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Analyzing the effects of tectonic faults on the characteristics of springs

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Abstract

Given to the increasing population, every day, more waterresources are needed. Also Surface water resources do not have enough. Because of this limitation, Attention has been drawn towards groundwater resources from the past. A geology consideration is important for groundwater studies, especially the study of lithology and tectonic geological formations that are involved in creating space and water storage. In this study, the effect of the fault (number of faults, faults, fault faulting length and density) were studied on the spring characteristics of Torbat-e Jam. In order to achieve these goals, ARCGIS software was used. The results shows that a large number of tectonic fault (347 pcs), the distance from the faults in three distance 1000, 3000 and 7000 meters, so that away from the faults, the number of Springs was reduced, High fault density (51/20 km/km^2) and the high faulting (716 km) have a positive effect on the Springs discharge and the appearance of them. Formation of P gn (gneiss, muscovite, biotite, quartz) has the highest average discharge (67/8 m^3/s) Because of high density and Formation of P vs (limestone, dolomite like gneiss) has the highest Total discharge (64/38 m^3/s) Because of high density fault. The overall resultshows the superiority of the aquifer formation on the sand-stone and limestone formations and the impact of faults on the appearance and discharge spring.

Keywords: Water Resources, Groundwater, Geomorphology, Torbat-e Jam, Tectonic.

1. Introduction

Geomorphology forms and processes serve as the most determinant factors in the formation and amount of groundwater resources. Among the geomorphology forms and processes, tectonic factors in each region play an important role in the permeability and recharge of groundwater (Krishnamurthy and Srinivas 1995). Folding systems have affected the pattern of seams and cracks, faults and lines, and orientation of the layers (Fenart et al. 1999). Exploring water resources and growing water in developing cities, groundwater can be studied as an available resource. In this regard, geomorphology, as a branch of geosciences, has the ability to identify new water sources that may be able to some extent resolve the problem of dehydration in major cities. To study groundwater, geological studies, in particular the study of tectonic formations that contribute to the formation of free space and water storage, are important. There have been enormous researches in this regard, some of which are mentioned. Taleghani and Saeid kia (2013) studied the role of geomorphic components in formation and feeding of groundwater table in Zahab plain. By integrating seven variables in the ARCGIS environment, they integrated the basin into hydrogeomorphological units. The results showed that there is a significant relationship between the elements of geomorphology and the groundwater source. Kalantari et al. (2012) after investigating the role of fractures in Cheshmeh Cham Aziz, in the northeast of Khuzestan, concluded that the fracture density, by creating porosity, increases the permeability of the formation and plays an important role in the springs. Kalantari et al. (2009) in their study of the effective factors in the emergence of springs in the catchment area of Izeh plain, concluded that there is a close relationship between the location of springs and the distance from the fractures, so that the location of the spring springs with abundance Fractures show good compliance. Shajari and Raeisi (2006) examined the role of 72-anticline building in groundwater movement in Zagros. Their studies showed that for layers, faults and anticline components play a controlling role in the flow of groundwater. Kassa et al. (2012) using mapping and satellite imagery, studied the relationship between the lines and the process of cave passageways and their impact on the Karst Valley system of the Kinta Valley in the Malaysian Peninsula. The results showed that the formation of karst is controlled by geological structures and caves are rich in groundwater. Preeja et al. (2011) studied and identified groundwater resources in the Kerala area of India, and identified the role of tectonic factors, various geological structures, including lime, as well as the effects of slopes and lands on various forms of underground water storage. Bense and Van Balen (2004) assessed the role of faults in groundwater movement in the Rhine dip in Poland. Their study showed that the structural characteristics of fault zones play an important role in the pattern of groundwater flow. Ahmed (1996) used lineaments as a guide to the exploration of groundwater in hard formations in the dry and semi-arid region of Morocco, and concluded that tectonics had a great influence on the hydrograph of the area and the fracture pattern indicated that faults were a major route for lateral movements And the vertical are groundwater.

Given the special climate situation in Iran and the lack of rainfall, as well as inappropriate spatial and temporal distribution, groundwater resources are of great importance (Anbazhagan et al. 2011). It can be said that without any water resources, every effort and economic effort will be fruitless. Therefore, countries that do not have sufficient surface resources often face water issues and, on the one hand, seek to develop new water resources, such as underground water resources (Shaahzeidi and Entezari 2014), on the other hand, the identification of groundwater resources costs and It is time to identify and exploit these resources through geological and geomorphological studies and, generally, geomorphological forms. Geosciences and geomorphology studies have been considered by geomorphologists due to providing indicators for groundwater exploration and rapid guidance of researchers to the water resources (Javani and Jabari 2009). In order to study groundwater, geological studies, especially tectonic formations that contribute to the creation of free space and water storage, are important. Unfortunately, little research has been done to identify the roughness of the Torbat-e Jam area and manage its water resources utilization. Environmental factors (including topography, morphometry, geology, climate and geomorphology) of the basin and their interaction with each other play an important role in feeding groundwater. Geological factors such as lithology, rock building and fractures each create a specific geomorphology problem and subsequently affect groundwater resources. In this study, the role of faults in groundwater resources nutrition has been investigated.

2. Materials and Methods

The city of Torbat-e Jam is one of the central cities of Khorasan Razavi province, which is located between coordinates 60 1, 17 E, 34 58 to 35 59 N. Based on the latest political divisions, the city has 5 sections called central, Saleh Abad, Nasrabad, Lower Jahan and Bojgan. It also has 10 villages and 447 villages, among which there are 201 villages and 246 villages. In the present research, the central sections of Nasrabad have been selected. Fig.1. shows the location of the region in Iran and the province. The area is 348976 hectares and its environment is 416 kilometers.

2.1. Tectonic (fault) and structural geology

The study area has high fault density, most of which are faults in the region and are often in the northwest-south-east. However, the faults in the region have a very important effect on the emergence of springs in the area that should be investigated. Fig. 2. shows the map of faults and springs in the Torbat-e Jam area. One of the most important measures at the county level is the exact study of the location and mode of operation of the faults, which plays an important role in the emergence of springs in the area. Torbat-e Jam city is located on Quaternary alluvial deposits. Fig. 3 illustrates the geospatial map of Torbat-e Jam. Table 1 shows the formations and their percentage area.

According to Table 1, the highest percentage of area related to the formation (Q t2) with the rocks of young gravels with 43.25% of the area of the area that has wind sands and the lowest area of the formation (PE bt and Q tr) with lithology, tuff is welded and travertine is 0.6% of the area.

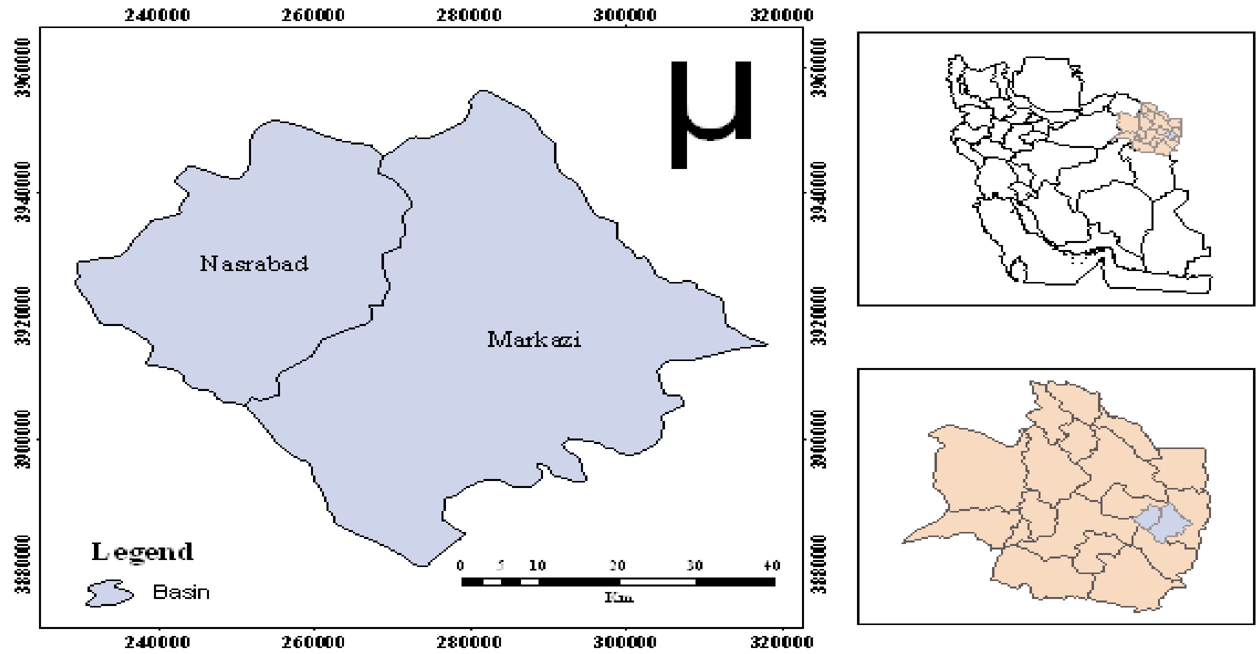

Figure 1. Location of the study area in Iran

Table 1. Formations, lithology and their percentage of area in Torbat-e Jam

formation	Litology	Area (ha)	Area (%)
PE bt	Tuff breccia	219.68	0.06
Q tr	Teravertine	225.16	0.06
P gn	Quartz,biotite,muscovite,sillimanite gneiss	272.28	0.08
K rs/2	Red sandstone	274.06	0.08
K ad	Limestone. Chalk. with grey and marl	283.89	0.08
E vsg/2	Green tuff,greywacke,sandstone,shale	303.06	0.09
Ng t	Dacitic tuff	328.55	0.09
Q1	Loess	393.19	0.11
P as	Andalusite garnet schist	442.88	0.13
PE ap	Porphyritic andesite	524.73	0.15
PE vc	Conglomerate with limestone and volcanic component	532.78	0.15
K m/1	Dark calcareous shale.limestone	568.71	0.16
p d	Recrystalized dolomite	721.52	0.21
PE a	Andesite	824.77	0.24
TR sh	Dolomite	844.07	0.24
Q s	Sand dunes	845.87	0.24
P t	Pylitic shale,limestone,tuffeceous sandstone	1056.80	0.30
E v	Shallow intrusive rocks,andesitic sub volcanic	1063.27	0.30
K c/1	Conglomerate,red sandstone	1103.34	0.32
PCa	Andalusite garnet schist	1184.15	0.34
P gr	Granite,quartz diorite(PROTEROZOIC)	1189.14	0.34
J c/k	Conglomerate .detrital limestone	1354.43	0.39
Kl	Orbitolina limestone	1426.48	0.41
E s	Dark red volcanic sandstone	1470.64	0.42
K 1s/2	Calcareous sandstone and conglomeratic sandy limes	1489.08	0.43
Qal	Recent alluvium	1551.72	0.44
E vm/2	Marl volcanics,sandstone,conglomerate,gypsum	1647.06	0.47
K bc/2	Breccia coarse conglomerate _sandstone	1900.46	0.54
J s	Sandstone .shale.(SHEMSHAK FORM)	1943.36	0.56
O sc	Dark red conglomerate	2025.96	0.58
P vs	Schist,metalava met.limestone,dolomite localy gnei	2230.55	0.64
K 1/1	Light-coloured orbitolina limestone with interlaye	2460.34	0.71
E cl	Coarse conglomerate(mostly andesitic components)	2889.24	0.83
J sh/k	Shale,sandstone	3049.24	0.87
P l	Limestone thic bedded to massive alternation of li	3613.78	1.04
g r	Granite.(MEZOZOIC)	3653.24	1.05
D d	Dolomite and dolomitic limestone	3761.43	1.08
P sd	Diabase,spilitic andesite,diabasic tuff,radiolarit	3920.45	1.12
P sh	Phylitic shale tuffeceous sandstone radiolarine	4564.97	1.31
J s/k	Sandstone,siltstone,conglomerate	5452.80	1.56
Ng cl	Conglomerate,coarse sandstone	5563.98	1.59
TR m	Shale,brownish,sandstone,coal	5954.69	1.71
Ng fc	Fluvialite conglomerate	6614.98	1.90
PE ab	Andesite.trachy andesite.Basalt.ignimbrite	7250.61	2.08
J s.sh/k	Sandstone and shale	10006.40	2.87
Ng c2	Poorly consolidated dark conglomerate	18015.86	5.16
Ng st	Brick red gypsiferous,marl,sandstone,siltstone	39769.48	11.40
Q t1	Old terraces	41260.97	11.82
Q t2	Younger gravel fans	150932.55	43.25
Total		348976.65	100

2.2. Groundwater resources

In the area of Torbat-e Jam, Fariman plain and Janatabad plain, there are 1154 wells, 43 semi-deep wells, 309 arches and springs. The annual discharge of these groundwater resources has been 675500 million cubic meters. The sources of the region selected for study are 221 cases. The data of Flow and the number of these springs in Table 2, the type of morphology and the percentage of springs in Table 3 and the type of spring's structure are also given in Table 4. According to the table, it can be seen that the most types of springs are seamy and split, which shows the great influence of the faults of the region on the construction of springs.

2.3. Research Methodology

First, using the documentary method, then through the experimental and field studies, and then the software related to the research, we identified the hydrogeomorphology of the region. The stages of this research work include the following steps:

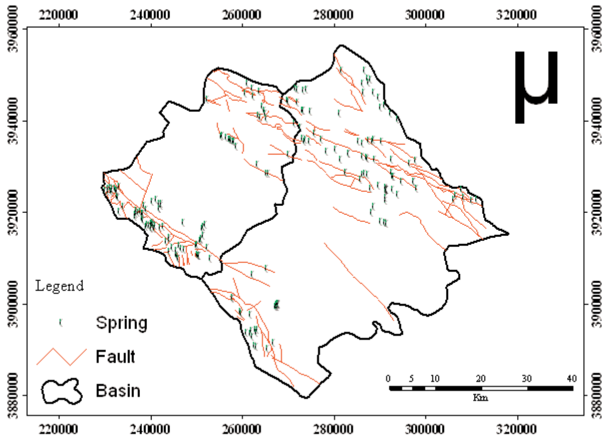

Figure 2. Map of faults and springs in Torbat-e Jam area

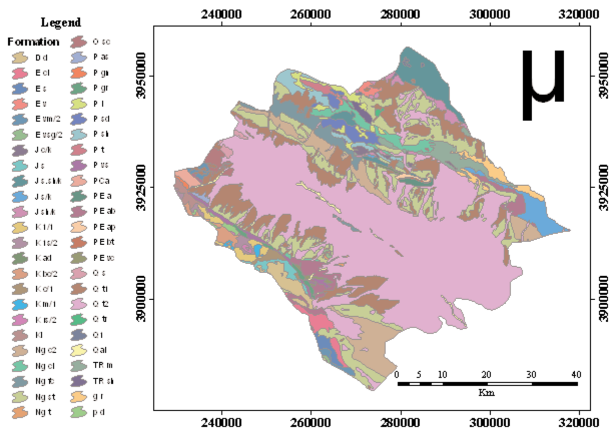

Figure 3. Geological map of Torbat-e Jam area

1. Preparation of fault maps and geological formations from geological map of Torbat-e Jam city at scale 1: 100000 to measure fault length and fault density in formations, and area and percentage of formations.

2. Locating springs in the GIS system and using the Google Earth software to ensure the actual location of springs in the area and their calculations.

3. Identification of geological units of the region on the map of geology and determining the age of the formation and its lithology and the relationship of these formations with faults and seams and their fractures.

4. Identification of underground water resources including wells, qanats and springs of the region (research subject) and determination of dis-

Table 3. Morphology of springs and their percentage

Morphology	Number	Percent
Valley	59	26.7
Hill slope	133	60.18
Plain	13	5.88
Stream bed	16	7.24

Table 4. Type of structure of springs and their percentage

Type of structure	Number	Percent
Hambry(?!)	14	6.34
Drainage	16	7.23
Lineament	191	86.42

Table 2. Number of springs with different discharge rates and percentage of discharge

Number of springs	Discharge (m3/s)	Discharge (%)	Number of springs	Discharge (m^3/s)	Discharge (%)
1	9	2.46	70	0	0
5	10	13.65	25	0.1	0.68
1	0.65	0.18	19	0.2	1.04
1	0.7	0.19	31	0.5	4.23
1	0.8	0.22	17	1	4.64
1	1.2	0.33	5	10	13.65
1	1.41	0.38	1	0.02	0.01
3	1.5	1.23	1	0.03	0.01
4	2	2.18	3	0.05	0.04
1	2.5	0.68	1	0.25	0.07
1	2.56	0.70	4	0.3	0.33
1	2.63	0.72	1	12	3.28
3	5	4.09	1	16	4.37
3	6	4.91	1	20	5.46
4	7	7.64	4	3	3.28
7	8	15.28	2	3.5	1.91
			2	4	2.18

charge, type of structure, springs morphology.

5. Investigating the effect of formations on the number and percentage of springs, total flow, mean and moment, percentage of fault density in different formations on the graph in Excel software and providing applied results.

6. In all of the above, to illustrate the relationship between different factors on springs, Excel software and to show the correlation between them, the R2 statistic has been used.

Considering that the study of the role of geomorphology and faults in the groundwater of Torbat-e Jam city is the basis of the work, therefore, based on the goals set forth in the research using the above-mentioned maps and the geological map on scale 1: 100,000 and repeated visits to map the geomorphology of the region to adapt data to nature. In the present research, a major part of the mathematical and morphometric data of the basin, lithology, and geomorphology is obtained through topographic maps, geology and field observations.

3. Results

3.1 Fault and distance from fault

Figure 4 shows the number and percentage of springs and their distance from the faults at three distances of 1000, 3000 and 7000 meters. According to the figure, the largest number of springs in the distance of 1000 meters with 138 mouths (62.44%) and the lowest number of springs are 7000 meters with 30 holes (13.57%). However, at a distance of 10,000 meters, no springs have emerged. Figure 5 shows how the springs and faults are placed in relation to each other at three distances of 1000, 3000; 7000 m. Table 5 shows the formation of the region and the fault length and the percentage of fault density in the formations. According to the table, the maximum fracture length in the Formation with 11.5626 km (16.41%) and the density of 0.3 (km/km^2) and the lowest fault length in the PE formation with 0.448 km (0.06%) and the density is 0.08 (km/km^2). Also, two Qt2 and formations have the lowest density with 0.05 (0.25%) and the highest density in the Kl formation is 1.13 (km/km^2) (49.5%).

3.2. Springs discharge and the distance from the fault

Figure 6 shows the relationship between the number and discharge of springs in relation to the distance from the fault. According to the charts of the springs located at 1000 m, there is more discharge fault than the 7000-meter fountains of the fault. The highest

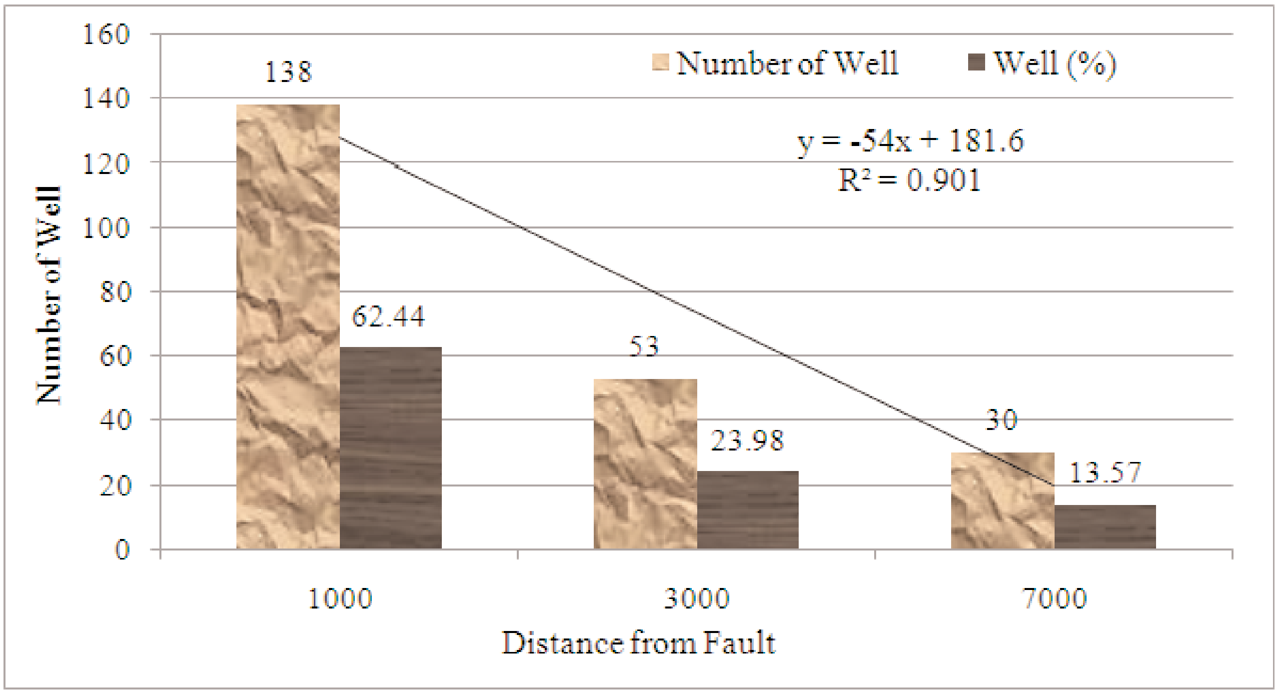

Figure 4. Number and percentage of springs and their distance from faults

rate of discharge was reported at 7000 m 1 m 3 of springs, and the lowest was reported as zero. The highest rate of discharge was reported at a distance of 3000 meters 9 m 3 and the lowest was zero. The highest rate of discharge in the springs with a distance of 1000 meters is 20 cubic meters, and the lowest is zero. Therefore, the descent rate of the springs is evident from the fault. Of course, the high number of springs with zero flux near the faults indicates the seasonality of these springs.

3.3. The effect of geological formations on the number and discharge of springs and fault density

Qt2 formation (young alluvium and cones) with 43.25% and Qtr (teravertine) with 0.66% have the largest and lowest area of the basin, respectively. The Qt2 formation with 42 shrubs and J sh/k (shale) without springs has the highest and lowest number of springs, respectively. Qt2 formation with 19% and J sh/k formation without percent were the highest and lowest percentage of the number of springs, respectively. The highest average discharge rate is in the Pgn Formation (quartz, biotite, Muscovite and sillimanite) at 8.67 cubic meters per second. The lowest amount of discharge in PEab formations (Andesite, Basalt and Ignimbrite), Qtr (Teravertine) and Ngc2 (dark Conglomerate) is 0.1 m3/s. Also, the formations J s/k, J sh/k, Km /l, P gr and PE ap are without a discharge. Figure 7 shows the flow of all springs in

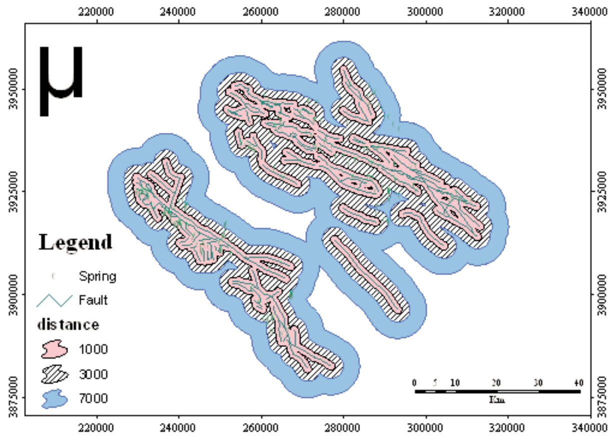

Figure 5. Location springs and faults with each other at distances of 1000, 3000 and 7000 meters

geological formations. According to the diagram, the maximum amount of total discharge in the P vs formation (schist, limestone and dolomite) is 38.64 cubic meters per second. The lowest amount of discharge in PEab formations (andesite, basalt and ignimbrite) and Qtr is 0.1 m3/s. Also, the formations J s/k, J sh/k, Km/l, P gr and PE ap are without a discharge. The highest instantaneous flow rate in the kl (limestone) formation is 6.6 m3/s and the lowest amount of discharge in the E cl (Andesite, conglomerate) is 0.02. Figure 8 shows the percentage of fault density in geologic formations. According to the graph, the highest percentage of fault density in the Kl formation is 1.13 km / km (49.5%) and the lowest percentage of fault density in Qt2 and Ev formations (surface and intrusive rocks and sub-volcanic andesites) to 0.05 (0.25%). The results of this study indicate the impact of Flow and the number of springs from geological formations and tectonic factors of the area (fault).

4. Discussion

The results indicate that springs occur at close distances to tectonic elements (faults) and the downtrend shows a decrease in frequency with increasing distance. From this we can conclude that many tectonic elements can act as a water passage. The high correlation coefficient (0.901) confirms that the faults are undoubtedly very influential in the emergence and even the discharge of springs. Also, the abundance of springs at farther distances can be explained by the geological conditions of the site and fractures that are not identified. The correlation between the discharge rate of the springs and the distance from the fault indicates a good correlation between these two parameters. The downtrend of the Flow Springs gradually extends to a distance of 7000 meters from the fault. Of course, the impact of geological formations should not be ignored. But the effect of the fault on the springs is more than the effect of geological formations. The fault density percentage is a very good indicator of fault formation of

Table 5. Formation of the region, fault length and fault density percentage in the formation

formation	Number of Fault	fault length (km)	Area Formation (ha)	fault density (km/km2)	Percentage of density	Percentage of density (%)
D d	6	17.872	37.61	0.48	2.32	2.49
E cl	6	10.428	28.89	0.36	1.76	1.46
E s	2	1.004	14.71	0.07	0.33	0.14
E v	1	0.552	10.63	0.05	0.25	0.08
E vm/2	1	2.742	16.47	0.17	0.81	0.38
g r	8	20.028	36.53	0.55	2.67	2.80
J c/k	5	3.511	13.54	0.26	1.26	0.49
J s	6	2.259	19.43	0.12	0.57	0.32
J s.sh/k	8	29.027	100.06	0.29	1.41	4.05
J s/k	7	49.372	54.53	0.91	4.41	6.89
J sh/k	3	2.078	30.49	0.07	0.33	0.29
K 1/1	14	14.616	24.60	0.59	2.90	2.04
K 1s/2	12	9.590	14.89	0.64	3.14	1.34
K ad	2	1.728	2.84	0.61	2.97	0.24
K bc/2	7	6.452	19.00	0.34	1.66	0.90
K c/1	4	1.455	11.03	0.13	0.64	0.20
K m/1	6	6.097	5.69	1.07	5.23	0.85
K rs/2	3	0.894	2.74	0.33	1.59	0.12
Kl	9	16.059	14.26	1.13	5.49	2.24
Ng c2	9	18.706	180.16	0.10	0.51	2.61
Ng cl	10	22.757	55.64	0.41	1.99	3.18
Ng fc	7	11.727	66.15	0.18	0.86	1.64
Ng st	43	117.562	397.69	0.30	1.44	16.41
Ng t	2	0.478	3.29	0.15	0.71	0.07
O sc	3	4.412	20.26	0.22	1.06	0.62
P as	3	3.887	4.43	0.88	4.28	0.54
p d	4	5.319	7.22	0.74	3.59	0.74
P gn	3	3.019	2.72	1.11	5.41	0.42
P gr	7	5.757	11.89	0.48	2.36	0.80
P l	8	13.571	36.14	0.38	1.83	1.89
P sd	9	28.364	39.20	0.72	3.53	3.96
P sh	8	21.434	45.65	0.47	2.29	2.99
P t	2	5.464	10.57	0.52	2.52	0.76
P vs	10	22.159	22.31	0.99	4.84	3.09
PCa	4	8.475	11.84	0.72	3.49	1.18
PE a	2	5.963	8.25	0.72	3.53	0.83
PE ab	11	34.575	72.51	0.48	2.33	4.83
PE ap	3	2.771	5.25	0.53	2.57	0.39
PE bt	2	0.600	2.20	0.27	1.33	0.08
PE vc	1	0.448	5.33	0.08	0.41	0.06
Q t1	36	56.847	412.61	0.14	0.67	7.93
Q t2	29	76.024	1509.33	0.05	0.25	10.61
Q1	1	1.086	3.93	0.28	1.35	0.15
Qal	7	1.968	15.52	0.13	0.62	0.27
TR m	11	42.047	59.55	0.71	3.44	5.87
TR sh	2	5.252	8.44	0.62	3.03	0.73
جمع	347	716.436	3476.03	20.51	100	100

geological formations. Formations Qt2 (alluvium and young cones) with 29 faults and 76 km long faults and Ev formation (intrusive surface rocks) with 1 fault and 0.55 mm fault length have the lowest fault density. Of course, Qt2 formation is expected to be high due to the number of faults and the high fault length, but due to the large area of this formation in the Torbat-e Jam region (1509 km2), the fault density is very low. Formations of P gn (quartz, biotite, moscovite, gneiss) with 3 faults and 3 km long faults, and Kl formation (limestone) with the number of 9 faults and 16 km fault length have the highest fault density. Due to the lithological type of formations and the small area in the region due to the type of faulting, the fault density has increased in these formations. The results of this study were investigated by Kalantari et al. (2012), Kalantari et al. (2009), Shajari and Raeisi (2006), Kassa et al. (2012), Preeja et al. (2011), Bense and Van Balen (2004) and Ahmed (1996), and introduces the fault as the most important tectonic factor on the springs.

Due to the large number of faults in the region and the existence of formations (Qt2, Qt1, and Ng st with 66.47 percent area), more springs can be expected in the region. The three formations with 71 shafts (32.12%) have the largest number of springs. Of course, 43 faults with length of 117.526 in Ng st formation, 36 faults with length of 56.847 in Qt1 formation and 29 faults in 76 km length, and 108 faults of 347 faults in the region should not be ignored. The highest average discharge rate is in the Pgn Formation (quartz, biotite, Muscovite and sillimanite) at 8.67 cubic meters per second. The reason is the high density of the fault (11.1 km/km) and the low area of the formation. Although the number of faults in this formation is small (3), but the length of the fault (3 km) has compensated it and affected the quartz and gnaise, and Flow has increased the mean of this formation. The formation of Kbc2 (conglomerate and limestone), although the number of faults and fault density (0.34) is low in this formation, but its lithology has increased mean discharges and placed this formation in the second rank average. Formation of J. s sh/k (sandstone and shale) although the number of faults and fault density (0.29) is low in this formation, its lithology has increased mean discharges and placed this formation in the third rank average Is. Formation of Kl (limestone), fault density (13.1) and high (16 km) fault length in this formation and the presence of limestone, has increased average discharges and placed this formation in the third rank average. The lowest amount of discharge in PEab formations (Andesite, Basalt and Ignimbrite), Qtr (Travertine) and Ngc2 (Integrated Black Conglomerate) is 0.1 m 3 / s. The reason for low flow rate in these formations is low lithology and low fault density (0.1), as well as large area. Also, the formations J s/k, J sh/k, Km/l, P gr and PE ap are average without the discharge. Given that the density and number of faults in these formations are high, but without Flow, the best justification is that the springs in these formations are seasonal. The maximum amount of total discharge in the P vs formation (schist, limestone and dolomite) is 38.64 cubic meters per second. This is due to high fault density (0.99) and high fault length (22 km) and low formation area (22 km2), as well as limestone and dolomite. The lowest amount of discharge in PEab formations (andesite, basalt and ignimbrite) and Qtr is 0.1 m3/s. Also, the formations J s/k, J sh/k, Km/l, P gr and PE ap are without a discharge. The highest instantaneous flow rate in the Kl (limestone) formation was 6.6 cubic meters per second due to high fault density (1.13 km/km) and high fault length (16 km) as well as low area This formation is the least amount of discharge in the E cl (Andesite conglomerate) at 0.02, due to the very low fault density (0.2) and the high area of the formation (28 square kilometers). The highest percentage of fault density in the Kl formation was 1.13 km/sq km (49.5%), P gn was 1.11 (41.5%), 1.07 km/l (23.5%), And the lowest percentage of fault density in Qt2 and Ev formations (intrusive rocks and andesites under volcanic) is 0.05 (0.25%). This high and low fault density depends on the type of lithology of the formations. The results of this research section are related to the studies of Taleghani and Saeid kia, (2013) and the role of geological formations in the formation, nutrition and development of groundwater table and, consequently, the formation of effective springs.

5. Conclusion

In this study, the fountain system was used to influence its formations and faults. The reason for choosing Torbat-e Jam city for this study is its high population and the need for new water resources, as well as the high diversity of geological formations of all geological periods in this area and the high number of

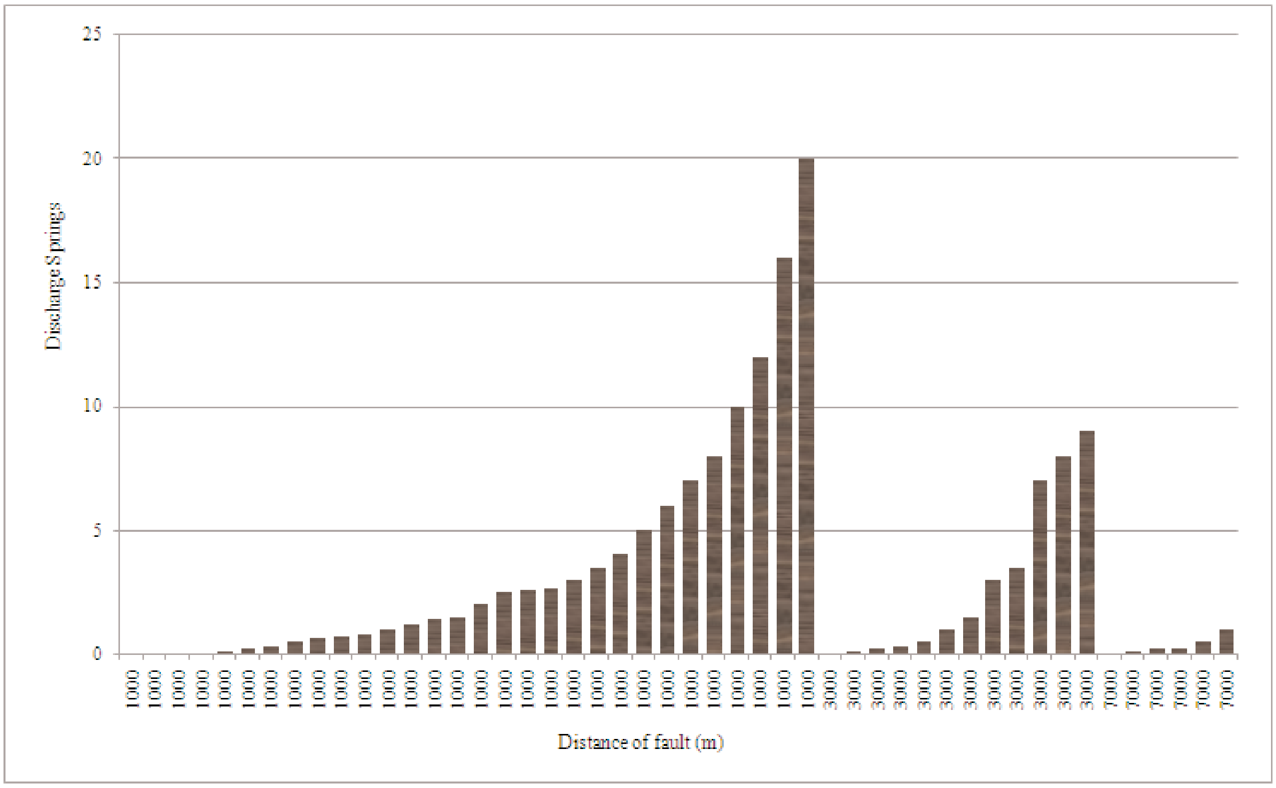

Figure 6. Number and discharge diagrams of springs in relation to the distance from the fault

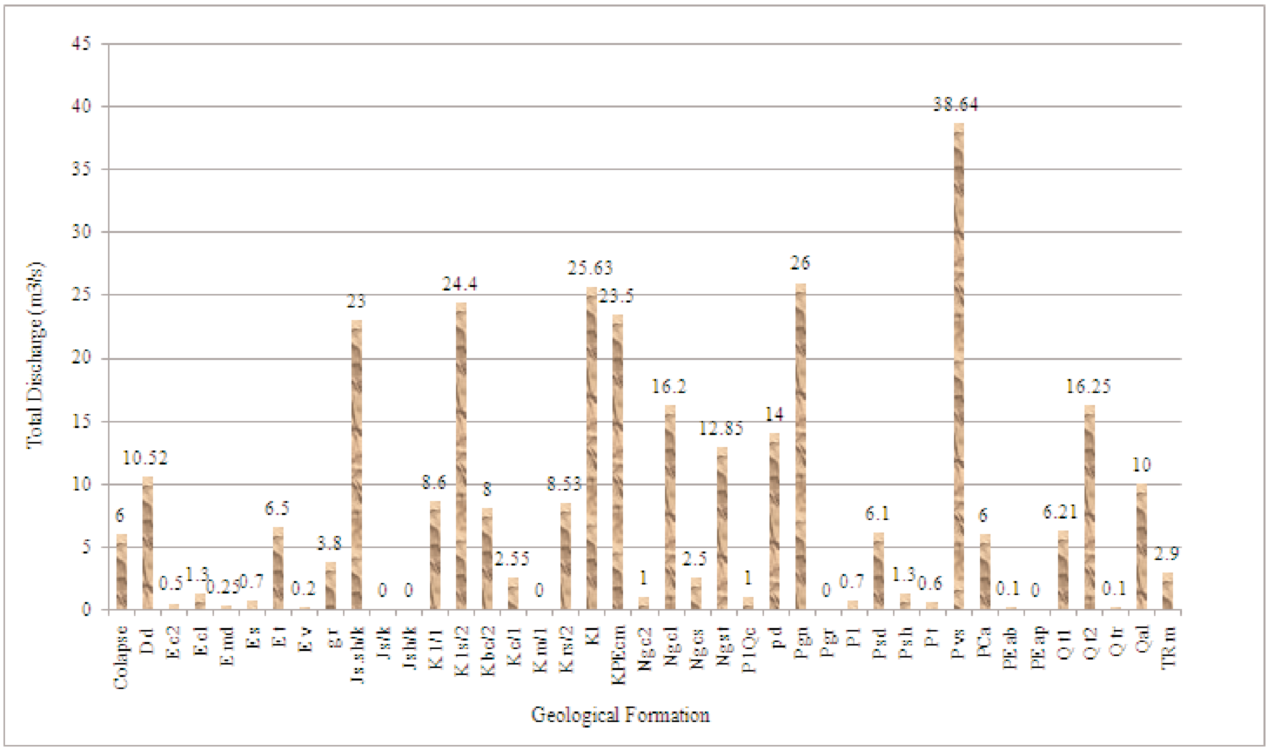

Figure 7. Discharge of all springs in geological formations

faults with a length of 436.616 km.

The results show that the density of the faults by creating porosity increases the permeability of the formation and plays an important role in the sprinkling of the springs. This indicates the obvious role of tectonic elements and the need to pay attention to the talent of water resources and the storage and transfer of groundwater. Therefore, structural factors play an

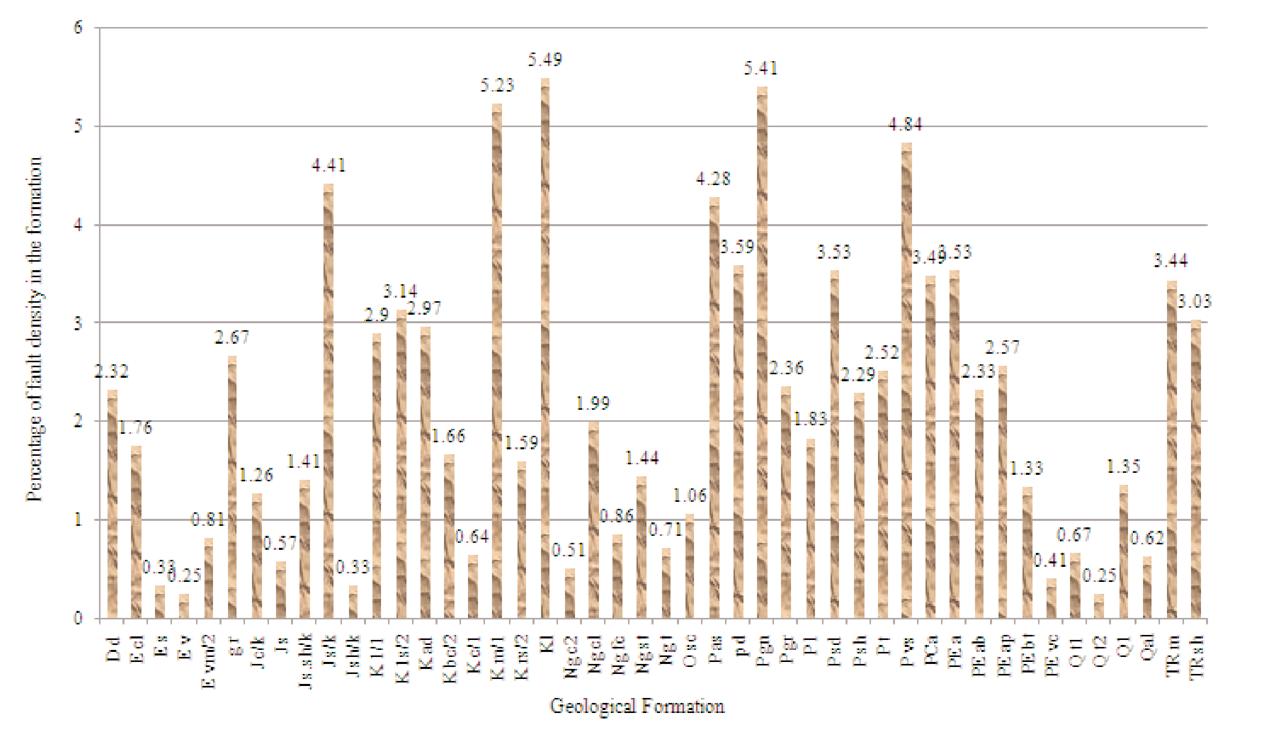

Figure 8. Percentage of fault density in geological formations

important role in the development and development of aquifers and also play a predominant role in penetrating water into the aquifer. Therefore, it can be concluded that whenever there is a fault, one can expect to find and use groundwater in the area.

In general, it can be concluded that the tectonic factors of fault (high), distance from fault (low), fault density (high) and fault length (high) on the source of springs and their emergence have a positive effect. The Qt2 formation (young alluvium and cone) has the largest number of springs. The P gn formation (Ganesis, Muscovite, Biotite, Quartz) has the highest mean flow due to high fault density, P vs formation (limestone, dolomite like ganesis). The highest total flow due to high fault density and good lithology and Kl (Limestone) has the most instantaneous flow due to the presence of limestone.

References

Ahmed M. 1996. Lineament as groundwater exploration guides in hard-rock terrenes of arid regions. *Canadian Journal of Remote Sensing*, 22(1): 108-116.

Anbazhagan S., Subramanian S.,YangX. 2011. Geo informatics in Applied Geomorphology. CRC Press, Taylor & Francis Group an informal business, p. 387.

Bense V.F.,Van BalenR. 2004. The effect offault relay and clay smearing on groundwater flowpatterns in the Lower Rhine Embayment. *BasinResearch*, 16(3): 397-411.

Fenart P., Cat N. N., Drogue C., Van Canhd D., PistreS. 1999. Influence of tectonics and geotectonic on the morphogenesis of the peak karst of Halong Bay, Vietnam. *Geodynamic Action*, 12(3-4): 193 - 200.

Javani V., Jabari I. 2009. Geomorphological Indices in Identification of Groundwater Resources (Case Study of Dasht-e-Ahar). *Geographical Space Journal of Islamic Azad University, Ahar Branch*, 9(25): 51 - 71.

Kalantari N., Mohammad RezaA. 2009.Effective factors in the emergence of spring in Izeh Plain. *Quarterly Journal of Applied Geology*, 5(2): 135 - 147.

Kassa S., Pierson B., Chow W.S., Talib J.B.A. 2012. Identification the link between lineament and Cave Passage trends to comprehend fractures continuity and influence on the Kinta Valley Karst system. *International Journal of Speleology*, 41(1): 59-73.

Krishnamurthy J., Srinivas G. 1995. Role of geological and geomorphologic factors in ground water exploration: a study using IRS LISS data. *International Journal of*

Remote Sensing, 16(14): 2595-2618.

PreejaK.R., Sabu J., Jobin T., Vijith H. 2011. Identification of Groundwater Potential Zones of a Tropical River Basin (Kerala, India) Using Remote Sensing and GIS Techniques. *Indian Soc Remote Sensing*, 39(1): 83-94.

Shaahzeidi S., Entezari M., 2014. The Effect of Active Tectonic to Morphology of Alluvial Fan of Shahdad in Kerman-Iran. *Journal of Earth Science and Engineering*, 4: 141-145.

Shajari J., Raeisi E. 2006. Influences of anticline structures on regional flow, Zagros, Iran. *Journal of Cave and Karst studies*, 68(3): 118-129.

Taleghani M., Saeid Kia M. 2013. The Role of Geomorphology Components in the Formation and Feeding of Groundwater Table (Case Study: Zahab Plain). *Journal of Geographical Research*, 28(2): 171 - 186.