Hot-water spring. The analysis of its water shows the high amount of Sulfur in the analyzed sample. The pathways (one of them from top of the mountain and the other one from the river) have very beautiful landscapes which are so attractive for the tourists and are not reachable by any vehicle and only by walking and climbing. The analysis of the Garmab Hot-water spring is as follows:

	M87/169	Units
PH	6.95	-
Total hardness	625.00	Mg/Lit
CO ₃ ⁻²	-	-
HCO ₃ ⁻	40.00	Mg/Lit
Ca (Hardness)	620.00	Mg/Lit
Mg (Hardness)	0.97	Mg/Lit
SO ₄	760.00	Mg/Lit
Cl	740.00	Mg/Lit
TDS	1784.00	Mg/Lit

4.6. Sir and Ahoo-Bam caves

Sir and Ahoo-Bam caves are located near to the Bardaskan township. These caves are Karstic cave. Such caves are landscapes which are underlain by limestone which has been eroded by dissolution, producing towers, fissures, sinkholes, etc. there are a lot of stalactites and stalagmites in these caves which can be interesting for tourists. The pathway is easy for approaching.



Fig. 2. The Geotourism potentialities plotted on the satellite map: 1- Taknar tectonical Zone, 2- Darouneh Fault, 3- Sir and Ahoob-Bam caves, 4- Erosional forms and statues, 5- Hot-water springs, 6- Alluvial fan deposits, 7- Bajestan Playa, 8- Taknar Copper mine, 9- Makki Kaoline mine, 10- Shahr Abad desert.

4.7. Bajestan Playa

This playa is one of the most interesting sedimentary environments in the world which can be considered as one the most important phenomenon in the area because of its seasonal lake property. It has 3725km width and is the second big playa in Iran. In spite of its geotourism value, it is important from the economical view because of the evaporate sediments which are exist in this playa [13].

4.8. The Taknar Copper mine

Taknar copper mine is located in the Northeast of Bardaskan township. It is 22km far from this township. This mine which is one of the most important mines in Iran was passive from 1977 but now it is active. It seems that the mineralization in this area is related to schists. The mentioned schists include of pyrite and magnetite. According to the layer shape of deposition we suggest that Taknar copper mine has a massive-sulphide type origin [8].

4.9. Makki Kaolin mine

This mine is located between the Kashmar township and Rivash village. This kaoline source is created by andesite alteration. In the surface parts there is a big amount of Iron-oxide. The deposition of this mine is about 7500t.

4.10. The other important mines

The other important mines which have the main role in the economy of this area are as follow: Dahaneh siah (copper mine), Zangaloo and Cheshmehgaz (copper mine), Kasf (copper mine), Tanoorche (Iron mine), Chalpoo (Arsenic mine), Kooh Sorkh (Kaolin mine), Khooshab (bentonite mine) and etc.

5. Results and Discussion

These important and attractive features can cause the local potential geotourism of this area to be improved considerably in the future as a global phenomenon. According to UNESCO's definition, geoparks has been defined as a geographical territory with well-defined limits that has large enough surface area to serve local economic development purposes. It comprises a certain number of geological heritage sites and may not only be of geological significance but also of ecological, archeological, historical or cultural value. Based on this, we may consider Kashmar region as a big geopark or a collection of several geoparks. The very important point here is the protection and preservation of the geological phenomena. Unfortunately, there have been numerous cases in which a phenomenon has been introduced and publicized to be visited while not considering the protective measures and this has caused seriously irretrievable damages and losses to that phenomenon.

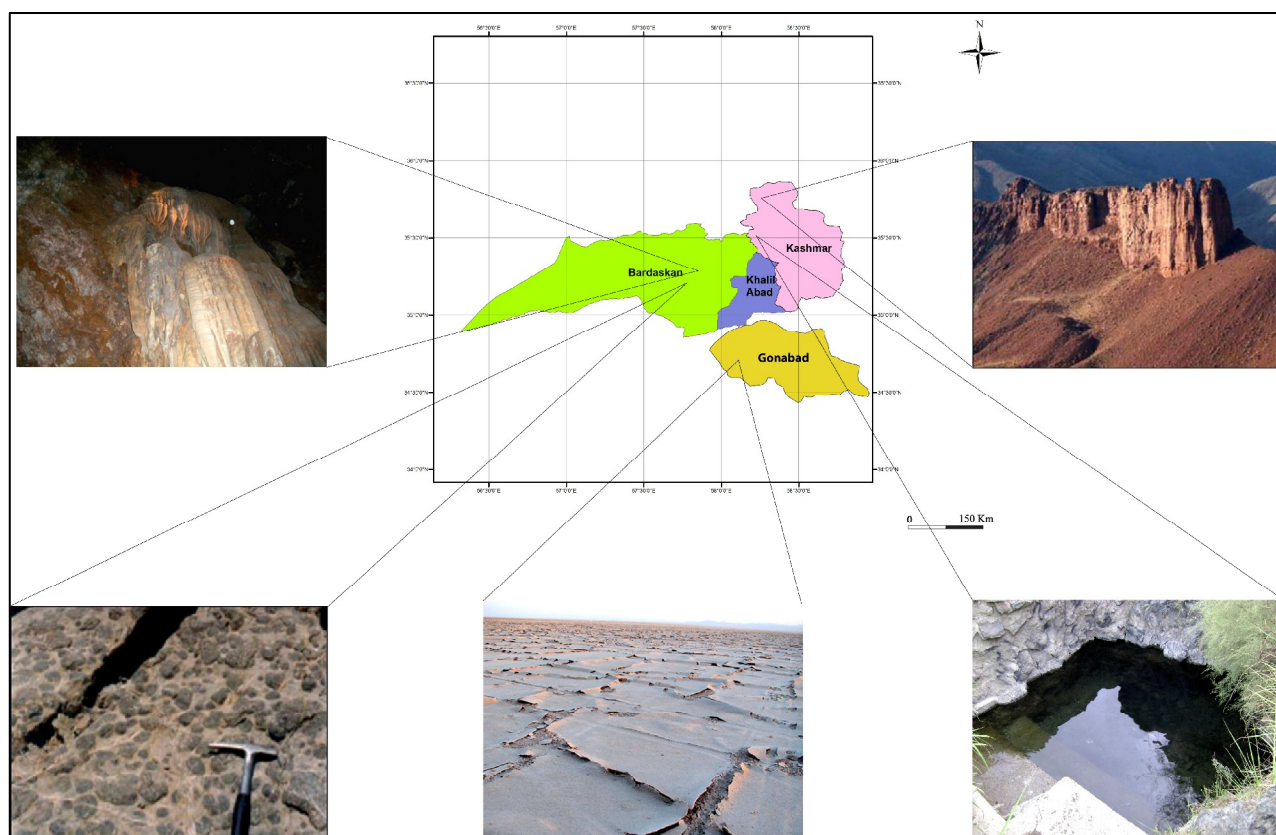


Fig. 3: Some distinguished Geotourism phenomena in a Geographical map.

To register a natural phenomenon on the list of the country's national heritage sites and subsequently on the list of UNESCO's geopark sites, we strongly need to prepare organizing, exploiting and protecting plans within the framework of the environmental considerations and definitions of sustainable development. We must also consider strongly to this point that disregarding the issue of protection and preservation not only prevents us from registering a phenomenon on the list of the world heritage sites, but also, even in the case of its already being registered, it may lead to its mission from the list, consciously or unconsciously. It is really important that authorities pay attention to this issue since it brings on them the heavy burden responsibility and duty for the present and future generations. It is upon us to diligently invest in this field and pave the ground for tourist activities through right policy-making and precise planning. The main geotourism potentials in the North east of Iran has introduced in this paper (such as Formations from the Paleozoic to Cenozoic, Hot-water springs, Faults and etc.). In this regard, we hope that this paper could be a beginning for the development and advancement of geotourism sector at a deeper level, in our vast, beautiful, and interesting with amazing landscapes, Persia.

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