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ACTIVE TECTONICS OF HAMEDAN AREA, WEST IRAN

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ABSTRACT

Hamedan area has located in the Sanandaj-Sirjan belt in the west Iran. Geomorphic indices of active tectonics are useful tools to analyze the influence of active tectonics. These indices have the advantage of being calculate from Arc GIS and remote sensing packages over large area as a reconnaissance tool to identify geomorphic anomalies possibly related to active tectonics. This is particularly valuable in where relatively little work on active tectonics based on this method was done, so this method is new and useful. Six geomorphic indices were calculated in the study area. Through averaging these indices we obtain index of active tectonics (Iat). The values of the index were divided into classes to define the degree of active tectonics. Therefore, relative tectonic activity was calculated and their values were classified and analyzed in three groups. The low class of Iat is mainly in the sub-basins of 1,7,10,11,16,22,24, 27&28 While the rest of the study area has moderate active tectonics in the sub-basins of 2 ,3 ,4 ,5 ,6 ,8 ,9 ,12 ,13,14,15,17,18,20,21,23,25,26 and high in the sub-basins of 19. Our results show that the moderate value has located along faulted area, which shows 3 class of relative tectonic activity.

Keywords: Active, Tectonics, Geomorphic, Index, Hamedan, Iran.

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Contribution/ Originality

This study documents active tectonics of Hamedan area, west Iran, for the first time.

1. INTRODUCTION

The study area is around of Hamedan city in the Sanandaj-Sirjan belt in the west Iran (Figure 1). Sanandaj- Sirjan overthrust belts that formed by metamorphic rocks of the northeastern part of Arabian plate. This province has continued to the north part of Dead Sea fault in the south Turkey. Late Cretaceous-Paleogene sequences in this belt have piled up on a wedge top part of Zagros proforeland basin, before regional metamorphism. Recently, pre-Cretaceous deformed and metamorphic rocks have exposed in this province by upthrusting of basement wedges.

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Kabodarahang depression on the north margin of this area with Urmieh- Dokhtar is an index cases from Supra-Arc troughs. This basin is significant in marking loss of the fore-arc basin beneath back- thrusts antithetic to the subduction direction and can explain the presence of younger molasses in a setting referred to as a suture zone (Qorashi and Arian, 2011; Arian, 2011a; Arian, 2013).

In this research, area is divided into 28 sub-basins and the following indices are calculated: stream –gradient index (Sl), valley floor width-valley height ratio (V*f*), and mountain-front sinuosity (Smf), drainage basin asymmetry (A*f*), hypsometric integral (Hi) and drainage basin shape (Bs).We use geomorphic indices of active tectonics, known to be useful in active tectonic studies (Bull and McFadden, 1977; Keller and Pinter, 2002; Silva *et al.*, 2003; Molin *et al.*, 2004) methodology has been previously tested as a valuable tool in different tectonically active areas, namely SW USA (Rockwell *et al.*, 1985) the Pacific coast of Costa Rica (Wells *et al.*, 1988) central Zagros, Iran (Dehbozorgi *et al.*, 2010).

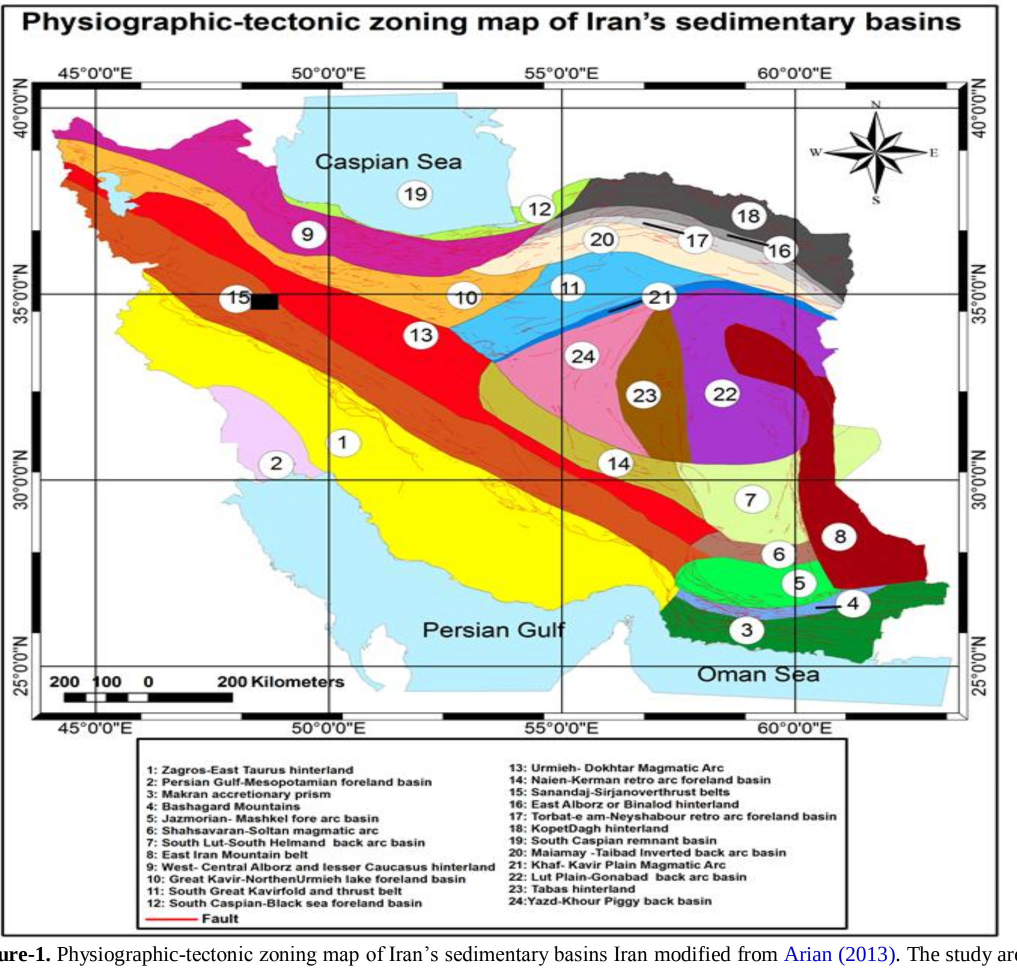

Figure-1. Physiographic-tectonic zoning map of Iran's sedimentary basins Iran modified from Arian (2013). The study area is shown in the black rectangle.

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2. MATERIALS AND METHODS

The calculated geomorphic indices are suitable for assessment of tectonic activity of the study area. The geomorphic indices such as: stream –gradient index (Sl), valley floor width-valley height ratio (V*f*) , mountain-front sinuosity (Smf), drainage basin asymmetry (A*f*), hypsometric integral(Hi) and drainage basin shape(Bs) are calculated in Hamedan area by using of topographic data and DEM (Figures 2 and 3). On the other hand, the area was divided to 28 sub-basins and for each one, indices were calculated, then all of the indices were combined to obtain index of active tectonics (Iat) by new method (El Hamdouni *et al.*, 2008). Therefore, sub-basins can be compared together. The study area is located between longitudes E48° - 49° and latitudes N34°,30′-35° in the Hamedan province, west Iran. Based on previous work on the salt diapirism (Pourkermani and Arian, 1997a; Pourkermani and Arian, 1998a; Asadian *et al.*, 2007; Asadian and Arian, 2009; Arian and Feizi, 2010; Arian, 2011b; Arian, 2012a; Arian, 2012b; Arian and Noroozpour, 2015a; Arian and Noroozpour, 2015b) and neotectonics regime in Iran (Pourkermani and Arian, 1997b; Pourkermani and Arian, 1998b; Arian and Maleki, 2008; Arian, 2010a; Arian, 2011c) Zagros in south Iran is the most active zone (Arian *et al.*, 2002; Arian *et al.*, 2003; Arian *et al.*, 2006; Arian and Hashemi, 2008; Baharvand *et al.*, 2010; Abdideh *et al.*, 2011; Mashal *et al.*, 2013; Arian and Aram, 2014; Pazhoohan *et al.*, 2014; Rahimi and Arian, 2014). Then, Alborz (Pourkermani and Arian, 2001; Arian *et al.*, 2003; Arian and Pourkermani, 2004a; Arian and Pourkermani, 2004b; Arian and Feizi, 2005; Arian and Pourkermani, 2005; Arian and Qorashi, 2006; Feizi and Arian, 2006; Feizi *et al.*, 2007; Khavari *et al.*, 2009; Khavari *et al.*, 2009; Poroohan *et al.*, 2009; Sorbi *et al.*, 2009; Khavari *et al.*, 2010; Arian *et al.*, 2011; Farrokhnia *et al.*, 2011; Feizi and Arian, 2011; Mardani *et al.*, 2011; Sorbi *et al.*, 2011; Arian and Bagha, 2012; Arian *et al.*, 2012; Nouri *et al.*, 2013; Poroohan *et al.*, 2013; Nouri *et al.*, 2013a; Nouri *et al.*, 2013b; Bagha *et al.*, 2014; Arian and Nouri, 2015; Bagha *et al.*, 2015; Bahiraee *et al.*, 2015; Javadi Mosavi and Arian, 2015; Moghimi *et al.*, 2015) and Central Iran (Pourkermani and Arian, 1997c; Arian and Pourkermani, 2001; Arian, 2010b; Arian *et al.*, 2011; Housini Toudeshki and Arian, 2011; Housini Toudeshki *et al.*, 2011; Arian *et al.*, 2011a; Arian *et al.*, 2011b; Eshghi *et al.*, 2012; Javadi Mosavi *et al.*, 2012; Alizadeh *et al.*, 2015; Jamalian Daryani *et al.*, 2015; Javadi Mosavi and Arian, 2015) have been situated in the next orders.

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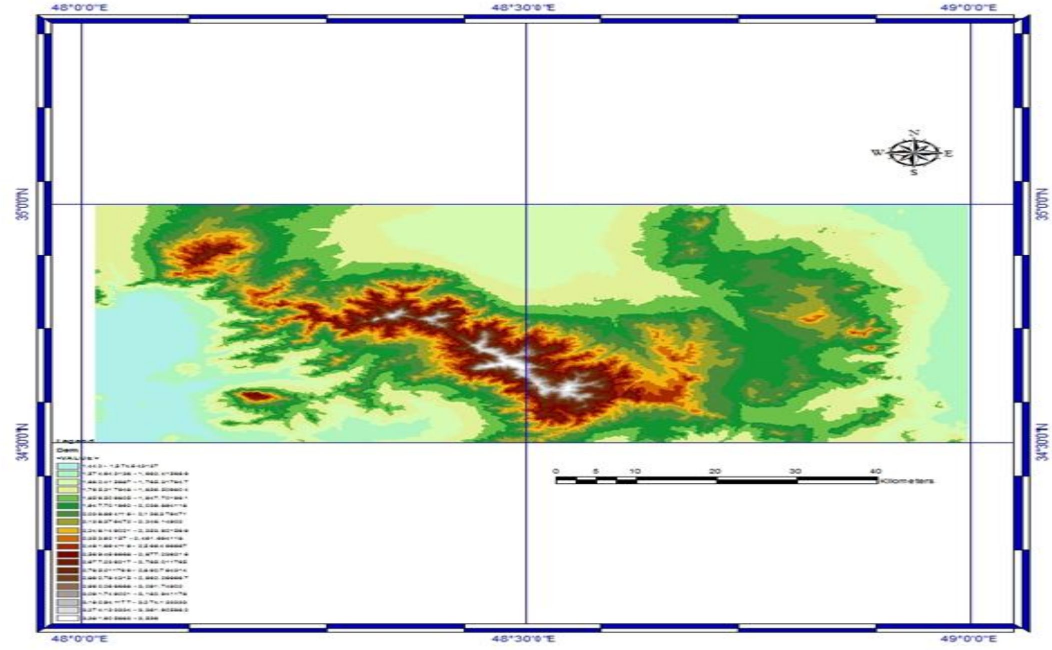

Figure-2. Digital Elevation model of the Hamedan area.

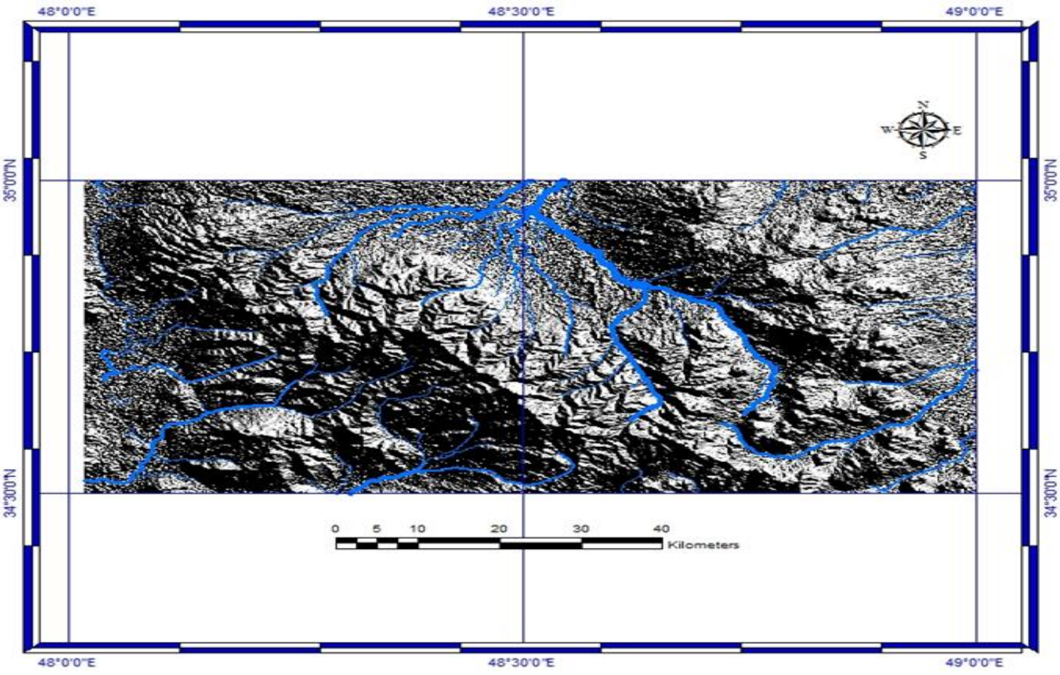

Figure-3. Shaded Relief of the Hamedan area for identification of drainage pattern based on digital elevation model.

3. RESULTS AND DISCUSSION

To study the indices, there is a formula which we turn to describe each one of indices; It is necessary to have some primary maps to calculate the indices, and the most important of which are: Digital Elevation Model (DEM), the drainage network and the sub-basins map of the Hamedan area that have been extracted from DEM (Figure 4). DEM extracted from a digitized

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topographic map (with 10 m intervals)

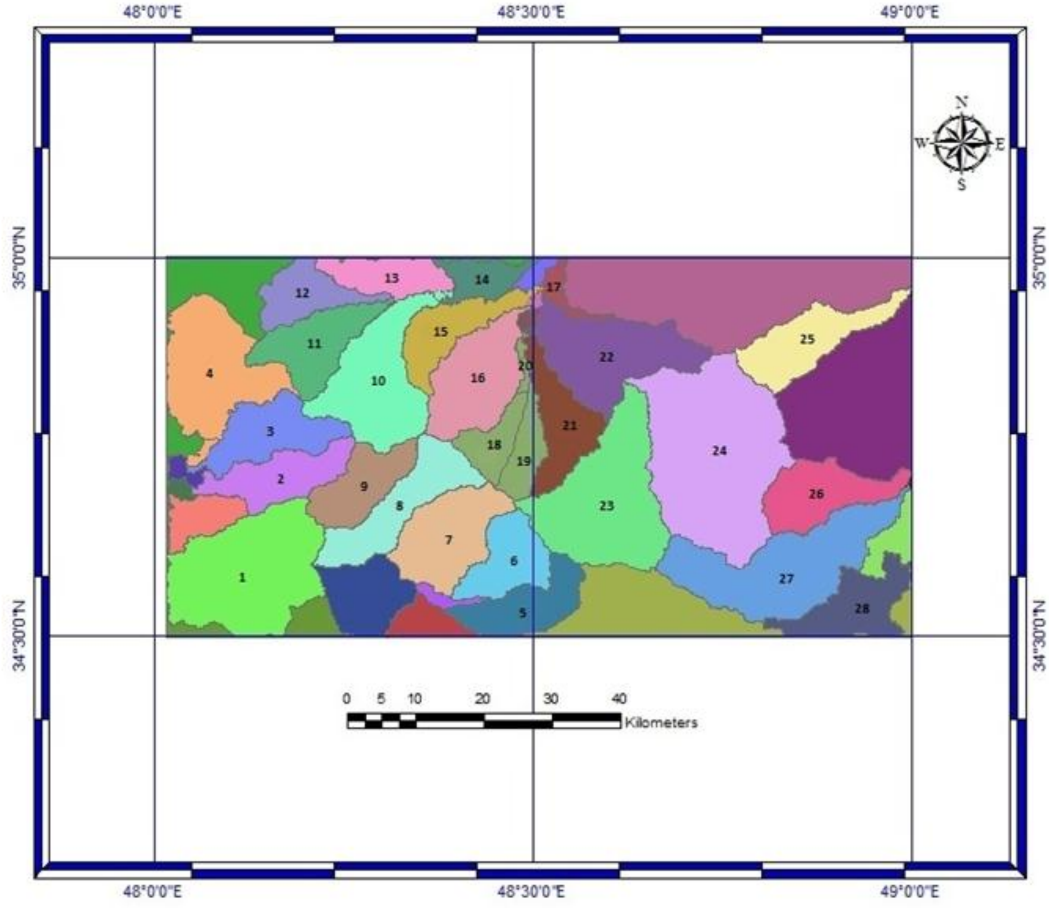

Figure-4. Determination of sub-basins in the Hamedan area based on Digital Elevation model (DEM).

3.1. The Stream –Gradient Index (SL)

The rivers flowing over rocks and soils of various strengths tend to reach equilibrium with specific longitudinal profiles and hydraulic geometrics (Brönnimann *et al.*, 1971; Bull, 2007). Hack (1973) defined the stream-gradient index (SL) to discuss influences of environmental variables on longitudinal stream profiles, and to test whether streams has reached equilibrium. The calculation formula is in this manner:

$SL = (\Delta H/\Delta L) L$

Where ($\Delta H/\Delta L$) is local slope of the channel segment that is located between two contours and L is the channel length from the division to the midpoint of the channel reaches for which the index is calculated. This index is calculated along the master streams of sub-basins (Table 1, Figure 5). The SL index can be used to evaluate relative tectonic activity. An area on soft rocks with high SL values can be indicated for active tectonics. Based on our results, there are two classes (Figure 6).

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Table-1. Values of stream length –gradient index for the selected sub-basins 1 and 2.

Sub-basin	SL	Δh(m)	Δl(km)	L(km)	SL=(Δh/Δl)L
1	1	50	7.28	12.38	85.03
	2	50	5.01	6.23	62.18
2	1	50	9.81	16.96	86.44
	2	50	2.27	10.91	240.31
	3	50	2.48	8.53	171.98
	4	50	2.16	6.2	143.52
	5	50	2.09	4.07	97.37
	6	50	1.53	2.26	73.86
	7	50	0.74	1.12	75.68

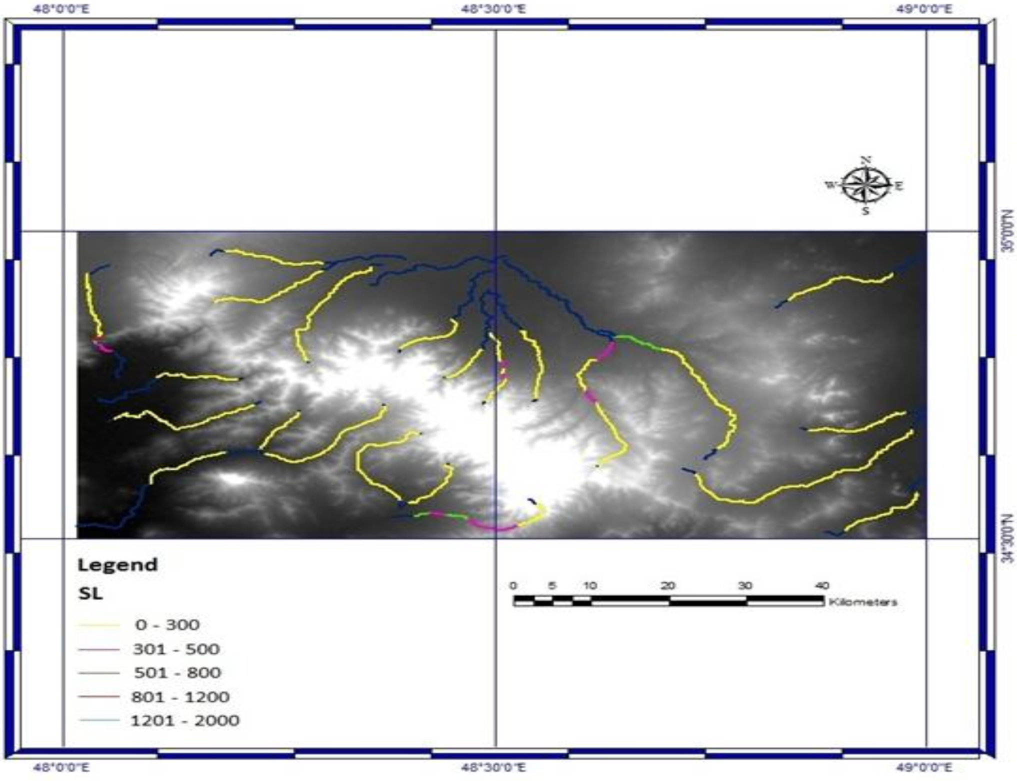

Figure-5. Stream length –gradient values along the master streams.

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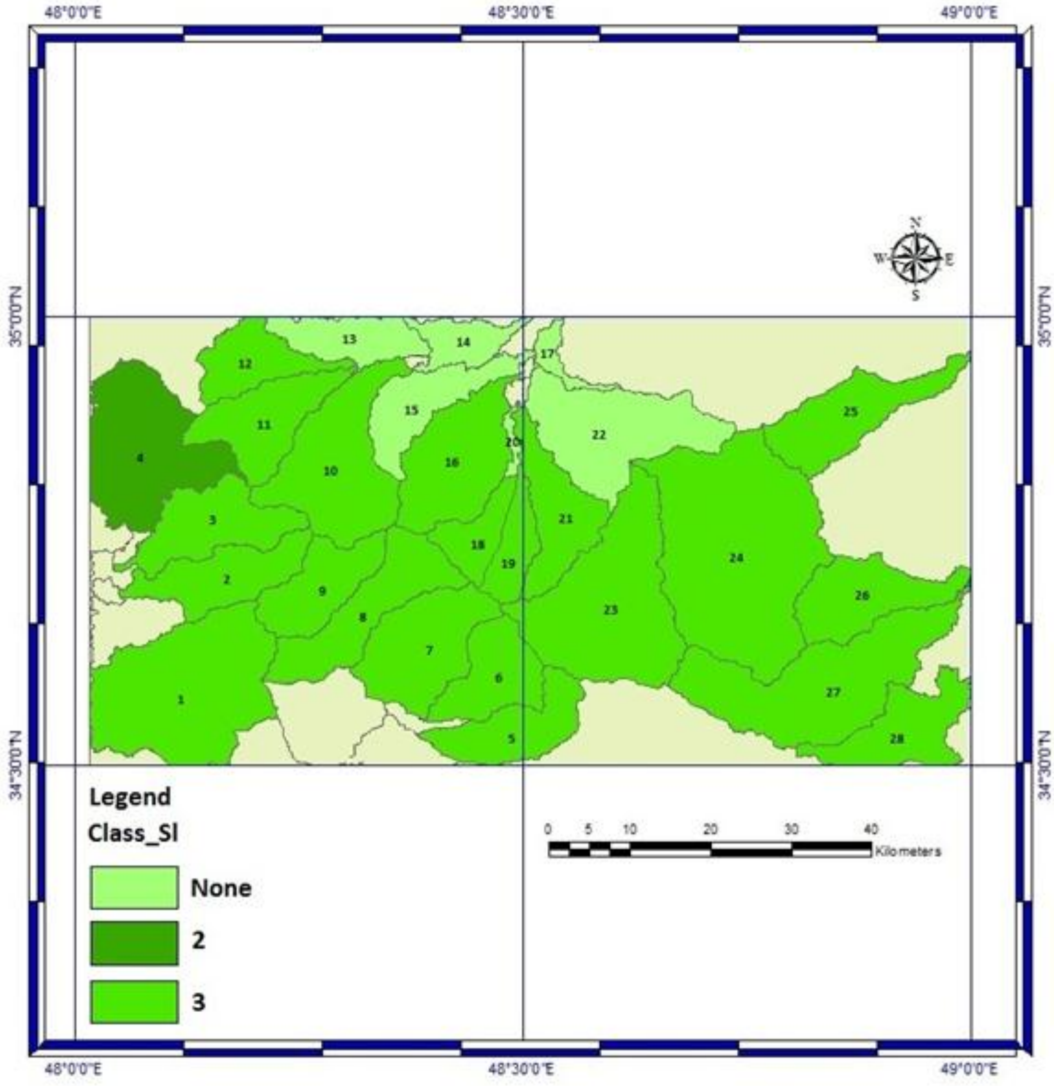

Figure-6. Classification of sub-basins based on stream length –gradient index.

3.2. Valley Floor Width-Valley Height Ratio (V*f*)

Another index sensitive to tectonic uplift is the valley floor width to valley height ratio (V*f*).This index can separate v-shaped valleys with small amounts from u-shaped valleys with greater amounts. The calculation formula is in this manner:

$Vf = 2\ Vfw / (\ Eld + Erd - 2Esc)$

Where V*f*w is the width of the valley floor, and Eld, Erd and Esc are the altitudes of the left and right divisions (looking downstream) and the stream channel, respectively (Bull, 2007). Bull and McFadden (1977) found significant differences in V*f* between tectonically active and inactive mountain fronts. Also, they found significant differences in V*f* between tectonically active and inactive mountain fronts, because a valley floor is narrowed due to rapid stream down cutting.

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Vfw value is obtained by measuring the length of a line which cuts the river and limits to two sides of a contour through which the river crosses (Table 2). Based on El Hamdouni *et al.* (2008) Vf values are divided into 3 classes: 1 ($Vf<0.3$), 2 ($0.3<Vf<1$), and 3 ($Vf>1$).Therefore, all of the valleys are in 1 class and show V- shape valleys (**Figure 7**).

Table-2. Values of Vf index for the selected sub-basins 1 and 2.

Sub-basin	Plot	E_{LD}(m)	E_{rD}(m)	E_{sC}(m)	V_{fw}(m)	V_f
	P1	65	55	2.5	7.5	0.13
1	P2	47.5	30	1	10	0.26
	P3	105	30	2.5	15	0.23
	P1	60	40	1.25	5	0.10
2	P2	75	65	2.5	5	0.07
	P3	65	75	2.5	10	0.14
	P1	70	80	2.5	2.5	0.01
	P2	95	90	2.5	4	0.01

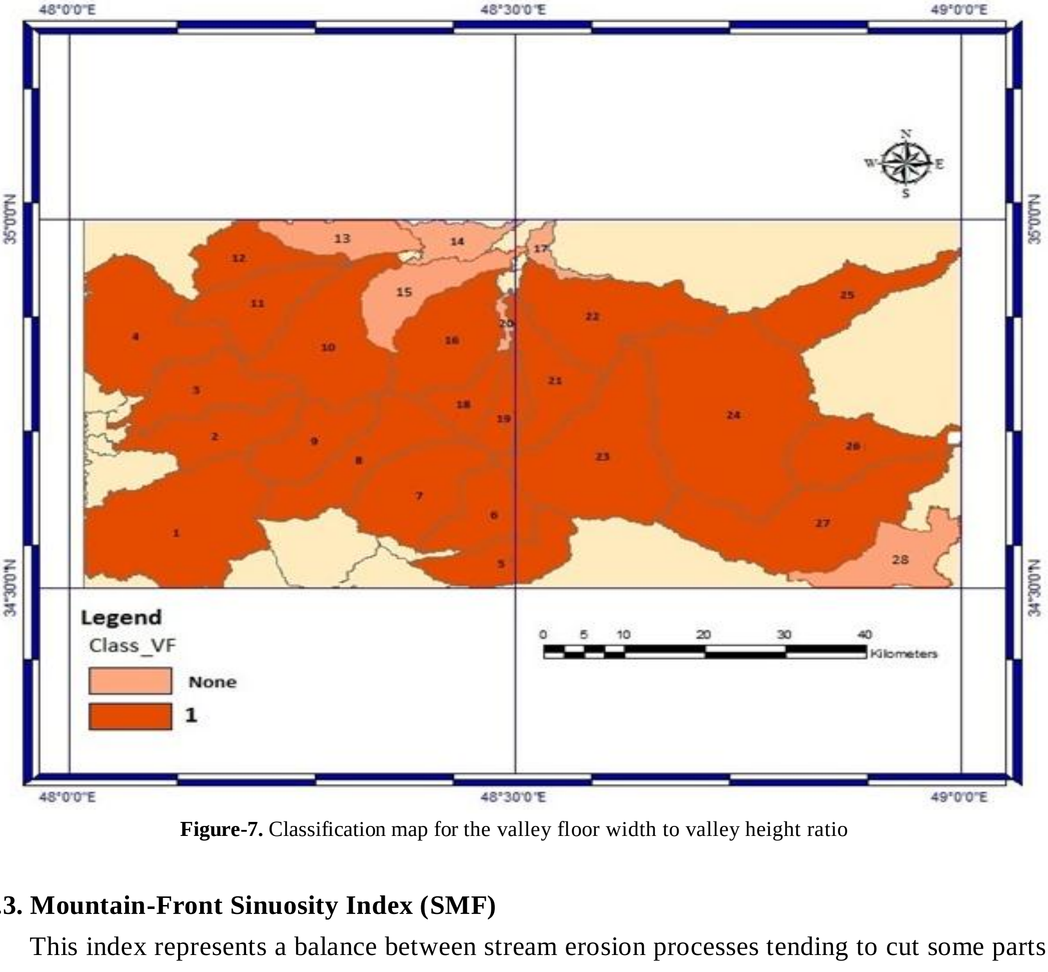

Figure-7. Classification map for the valley floor width to valley height ratio

3.3. Mountain-Front Sinuosity Index (SMF)

This index represents a balance between stream erosion processes tending to cut some parts of a mountain front and active vertical tectonics that tend to produce straight mountain fronts.

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Index of mountain front sinuosity (Arian, 2011a) is defined by:

Smf=Lj / Ls

Where Lj is the planimetric length of the mountain along the mountain-piedmont junction, and Ls is the straight–line length of the front. The Mountain fronts sinuosity classification of the study area have drawn in Figure 8. Smf is commonly less than 3, and approaches 1 where steep mountains rise rapidly along a fault or fold (Bull, 2007). Therefore, this index can play an important role in tectonic activity. Considering that mountain fronts sites are independent from basins places, chances are some of them have various fronts (Table 3).Values of Smf are readily calculated from topographic maps for sub-basins.

Based on El Hamdouni *et al.* (2008) Smf values are divided into 3 classes: 1 (Smf<1.1), 2(1.1<Smf<1.5), and 3(Smf>1.5) and in the study area most of the obtained values are in 2 class.

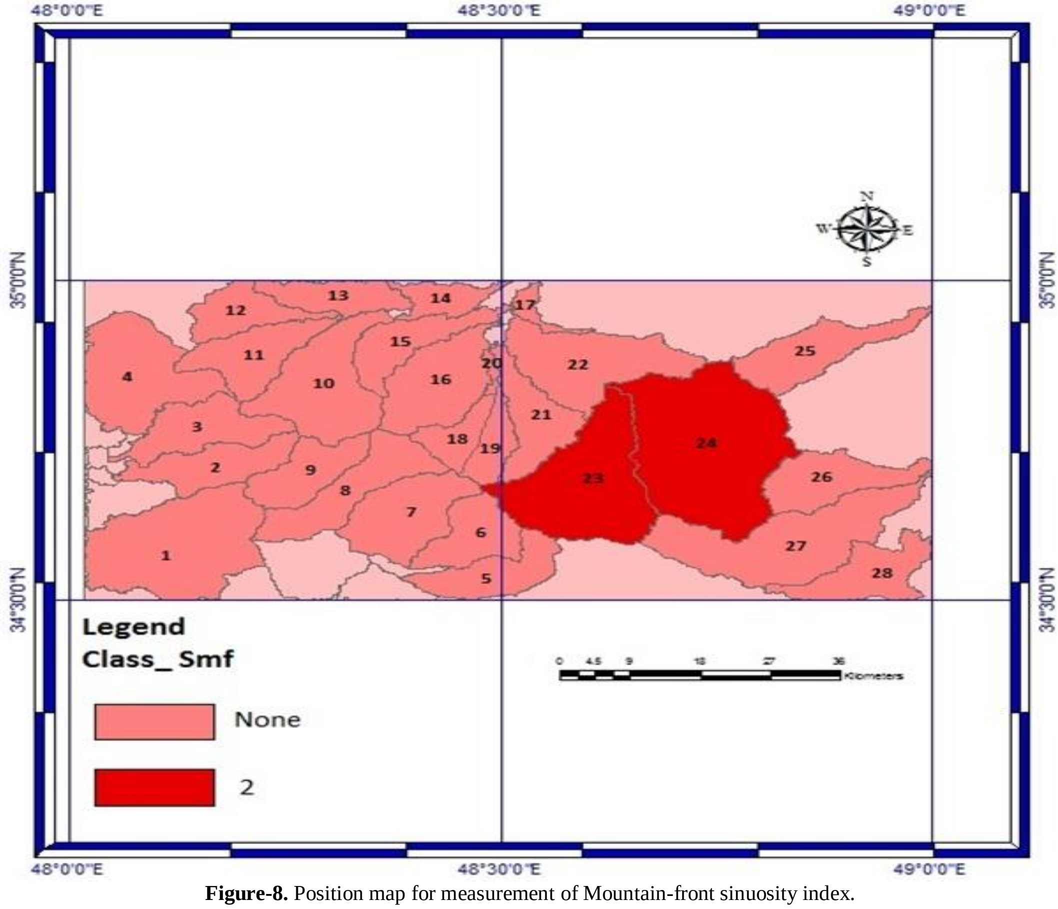

Figure-8. Position map for measurement of Mountain-front sinuosity index.

3.4. Asymmetry Factor (A*f*)

This index is related to two tectonic and none tectonic factors. None tectonic factors may relate to lithology and rock fabrics. It is a way to evaluate the existence of tectonic tilting at the

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scale of a drainage basin. The index is defined as follows:

A*f*=(Ar /At)100

Where Ar is the right side area of the master stream basin (looking downstream) and At is the total area of the basin that can be measured by GIS software. To calculate this index in the area At and Ar are obtained using the sub-basins and the master river maps. A*f* is close to 50 if there is no or little tilting perpendicular to the direction of the master stream. A*f* is significantly greater or smaller than 50 under the effects of active tectonics or strong lithologic control. The values of this index are divided into three categories.1 :(A*f*<35 or A*f*>63) 2:(57<A*f*<65) or (35<A*f*<43) and 3:(43<A*f*<57),based on El Hamdouni *et al.* (2008).

Among the obtained values (Table 3), a map has prepared that it shows Asymmetry factor of study area (Figure 9).

Table-3. Values of Af index.

Sub-basin	**A_t**	**A_r**	**AF= (A_r/A_t)۱۰۰**	**│AF-۵۰│**
1	279	128	45.87	4.12
2	104	69	66.34	16.34
3	115	72	62.60	12.60
4	196	38	19.38	30.61
5	96	45	46.87	3.12
6	94	22	23.40	26.59
7	143	63	44.05	5.94
8	132	48	36.36	13.63
9	95	68	71.57	21.57
10	188	93	49.46	0.53
11	111	61	54.95	4.95
12	79	49	62.02	12.02
13	74	20	27.02	22.97
14	49	10	20.40	29.59
15	93	81	87.09	37.09
16	149	68	45.63	4.36
17	20	17	85	35
18	52	38	73.07	23.07
19	51	16	31.37	18.62
21	103	35	33.98	16.01
22	184	97	52.71	2.71
23	264	93	35.22	14.77
24	397	224	56.42	6.42
25	119	73	61.34	11.34
26	112	45	35.71	14.28
27	254	137	53.93	3.93
28	105	37	35.23	14.77

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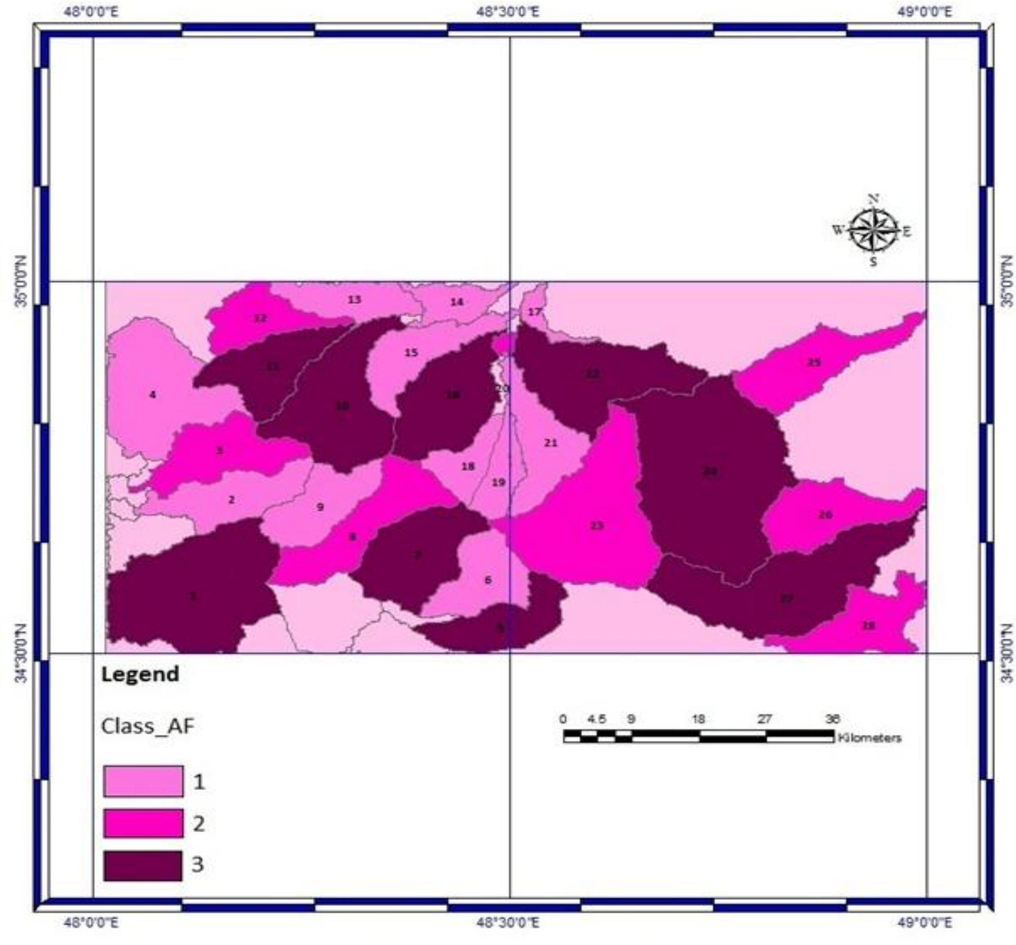

Figure-9. Asymmetry factor map of study area

3.5. Basin Shape Index (BS)

Relatively young drainage basins in active tectonic areas tend to be more elongated than their normal shape to the topographic slope of a mountain. The elongated shape tends to evolve into a more circular shape (Bull and McFadden, 1977). The horizontal projection of the basin shape may be described by the basin shape index or the elongation ratio, Bs Keller and Pinter (2002). The calculation formula is:

Bs=Bl / Bw

Where Bl is the length of the basin measured from the headwater to the mount, and Bw is basin width in the widest point of the basin.

To calculate this index in the area, Bl and Bw are obtained using the sub-basins and the master river maps then the values are divided into 3 classes.1:(Bs>4) 2:(3<Bs<4) 3:(Bs<3) ,based on El Hamdouni *et al.* (2008). According to figure 10 the maximum value belongs to sub-basin no.19 (Class1).

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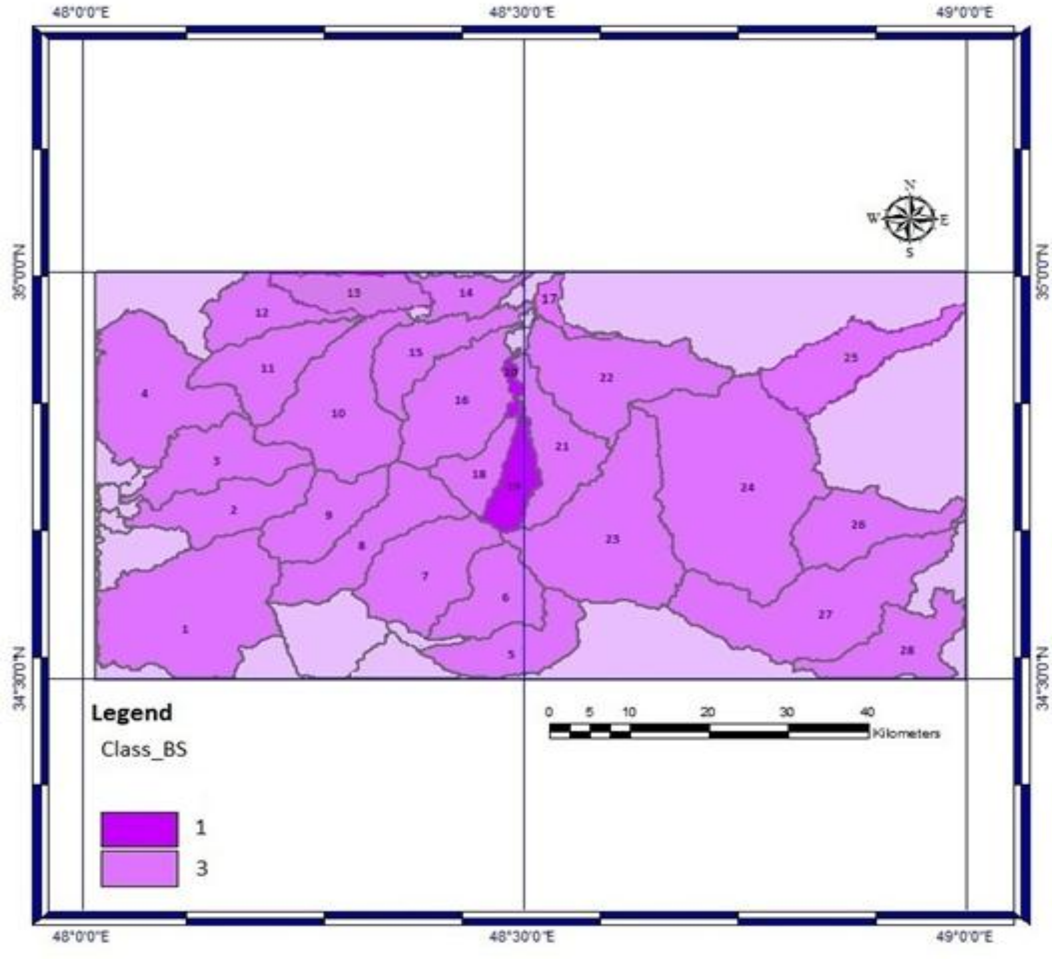

Figure-10. Basin shape map of study area

3.6. Hypsometric Integral Index (Hi)

The hypsometric integral (Hi) describes the relative distribution of elevation in a given area of a landscape particularly a drainage basin. The index is defined as the relative area below the hypsometric curve and it is an important indicator for topographic maturity. H_{max}, H_{min} and H_{ave} are calculated on DEM. This index is calculated to all sub-basins in the area. The hypsometric integral reveals the maturity stages of topography that can, indirectly, be an indicator of active tectonics.

In general, high values of the hypsometric integral are convex, and these values are generally >0.5. Intermediate values tend to be more concave-convex or straight, and generally have values between 0.4 and 0.5. Finally, lower values (<0.4) tend to have concave shapes (El Hamdouni *et al.*, 2008). We can consider class 1 for Hi>0.5, class 2 for Hi between 0.4 and 0.5 and class 3 for Hi<0.4 (Figure 11) and so, sub-basins no.5,18 and 25 shows younger topography(Figure 12).

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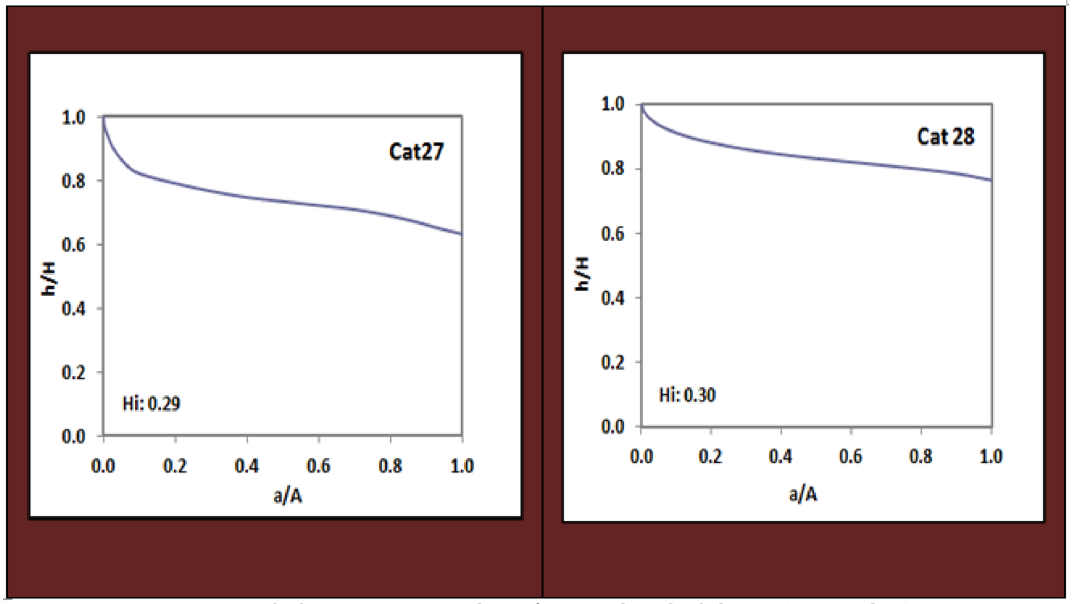

Figure-11. The hypsometric integral (Hi) for two selected sub-basins (no.27 and 28)

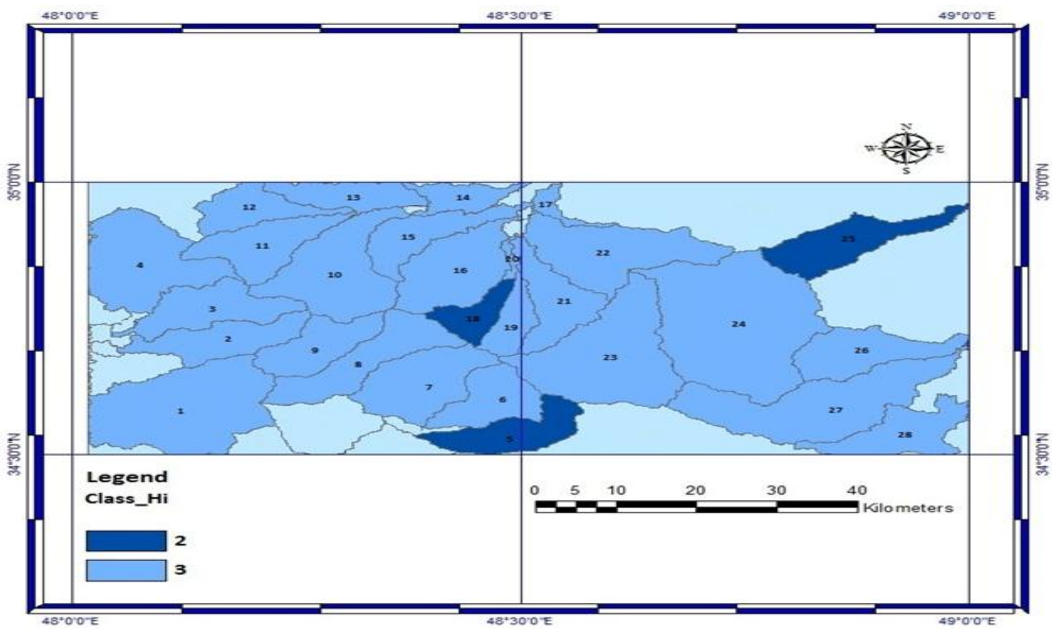

Figure-12. The hypsometric integral classification map for study area

4. RESULTS AND DISCUSSION

The average of the six measured geomorphic indices (V*f*, Smf, SL,Af ,Bs and Hi) was used to evaluate the distribution of relative tectonic activity. Through averaging these six indices (**Table 4**).we obtain one index that is known index of active tectonics (Iat). The values of the index were divided into four classes to define the degree of active tectonics: 1-very high (1<Iat<1.5), 2-high (1.5<Iat<2), 3-moderate (2<Iat<2.5), 4-low (2.5<Iat) (El Hamdouni *et al.*, 2008).

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Table-4. Relative Tectonic activity classification.

Sub-basin	Class of V_f index	Class of S_{mf} index	Class of H_i index	Class of B_s index	Class of AF index	Class of SL index	S/n	Iat index
1	1	-	3	3	3	3	2.6	4
2	1	-	3	3	1	3	2.2	3
3	1	-	3	3	2	3	2.4	3
4	1	-	3	3	1	2	2	3
5	1	-	2	3	3	3	2.4	3
6	1	-	3	3	1	3	2.2	3
7	1	-	3	3	3	3	2.6	4
8	1	-	3	3	2	3	2.4	3
9	1	-	3	3	1	3	2.2	3
10	1	-	3	3	3	3	2.6	4
11	1	-	3	3	3	3	2.6	4
12	1	-	3	3	2	3	2.4	3
13	-	-	3	3	1	-	2.3	3
14	-	-	3	3	1	-	2.3	3
15	-	-	3	3	1	-	2.3	3
16	1	-	3	3	3	3	2.6	4
17	-	-	3	3	1	-	2.3	3
18	1	-	2	3	1	3	2	3
19	1	-	3	1	1	3	1.8	2
20	-	-	3	1	-	-	2	3
21	1	-	3	3	1	3	2.2	3
22	1	-	3	3	3	-	2.5	4
23	1	2	3	3	2	3	2.3	3
24	1	2	3	3	3	3	2.5	4
25	1	-	2	3	2	3	2.2	3
26	1	-	3	3	2	3	2.4	3
27	1	-	3	3	3	3	2.6	4
28	-	-	3	3	2	3	2.7	4

Thus, there are low relative tectonic activities in sub-basin no. 1,7,10,11,16,22,24, 27&28 and moderate relative tectonic activities in sub-basins no. 2 ,3 ,4 ,5 ,6 ,8 ,9 ,12 ,13,14,15,17,18,20,21,23,25 and 26. The sub-basin no.19 has situated in the middle part of study area, has got high relative tectonic activity by movements of sallow intrusive body (**Figure 13)**.

Also, based on Arian (2010a) this area is a moderate seismic risk zone with following seismicity parameter: b = 0.82, M max =7.1. Focal mechanisms of several earthquakes are reversed and thrusted such as Changureh (Ms=6.4, 2002)

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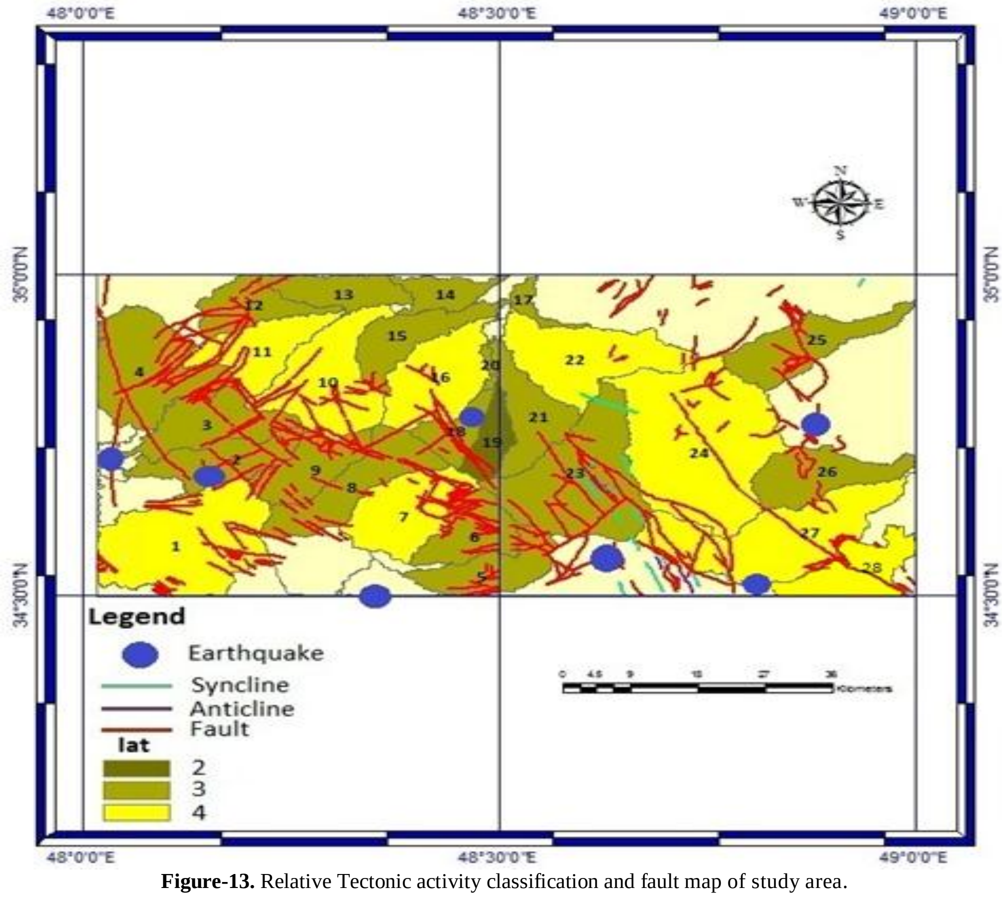

Figure-13. Relative Tectonic activity classification and fault map of study area.

This area is struck by low to moderate earthquakes with low frequency, medium repeat time and down to 10Km focal depth. Intensity of earthquakes is in high levels in which there are cold igneous rocks. Sometimes, focal depths exceed to 70Km that it is indicator for initial stages of thick-skinned tectonics. The most serious seismic hazards in Hamedan area, are settlement in Kabodarahang plain and surface faulting.

5. CONCLUSIONS

The calculated geomorphic indices are suitable for assessment of tectonic activity of the study area. The six geomorphic indices; stream –gradient index (Sl), valley floor width-valley height ratio (V*f*) and mountain-front sinuosity (Smf), drainage basin asymmetry (A*f*), hypsometric integral(Hi) and drainage basin shape(Bs) have calculated in Hamedan area.

Therefore, firstly the area was divided to 28 sub-basins and for each one, indices were calculated, then all of the indices were divided into relative tectonic activity classes. Afterwards, the six measured indices for each sub-basin were compounded and a unit index obtained as index of active tectonics (Iat). According to this index, there are low, moderate and high relative tectonic activities levels.

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Low relative tectonic activities level has been fund in sub-basin no. 1,7,10,11,16,22,24, 27 and 28, moderate relative tectonic activities level, has been fund in sub-basins no. 2 ,3 ,4 ,5 ,6 ,8 ,9 ,12 ,13,14,15,17,18,20,21,23,25 & 26 and high relative tectonic activities level, has been fund in sub-basin no. 19. It means that sub-basin no.19 has got the more active uplifting by movements of sallow intrusive body.

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REFERENCES

Abdideh, M., M. Qorashi, K. Rangzan and M. Arian, 2011. Assessment of relative active tectonics using morphometric analysis, case study of Dez River (Southwestern, Iran). Geosciences, 20(80): 33-46.

Alizadeh, H., M. Arian, M. Lotfi, M. Ghorashi and M. Ghorbani, 2015. Determination of porphyry copper deposit locations using photo lineament factor in Northern parts of the Dehaj-Sardoiyeh belt. Geosciences, 24(94): 247-252.

Arian, M., 2010a. Applied seismotectonics. Tehran: Farazamin Press. pp: 304.

Arian, M., 2010b. Earthquake-fault hazard investigations in the Kerman quadrangle. Journal of Sciences, 19(77): 176-182.

Arian, M., 2011a. Basement tectonics and geology of Iran. Qum: Asar Nafis Press. pp: 300.

Arian, M., 2011b. A preface on salt diapirism of Iran. Qum: AsarNafis Press. pp: 309.

Arian, M., 2011c. Middle East tectonics. Qum: Asar Nafis Press. pp: 236.

Arian, M., 2012a. Salt diapirism and tectonics. 2nd Edn., Qum: Asar Nafis Press. pp: 319.

Arian, M., 2012b. Clustering of diapiric provinces in the central Iran basin. Carbonates and Evaporites, 27(1): 9-18.

Arian, M., 2013. Physiographic-tectonic zoning of Iran's sedimentary basins. Open Journal of Geology, 3(3): 169-177.

Arian, M., A. Ahmadnia, M. Qorashi and M. Pourkermani, 2002. Structural analysis of Mengharak transcurrent fault system in Zagros, Iran. Special Geo 2002 Conference Issue Geoarabia, 7 (1) : 209-210.

Arian, M. and Z. Aram, 2014. Relative tectonic activity classification in the Kermanshah area. Western Iran. Solid Earth, 5(2): 1277-1291.

Arian, M. and N. Bagha, 2012. Active tectonics of Tehran area, Iran. J. Bas. Appli. Sci. Res, 2(4): 3805-3819.

Arian, M., N. Bagha, R. Khavari and H. Noroozpour, 2012. Seismic sources and neo-tectonics of Tehran area (North Iran). Indian Journal of Science and Technology, 5(3): 2379-2383.

Arian, M. and F. Feizi, 2005. Application of geomorphic indices to the assessment of relative tectonic activity levels in the Alborz-central Iran border zone. Journal of Sciences, 15(57): 378-403.

© 2015 Conscientia Beam. All Rights Reserved.

Arian, M. and F. Feizi, 2010. The significance of faulting on the surficial spreading of evaporitic deposits in the Vara-Min-Semnan area. Journal of Earth and Resources, 3(8): 1-20.

Arian, M. and A. Hashemi, 2008. Seismotectonic zoning in the Zagros. Journal of Sciences, 8(69): 63-76.

Arian, M. and R. Maleki, 2008. Neotectonics. Tehran: Farazamin Research Center. pp: 150.

Arian, M., Z. Maleki and H. Noroozpour, 2011. Cenozoic diastrophism and deformational events in the East central Alborz. Journal of Basic and Applied Scientific Research, 1(11): 2394-2400.

Arian, M. and H. Noroozpour, 2015a. The biggest salt-tongue canopy of central Iran. Open Journal of Geology, 5(2): 55-60.

Arian, M. and H. Noroozpour, 2015b. Tectonic geomorphology of Iran's salt structures. Open Journal of Geology, 5(2): 61-72.

Arian, M. and R. Nouri, 2015. Lineament tectonics and mineralization in Tarom area, North Iran. Open Journal of Geology, 5(3): 115-124.

Arian, M. and M. Pourkermani, 2001. Rivers morphology and active tectonic (Reviewing the Current Status of Ghezel Ozon River in the Province of Zanjan). 5th Conference of Geological Society of Iran, Tehran, 556.

Arian, M. and M. Pourkermani, 2004a. Tectonic elements of South flank in the East-central Alborz Mountain. Journal of Sciences, Teacher Training University, 4(1): 359-368.

Arian, M. and M. Pourkermani, 2004b. Structural significance of North Semnan and attary faults in Alborz-central Iran border zone. Journal of Science, 14(53): 4551–4569.

Arian, M. and M. Pourkermani, 2005. Cenozoic diastrophism and deformational events in the Southern flank of central-East Alborz. Journal of Faculty Earth Sciences, 10(1): 43–51

Arian, M., M. Pourkermani, M. Qorashi and M. Ghasemi, 2003. North Semnan fault system and its role on basin division. 8th Sym-posium of Geological Society of Iran, Shahrood University of Technology. pp: 11–17.

Arian, M., M. Pourkermani, A. Sistanipour and H. Noroozpour, 2011a. Kinematic significance of fold- and fault-related fracture systems in the Rafsanjan's Northeast Highlands (Central Iran). J. Bas. Appli. Sci. Res, 1(11): 3398-3406.

Arian, M., M. Pourkermani, A. Sistanipour and H. Noroozpour, 2011b. Seismicity and fault segmentation of bafq-baghin fault system (Central Iran). Journal of Applied Environmental and Biological Sciences, 1(10): 382-396.

Arian, M. and M. Qorashi, 2006. The movement potential evaluation of the major quaternary faults in Alborz-central Iran border zone, from the East of Tehran to the East of Semnan. Journal of Geosciences, Geological Survey of Iran, 15(59): 184-188.

Arian, M., M. Qorashi, M. Pourkermani and A. Ahmadnia, 2003. Fractal analysis of Mengharak transcurrent fault system in Zagros, Iran. Abstracts of Fourth International Conference on Seismology and Earthquake Engineering, Iran, 23.

Arian, M., M. Qorashi, M. Pourkermani and A. Ahmadnia, 2006. The structural significance kareh bas transcurrent fault system in the Zagros fold and thrust belt. Journal of Geosciences, 15(58): 126-133.

© 2015 Conscientia Beam. All Rights Reserved.

Arian, M., V.H. Toudeshki and H. Noroozpour, 2011. Active tectonics of Qezel Ozan River Basin, NW Iran. Journal of Applied Environmental and Biological Sciences, 1(9): 291-295.

Asadian, F. and M. Arian, 2009. Identification of diapiric provinces of central Iran through geological and geographical analysis. International Journal of Agriculture Environment & Biotechnology, 2(1): 3443-3451.

Asadian, F., M. Pourkermani and M. Arian, 2007. Tectonic geomorphology of salt structures in the Garmsar-Lasjerd area. Geographical Research, 39(60): 75-84.

Bagha, N., M. Arian, M. Ghorashi, M. Pourkermani, R. El Hamdouni and A. Solgi, 2014. Evaluation of relative tectonic activity in the Tehran Basin, Central Alborz, Northern Iran. Geomorphology, 213(1): 66-87.

Bagha, N., M. Ghorashi, M. Arian, M. Pourkermani and A. Solgi, 2015. Neotectonic analysis of Mosha-North Tehran fault zone, based on morphotectonic features, central Alborz, Northern Iran. Geosciences, 24(94): 41-52.

Baharvand, S., M. Pourkermani, R. Ajalloian, M. Arian and A.R. Nouryazdan, 2010. Seymareh landslide and its role in environmental and geomorphologic changes of the Pole-Dokhtar area. Journal of the Earth, 4(4): 13-24.

Bahiraee, S., M. Arian, M. Qorashi and M. Solgi, 2015. The movement potential evaluation of the Mosha fault (The West of Firoozkuh to the Shahrestanak). Geosciences, 24(94): 123-126.

Brönnimann, P., L. Zaninetti, F. Bozorgnia, G.R. Dashti and A. Moshtaghian, 1971. Lithostratigraphy and foraminifera of the upper triassic Naiband formation, Iran. Revue de Micropaléontologie, 14(4): 7-16.

Bull, W.B., 2007. Tectonic geomorphology of mountains: A new approach to paleoseismology. Malden: Blackwell.

Bull, W.B. and L.D. McFadden, 1977. Tectonic geomorphology North and South of the Garlock fault, California. In: Doehring D.O. (Eds). Geomorphology in arid regions. Proceedings of the Eighth Annual Geomorphology Symposium. State University of New York, Binghamton. pp: 115-138.

Dehbozorgi, M., M. Pourkermani, M. Arian, A.A. Matkan, H. Motamedi and A. Hosseiniasl, 2010. Quantitative analysis of relative tectonic activity in the Sarvestan area, central Zagros, Iran. Geomorphology, 121(3): 329-341.

El Hamdouni, R., C. Irigaray, T. Fernandez, J. Chacon and E.A. Keller, 2008. Assessment of relative active tectonics, Southwest border of Sierra Nevada (Southern Spain). Geomorphology, 96(4): 150-173.

Eshghi, Z., M. Arian and M. Pourkermani, 2012. Structural investigation on the lak mining area (Bueen Zahra) based on remote sensing, used for its mineralization. Journal of The Earth, 6(22): 145-155.

Farrokhnia, A.R., S. Pirasteh, M. Pourkermani and M. Arian, 2011. Geo-Information technology for mass wast-ing hazard zonation: Central-West Alborz-Iran. Disaster Advances, 4(3): 24-33.

Feizi, F., A. Arian and R. Rahmani, 2007. Seismotectonic zoning in the Eastern part of the central Alborz. Journal of Sciences, 17(65): 151-164.

Feizi, F. and M. Arian, 2006. The classification of thrust fronts in the Alborz-central Iran border zone from the East of varamin to the East of Semnan. Journal of Sciences, 16(61): 75-87.

© 2015 Conscientia Beam. All Rights Reserved.

Feizi, F. and M. Arian, 2011. The role of structural controllers in geneses of copper deposits in 1:50000 map of Saiin Qaleh. Journal of Sciences, 21(81): 1-10.

Hack, J.T., 1973. Stream-profiles analysis and stream-gradient index. Journal of Research of the U.S. G.S, 1(2): 421-429.

Housini Toudeshki, V. and M. Arian, 2011. Morphotectonic analysis in the Ghezel Ozan River Basin, NW Iran. Journal of Geography and Geology, 3(1): 258-260.

Housini Toudeshki, V., M. Pourkermani, M. Arian and K.H. Khosrotehrani, 2011. Influence of structures on the Ghezel Ozan River. Geosciences, 21(81): 55-60.

Jamalian Daryani, N., M. Arian and N. Rashidnezhad Omran, 2015. Tectonics and mineralization of copper in the Ar-Destan-Kahang area, central Iran by remote sensing. Open Journal of Geology, 5(4): 188-196.

Javadi Mosavi, E. and M. Arian, 2015. Neotectonics of Tabas area, central Iran by index of active tectonics (IAT). Open Journal of Geology, 5(4): 209-223.

Javadi Mosavi, E., M. Arian, M. Ghorashi and M. Nazemi, 2012. Measurments of geomorphic indices in Tabas area. Journal of the Earth, 7(24): 213-225.

Keller, E. and N. Pinter, 2002. Active tectonics: Earthquakes, uplift, and landscape. New Jersey: Prentice Hall. pp: 432.

Khavari, R., M. Arian and M. Ghorashi, 2009. Neotectonics of the South central Alborz drainage basin, in NW Tehran, N Iran. Journal of Applied Sciences, 9(23): 4115-4126.

Khavari, R., M. Ghorashi and M. Arian, 2009. Assessment of relative active tectonics, South central Alborz (North Iran). EGU General Assembly Conference Abstracts, 11:1137.

Khavari, R., M. Ghorashi, M. Arian and K. Khosrotehrani, 2010. Geomorphic signatures of active tectonics in the karaj drainage basin in South central Alborz, N, Iran. Geosciences, 19(75): 67-74.

Mardani, Z., M. Ghorashi and M. Arian, 2011. Geomorphic signatures of active tectonics in the Talaghan Rud, ShahRud and sefidrud drainage basins in central Alborz, N Iran. Geosciences, 20(78): 159-166.

Mashal, M., M.P. Kermani, A. Charchi, M. Almasian and M. Arian, 2013. Pattern of structural geology underground in Eastern of North Dezfol embayment. Advances in Environmental Biology, 7(2): 260-268.

Moghimi, H., M. Arian and A. Sorbi, 2015. Fault movement potential of Marzanabad area, North Alborz, Iran. Open Journal of Geology, 5(3): 126-135.

Molin, P., F.J. Pazzaglia and F. Dramis, 2004. Geomorphic expression of active tectonics in a rapidly-deforming fore arc, sila massif. Calabria, Southern Italy. American Journal of Science, 304(4): 559-589.

Nouri, R., P. Afzal, M. Arian, M. Jafari and F. Feizi, 2013. Reconnaissance of copper and gold mineralization using ana-lytical hierarchy process in the Rudbar 1: 100,000 map sheet, Northwest Iran. Journal of Mining and Metallurgy, 49(1): 9-19.

Nouri, R., M.R. Jafari, M. Arian, F. Feizi and P. Afzal, 2013a. Correlation between cu mineralization and major faults using multifractal modelling in the Tarom area (NW Iran). Geologica Carpathica, 64(5): 409-416.

© 2015 Conscientia Beam. All Rights Reserved.

Nouri, R., M.R. Jafari, M. Arian, F. Feizi and P. Afzal, 2013b. Prospection for copper mineralization with contribution of remote sensing, geochemical and mineralographical data in Abhar 1:100,000 sheet, NW Iran. Archives of Mining Sciences, 58(4): 1071-1084.

Pazhoohan, M., M. Arian, M. Ghorashi and K. Khosrotehrani, 2014. A study of drainage pattern responses to active tec-tonics in Tadvan region, SW Iran. Geodynamics, 1(2): 36-41.

Poroohan, N., M. Poukermani and M. Arian, 2009. An assessment on correlations of seismotectonic parameters preceding and following Roudbar-Manjil Earthquake (Gilan, North of Iran). Australian Journal of Basic & Applied Sciences, 3(4): 2643-2652.

Poroohan, N., M. Pourkermani and M. Arian, 2013. An assessment of relationship in F-parameter and paleostress fields in heterogeneous lithologies: Roudbar area (Northwest of Iran). Australian Journal of Basic & Applied Sciences, 7(2): 933-942.

Pourkermani, M. and M. Arian, 1997a. Salt domes of central Iran. Journal of Humanities, 3(2): 29-41.

Pourkermani, M. and M. Arian, 1997b. Seismotectonics. Tehran: Dez Ab Consulting Engineers Company Press. pp: 270.

Pourkermani, M. and M. Arian, 1997c. Salt domes of central Iran. Journal of Humanities, 3(2): 29-41.

Pourkermani, M. and M. Arian, 1998a. Tectonic geomorphology of salt domes in West of Zanjan province, Iran. Geographical Research, 47: 44–53.

Pourkermani, M. and M. Arian, 1998b. Seismicity of Iran. Tehran: Shahid Beheshti University Press. pp: 212.

Pourkermani, M. and M. Arian, 2001. Structural geomorphology of Northeastern Kurdistan. Journal of Humanities, 7(16): 37-48.

Qorashi, M. and M. Arian, 2011. Tectonics of Iran. Tehran: Geologic Survey of Iran. pp: 336.

Rahimi, N. and M. Arian, 2014. Tectonic geomorphplogy of Hamedan-Sosangerd region, West Iran. Advances in Environ-mental Biology, 8(24): 119-124.

Rockwell, T.K., E.A. Keller and D.L. Jonson, 1985. Tectonic geomorphology of alluvial fans and mountain fronts near Ventura, California. In: Morisawa, M. (Eds). Tectonic geomorphology. Proceedings of the 15th Annual Geomorphology Symposium. Allen and Unwin Publishers, Boston. pp: 183-207.

Silva, P.G., J.L. Goy, C. Zazo and T. Bardajm, 2003. Fault generated mountain fronts in Southeast Spain: Geomorphologic assessment of tectonic and earthquake activity. Geomorphology, 250: 203-226.

Sorbi, A., M. Arian and M. Pourkermani, 2009. The movement potential evaluation of the major quaternary faults in Tehran quad-rangle. Journal of the Earth, 19(73): 176-182.

Sorbi, A., M. Arian and M. Pourkermani, 2011. The application of geomorphic indices to the assessment of relative tectonic activity levels in Tehran quadrangle. Journal of the Earth, 6(20): 1-9.

Wells, S.G., T.F. Bullard, T.M. Menges, P.G. Drake, P.A. Karas, K.I. Kelson, J.B. Ritter and J.R. Wesling, 1988. Regional variations in tectonic geomorphology along segmented convergent plate boundary. Geomorphology, 1(4): 239-265.

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