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A Study on Karst Morphology Forms in Manjil Region of Gilan Province

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Abstract: The purpose of this study is The Study on Karst Morphology Forms in Manjil Region of Gilan Province. Due to geological features and quantity and type of rainfalls in Gilan Province and other effective factors on formation and development of Karst and Karst water resources, it is necessary to study karst morphology forms of this region. This study has studied Manjil region. It has first studied and identified karst forms of the region and then considered their formation in relation to the regional tectonic and creation of water potentials. Karst morphology forms of the region were identified and the cause of their creation was specified. Among them, Dorfak Mountain with an altitude of 2714 m in the south- central part of Gilan Province in Rudbar City near to Manjil can be mentioned as an example. Also Manjil Cheshmeh Bad Cave with an altitude of 1400 m above sea level is among other karst phenomena of the region and is regarded as the most important karst phenomenon in Asmari limestone.

Keywords: Cheshmeh bad cave, dorfak mountain, geomorphology, karst forms, Manjil, polje

INTRODUCTION

Morphology means presence of a network of holes by karst processes. So, morphology of a karstic region and subsequently its hydraulic features and conditions change in long term. Karst morphology is usually described in carbonate rocks like limestone, dolomite and marble. Due to high dissolution or carbonate minerals (particularly calcite) in acidic water, a similar morphology is formed in Silicate rocks and is called Pseudo-karst (Millanovic, 1988). The word karst refers to a set of phenomena caused by lime stones within and below the Earth's crust which mainly includes phenomena caused by stones dissolution. By development of karst, some forms with a special morphology like Sinkholes (Doline), Karen (lapiez), wells (Jama), caves, ponors (devourer holes), intermittent springs, lost rivers, karstic plains and multiple intermittent phenomena are appeared, these forms drive groundwater aquifers (Mahmudi, 2006). Sinkhole is the most diagnostic surface expression of karst landscape that is understandable widely all over the world, approximately 7-10% of the earth surface has been classified as the karstic areas. In the scientific literature, both doline and sinkhole are used in a broad sense which represents a closed pit that does not keep water, the word doline is mainly used in the European literature and represents forms related to karst. While sinkhole is mostly used in the North American literature for defining any kind of hole without considering its origin. Morphometric analysis of sinkholes has different aspects: a sinkhole may become a natural drainage into the underground or entrance of a cave that damages constructs; sinkhole has a geological and hydrological value and is a part of an integrated system that supports unusual species of plants or animals. There is no research regarding morphology of karst forms in Manjil region. This study is a necessary and new research in this regard since it studies tectonic conditions and karst morphology conditions of the region. Among karst forms, sinkholes are the main forms of the region. Furthermore, sinkholes are among forms that may be related to the karst subsurface forms and represent an indicator of presence of water flow in karst regions. So, to know karst subsurface forms, studying the formation and development trend and type of surface forms morphology seems necessary.

THEORETICAL BASES AND RESEARCH LITERATURE

Among Non-grained sedimentary rocks, lime stone is the most important one. In the forms composed of lime stone, the most important land form is karst. Albeit it must be noted that in the regions that are not prone to karst formation (hot and dry regions), rocky protrusions are seen in lime stone forms because lime stone is a hard stone per se. So, such mountains are hard and rocky and lack vegetation. But in humid regions, mile stone formations are karstic (Haririan, 1990).

Karst is geological formation that is created due to dissolution of layer(s) of soluble bedrock. This bedrock is usually carbonate rocks like lime stone or dolomite. However it has been reported that karst landform is created in the stone resistant to weathering like quartz

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under certain conditions. So, water is necessary in formation of karst landforms. Also, in karst landforms, unusual drainage system is seen. In the other words, in non-karstic landforms, waterways join each other somewhere while in karst drainage system, waterways are not linked to each other or there is a waterway that disappears suddenly in its path.

Due to subsurface movements of water in these formations, no river may be seen in the karst landform surface. In these regions, special karst forms like dolines, caves, ponor, polje, etc. are seen. However, none of the above mentioned phenomena may be seen in the landform surface where soluble bedrock has been covered by glacial sediments or dissoluble sediments (Haririan, 1990).

Chemistry of karsts: Karst landforms are caused by the effect of acidic water on soluble bedrock like lime stone or dolomite. Water with low pH starts dissolution of bedrock along fractures or weak areas of bedrock. So, karst formation is facilitated where there are tectonic activities due to creation of seams in lime stones. By more bedrock dissolution over time, areas of dissolution are developed and size of holes in the bedrock gets bigger and bigger and underground drainage system is created in this kind of land forms. Thus more water penetrates into this kind of formation and different karst forms are created.

Mechanism of dissolution: Mechanism of formation of these land forms is that rainwater dissolves carbon dioxide when passing through the atmosphere and weak carbonic acid H2CO3 is created. So, to create acidic water, dissolution of carbon dioxide in water is necessary. Besides water, carbon dioxide plays an essential role in the formation of karst landforms. Since dissolution of CO2 in water is increased when whether gets cold, probability of karst landform creation is increased in lime stone formation by altitude increase due to colder weather. With the entry of water into the soil, water may dissolve more carbon dioxide and so more acid may be produced in water. Existence of vegetation in the soil plays an important role in formation of karst landforms due to production of carbon dioxide by plants root (Mahmudi, 2006).

Karst morphology: A karstic landscape may create large and small forms on the surface or under this kind of landform. In the external surfaces of these landforms, small forms may include protrusions that are called lapiez. Medium forms may include sinkholes, cenotes or closed basins and large forms include polje and canyons. In the mature and old calcareous landscapes where a major part of bedrock has been faded away, karst towers or haystack/eggbox landscapes may be created. Below the earth surface, complex drainage systems and wide caves may be created (Ford and Williams, 2007).

Once the water containing calcium carbonate looses a part of its carbon dioxide, its calcium carbonate and other dissolved minerals may sink down and form stalagmite and stalactites.

It must be noted that the harder is the lime stone, the more is the probability of karst landforms formation; because soft rocks are crumbled quickly and different landforms are not created in them. That's why such landforms are not seen in gypsum formations because gypsum is not so much hard and it is broken down and disappeared.

Dispersion of karst masses in our country particularly karsts of dry and semi-dry regions have created various geomorphology forms in them; moreover, existence of limestone springs with high discharge are very important in supplying water resources of villages and towns near to karst masses. At the present juncture, over 85% of Iran southern towns supply their drinkable water from these formations (Afrasiabian, 1998). Among other important karst features, tourist attractions can be mentioned. In our country, there are beautiful waterfalls, basins and caves like Ali Sadr Cave in Hamedan and Katalekhor in the south of Abhar that attract tourists (Moghimi, 2005). Also water of karst resources is cheap because using karst water is cheaper than dam construction, if studied accurately.

Research background: Attention to the karst and its forms dates back to the old times, i.e., when the first humans lived in the caves. The first Greek theories regarding springs and underground water have been based on observations in lime stones of Greece and the first forums and towns have been formed by knowing karst in these places (Velayati and Khanalizadeh, 2011). The most karst attractions are in the Mediterranean basin particularly in dinaric mountains. As regards dinaric regions, some research has been carried out by Ford, Williams and Millanovic. The particular importance in extension of karst scientific thoughts owe three scholars namely, Grund, Katzer and Ballif and the famous geo-morphologist of Yugoslavia, Cvijic (Millanovic, 1988). The first karst studies in Iran have been started from 1971 in Zagros karst basins. However comprehensive studies commenced from 1990 by establishment of karst research center in Shiraz. This center started its research in Maharlu karst basin with an area of 4,200 km^2 and then extends its studies to other Zagros karst basins (Afrasiabian, 1998). On the other hand, some research has been carried out by such persons as Ahmadipour in Alashtar basin, Raeisi and Karami in karst springs of Gar, Barm Firouz, Moor Mountains in west of Shiraz, Rezaei and Zamani in north of Ardakan in Fars.

RESEARCH METHOD

Two descriptive-analytical and deductive methods have been used in this study. First, karst forms of the region have been studied and then their formation in relation with the region tectonic and creation of water

potentials were considered and deductive research method has been used in this section. Data has been gathered by documentary and field methods. In the documentary method, the required statistics regarding the climate have been used; and in the field method, GPS has been used to find the location of karst forms and then the data has been entered into Arc GIS software and the geomorphology map of the studied area was prepared.

RESULTS ANALYSIS

Geographical location: Manjil City has been located between 36° and 32 min to 37° and 7 min from the equator and at longitude 49° and 11 min to 50° and 5 min east from the meridian. Manjil has been located at an altitude of 396 m above sea level and at the last eastern part of Alborz Mountains on the right beach of Qezel Ozan and at 500 m to south of Manjil Dam and near to Qezel Ozan and Shahrud confluence point, at 80 km to Rasht and 100 km to Qazvin in the great Qazvin-Rasht road.

It is among foothill towns of Gilan and is located at the slopes of Alborz and Talesh Mountains along Sefid Rood River and olive gardens. Its climate is Mediterranean and it has moderate and slightly humid winters and hot and dry summers (Fig. 1).

Climate: Manjil City is the confluence point of moderate climate of Khazar, mountain climate of Alborz and dry and hot climate of central Iran and it has a unique weather. Also due to the confluence of these three climates, usually the wind blows with more intensity in spring and summer and with less intensity in autumn and winter. The average minimum and maximum temperatures of Manjil have been reported 7.2 and 31.1°C, respectively. Rainfall in Gilan Province depends upon humid winds that blow in winter from northwest, in spring from east and in summer and autumn from west. These winds drive humid weather of the sea towards Gilan plain. Collision of these air masses with moist air masses that come from Mediterranean Sea causes abundant and long rainfalls.

In general, the average relative humidity in Manjil is about 80% which can reach to at most 96% in October and at least 55% in July. The relative humidity in Manjil is maximized in autumn and winter and is decreased in spring and summer. The average rainfall is about 1506 mm per year. Rudbar and Manjil are regarded as among high lands of Gilan and rainfall in these regions are less than other parts of Gilan and so their relative humidity is less.

Geology of the region: The geological map of the region and type of soils in different regions has been shown (Fig. 2).

Fig. 1: Location in Iran (Point A)

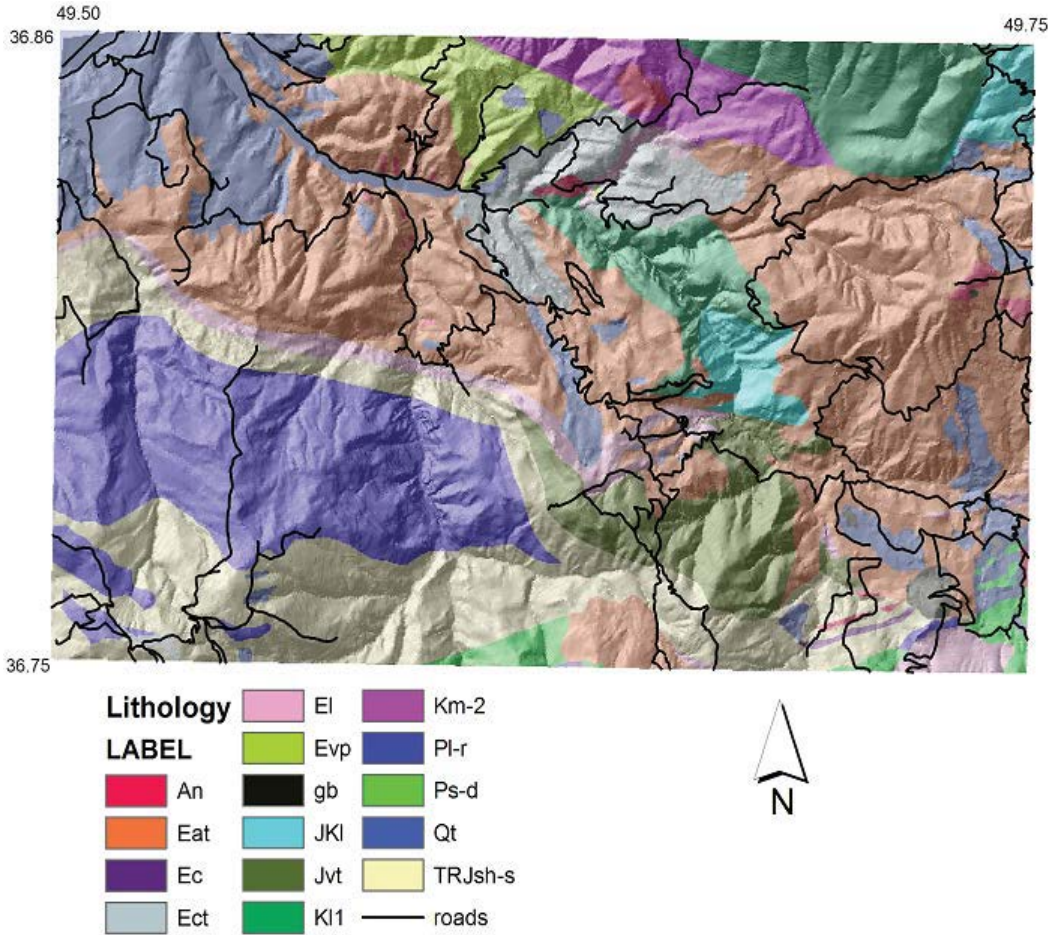

Fig. 2: Geological map of the studied region (Appendix 1)

River: Seasonal and permanent rivers along Darband originating from Sardgah, AsemanSara and Gav Kuh to upper and lower Harzvil and Manjil City to the back of Sefid Rood Lake.

Lakes: Darband with Ponds namely, Dashdan Qolombeh, Hasan Qolombeh, Jik Jik Bulaghi, Ughri Bulaghi, Buz Bulaghi, Yeli Bulaghi, Leili Bulaghi, Khezel Bulaghi, Khushab Khozeh, Khiar Bulaghi and several ponds, basins and seasonal snow pits in Aseman Sara and Sardgah peaks.

Tectonic and structural geology: Alborz Mountain along the east-west constitutes the border between South Caspian alluviums and Central plateau of Iran. Alborz Mountains have been created due to two Precambrian and Alpine orogenic phases. The studied area relates to the western part of Alborz and probably after the end of Percambrian orogenic cycle up to Triassic period, sedimentation with platform features has occurred. During the Paleozoic, this zone has been in the form of a sustainable platform and no orogenic activities have occurred. Caledonian and Hercynian orogenic phases have had orogenic activities too and have caused post Ordovician and post Carboniferous. However from Triassic onwards in Cimmerian orogenic cycle, orogenic activities have gradually led to layers folding. Tectonic forces have been quite effective on determining the face of this region and are highly folded and have ample ruggedness. High lands are combined with fractures and faults. Qezel Ozan (Manjil) that passes from Manjil Sefid Rood Dam can be mentioned as an example. Its length is 65 km along with Karaj formation stones that have been guided on the neogene marls and quartz alluviums of Manjil and Sefid Rood. Furthermore, there are many local fractures and faults and their total re-performance will bring about further more destructive effects.

All folds pass through an evolutionary trend and Western Alborz is not excluded from this rule. At present, Alborz is at the first stage of ruggedness formation, i.e., young ruggedness stage and the mentioned folds are young. In this kind of ruggedness, high lands are matched with anticline and valleys with nadis. Albeit they must be cut due to erosion by anticline flowing water and so the Cluse River is created. For example Sefid Rood, perpendicular to the fold axis, cuts Alborz anticlines, it has created relatively

wide alluvial plains. Also there are alluvial terraces on its both sides and this indicates the effect of tectonic stresses and isostasy factor on changes in the surface.

Karst forms geomorphology: The formation of karst morphology depends upon carbonate stones, chemical features, structural features, climatic conditions and time (Moghimi, 2005). Sensitivity of some sedimentary stones to dissolution and its importance in ruggedness feature create particular forms that are called karst. This name has been derived from the name of a state in Yugoslavia where there are relatively complete stages of calcareous forms. Though these forms are dense and voluminous lime stones, some species of them may develop within evaporite rocks (gypsum and salt). Among morphology forms of the studied region, Dorfak Mountain with an altitude of 2714 m in the south center of Gilan Province in Rudbar City and near to Manjil can be mentioned.

Polje: It refers to the dents created in the lime stones with an approximate flat base. Polje that is the most important karst geomorphology phenomenon is developed in relation with the earth internal movements (Ford and Williams, 2007). A dent has been created on Dorfak peak. This is polje that has been created due to erosion and dissolution of lime stones of Dorfak Mountain. The base of this polje like other poljes has seasonal lakes and its height difference with the adjacent peaks is near 200 to 300 m. this polje is the most important topographic phenomenon of Dorfak peak.

Doline: It is among the most prominent karst morphological forms. In most cases, dolines are resulted from the chemical effect of water on lime stones. This effect is the most important factor, but it is not regarded as the mere effective factor on their formation. Dolines, with an area of a few meters to several tens of meters, are usually observed on the calcareous slopes in gray color and without vegetation and their bases have been covered by clay materials. On the edge of eastern slope of Dorfak, there are several dolines in the northwest of Arbnab and western slopes of Dorfak (Saburi, 2000). Dolines may be used as watering place and after evaporation of the water, doline places are clear as the areas without vegetation in dark brown to black.

Lapiez: The effect of water erosion on calcareous formations is called lapiez. In the other words, lapiezes are notches of lime stones surface. The created Grooves or notches may be covered by surface soils or may be naked which are called visible or invisible lapiez. These grooves are formed due to the existence of wet soils containing carbonic acid on the surface of calcareous masses. This phenomenon that is usually associated with seams of stratification levels, tectonic fractures and seams caused by destruction and weathering existing in the studied region, has provided proper places for penetration of surface waters into aquifers (Saburi, 2000).

Cave and underground holes: Creation of holes and caves is the most important and obvious karst phenomena in Asmari lime stones (Gillison, 2004). Manjil Cheshmeh Bad Cave with an altitude 1400 m from sea level, Darband Rashi Cave and Spahbodan

Fig. 3: Manjil Cheshmeh bad cave

Fig. 4: Espahbodan cave

Appendix 1: Description of the parameters related to the region geological map

Lithology unit	Description	Outcrop area (km^2)	Outcrop percentage (%)
An	Volcanic masses andesite and basalt	2.700	0.870
Eat	Tuffs of andesite, dacite and agglomerate	97.29	31.46
Ec	Conglomerate	0.420	0.140
Ect	Andesite and basaltic tuffs	11.14	3.600
E1	Gray limestone and tuff	10.05	3.250
Evp	Tuffs of andesite, dacite and agglomerate	8.820	2.850
Gb	Gabbro	1.120	0.360
Jk1	Fossiliferous limestones	6.870	2.220
Jvt	Andesitic volcanic, basalts and tuffs	14.82	4.790
K1-r	Limestone	20.99	6.790
2-Km	Limestone, marl and sandstone	9.480	3.070
P1-r	Medium to thick limestone layer (Nessen formation)	42.91	13.88
Ps-d	Shale and sandstone (Dorud formation)	3.85	1.25
Qt	Sediments of the present era and alluvial terraces	31.72	10.26
TRJSH-s	Shale and sandstone (Shemshak formation)	47.04	15.21

Cave can be mentioned as the examples. The created karst forms like caves can be regarded as among tourist attractions for that region (Hematizadeh, 2011) (Fig. 3 and 4).

CONCLUSION

Multiple factors are effective on formation of karst forms including lithology, tectonic structures, climate, water and pores in the stones. The studied area relates to the western part of Alborz and probably after the end of Percambrian orogenic cycle up to Triassic period, sedimentation with platform features has occurred. From Triassic onwards in Cimmerian orogenic cycle, orogenic activities have gradually led to layers folding. Tectonic forces have been quite effective on determining the face of this region and are highly folded and have ample ruggedness.

The existence of karst forms, polje, doline, lapiez, cave and lakes created due to dissolution in Asmari lime stones and tectonic and all karst stages are observable in them can be regarded as among tourist attractions in Manjil.

REFERENCES

Afrasiabian, A., 1998. The importance of karst water resources research in Iran. Proceeding of the 2nd Global Conference on Water in Karst Formations, Tehran.

Ford, D. and P. Williams, 2007. Karst Hydrogeology and Geomorphology. John Wiley and Sons Ltd., the West Sussex, England, pp: 562.

Gillison, D., 2004. Caves, Processes, Development and Management. Edvard Arnold, London.

Haririan, M., 1990. Iran Geomorphology. Publication of Islamic Azad University, Iran, pp: 96.

Hematizadeh, M., 2011. A study on geo-tourism capacities of Karst forms in Arzhan plain in Fars province. Proceeding of the 3rd National Scientific Conference on Geography. Tehran University, Iran.

Mahmudi, F., 2006. Structural Geomorphology. Publication of Payame Noor University, Iran, pp: 80-90.

Millanovic, P., 1988. Karst Hydrology WRP. Colorado, U.S.A.

Moghimi, H., 2005. Karst Hydrology. Publication of Payame Noor University, Tehran, Iran.

Saburi, T., 2000. Natural geographical features of Dorfak. Islamic Azad University, Shahre Rey Branch, Tehran, Iran.

Velayati, S. and F. Khanalizadeh, 2011. A study on the relation between techtonic structures and karst forms (case study: Kardeh Catchment), Joqrafia. Q. J. Iran Geograp. Soc., 31: 171-189.