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Tectonics movements of Kuhbanan fault system in Bahabad region, Central Iran

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Abstract

Kuhbanan fault system, as one of the intracontinental faults of central Iran, is recognized by considerable seismogenic activities and modern morphotectonics evidences with a strike-slip (reverse component) motion. According to the geometric and kinematics data, Kuhbanan fault has been divided into 5 segments (S_{26}, S_{27}, S_{28}, S_{29}, S_{30}) in Bahabad region. Measured geomorphic indices of ratio of valley-floor width to valley height (V_f) and morphology of the valley (V) manifest the maximum denudation rate for the S_{28} segment. The mean calculated values of mountain-front sinuosity (S_{mf}) and %facet parameters for different segments of the fault are 1.1 and 83.16, consequently. Regarding to these geomorphic indices, a denudation rate of about 2-4 $mmyr^{-1}$ is suggested for this region. According to reconstruction of Kuhbanan fault since 360 ka, minimum horizontal cumulative displacement of 750 m and minimum slip rate of about 2-1.4±0.1 $mmyr^{-1}$ is inferred from well preserved geomorphology in the northern segment of the fault. Applying this horizontal cumulative displacement causes reconstruction of geomorphic markers such as drainages and shuttered ridges.

Keywords: *Active tectonics, Geomorphic indices, Drainage reconstruction, Cumulative displacement, slip rate, Kuhbanan fault system*

1. Introduction

According to previous studies, Iranian plate which compress by Arabian plate from south and Eurasian plate from north. Contain two micro plates of central Iran and NW Iranian plateau (Berberian and yeats, 1999; Walker et al., 2004) (Fig. 1). Iran micro plate divided to some blocks, which separated by any intracontinental faults system. These faults caused considerable structural and topographic variety in central Iran (Fig. 2). One of mentioned faults system is Kuhbanan fault system, which caused convergent faults system with Nayband fault , lakarkuh fault and Gowk fault system in west of Dasht-e-Lut.
Kuhbanan fault system with NW-SE trending and a long about 280 km extended from Bahabad region to northern part of Kerman state.Seismic activities in southern part of central Iran for this fault are evidences for these fault movements.

2. Tectonic setting of Kuhbanan fault system in west of Bahabad

2.1. Geology

Kuhbanan fault system in Bahabad region separated western fold and faulted blocks from Bahabad depression in east. Western rock units are mixed complex of dolomite, sandstone and evaporate sediments of Vendian (Rizu Seri) with brown dolomites and cherts of Cambrian (Mila Formation), Triassic dolomite and Jurassic sandstone and that Tertiary conglomerates. Mentioned rock units strongly affected by folding and faulting and plutonic dikes and stocks with acidic to intermediates component enter to them (Fig. 3).

2.2. Earthquakes

According to available seismic historical, 20th century and instrumental), Kuhbanan fault system caused 9 large earthquakes (Fig. 4; Table 1) (Ambrasays and Melville, 1982; Berberian and yeats, 1999, 2001; IIEES, 2008).

2.3. Active tectonics

According to geodynamics studies (Vernant et. al 2004. Nilforoushan et. al 2003), convergent displacement rate between central Iran blocks is less than 2 mm/yr, but low seismic rate in central Iran indicate strain accumulation in central Iran is less than 10% of that strain which caused by convergent movement between Iran-Eurasia plates.

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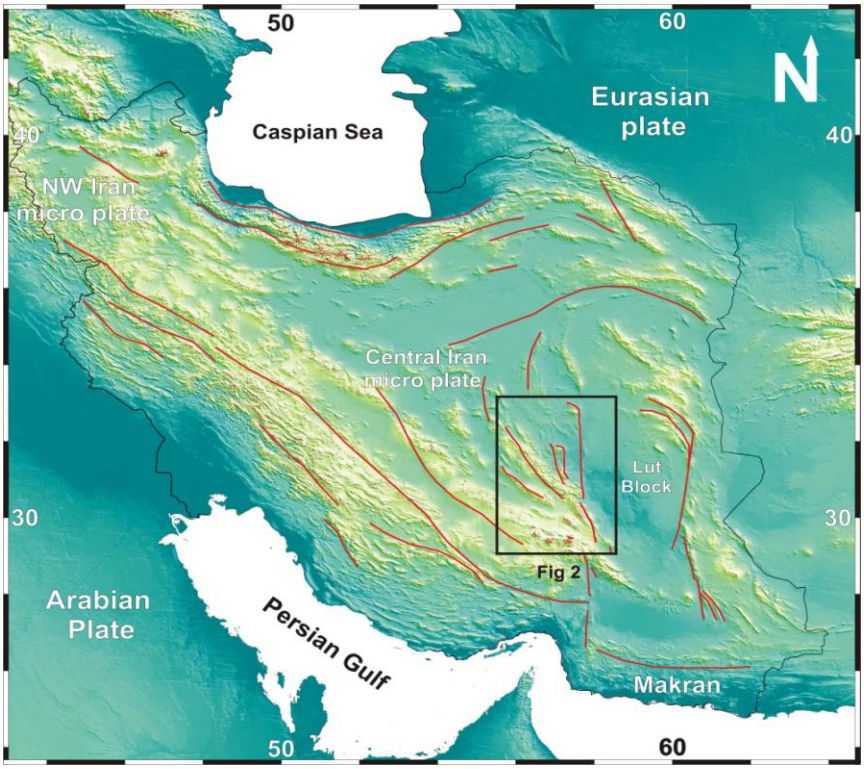

Fig. 1. Main structural unites of Iran and surrounds Plates.

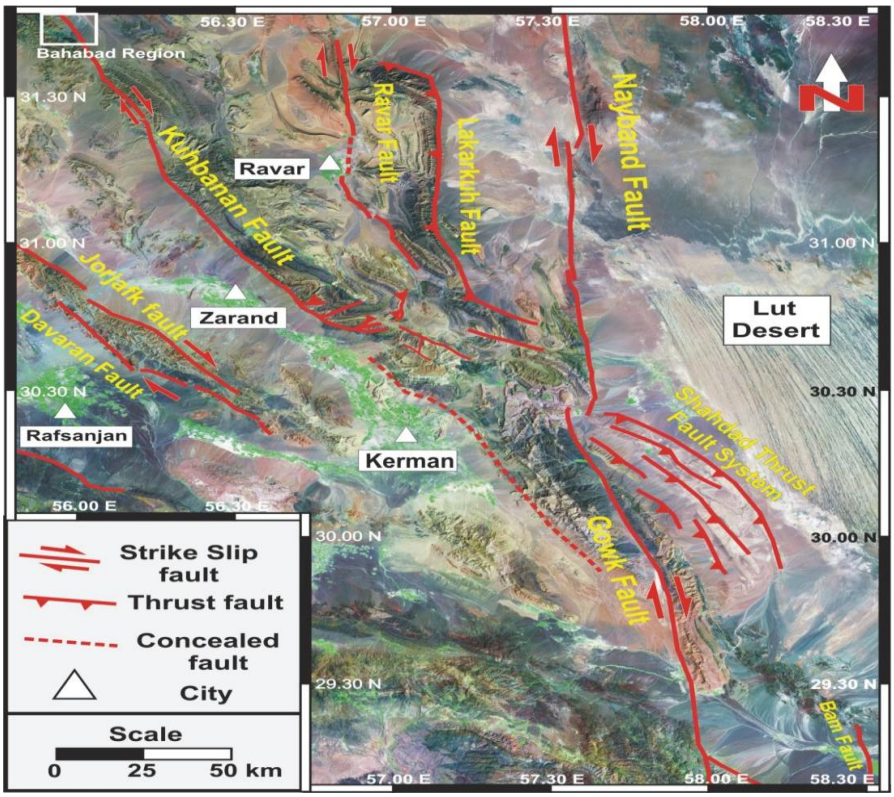

Fig. 2. Satellite image of south of central Iran with its faults system. (Notes to faults system convergence in this region).

Base on trend and magnitude of GPS velocity vectors, most strain accumulation rate in central Iran crust is aggregate at north Kerman and attends with seismic events and recent deformation in this region (Shafiei bafti, 2005). For investigation of neotectonics and morphotectonics reconstruction of Kuhbanan fault system in Bahabad region, we prepare morphotectonics map of this region (Fig. 3). In figure 3, Jurassic sandstone shale's shown with A and A´ and upper Miocene-Lower Pliocene conglomerates shown with B and B´. separation of A´and B´ unites along Kuhbanan fault trace is about 7 km. and cumulative displacement of Kuhbanan fault for B´ and B" unites , in AZ= 135, measured about 750m. mentioned movement are dextral strike-slip with reverse vector.

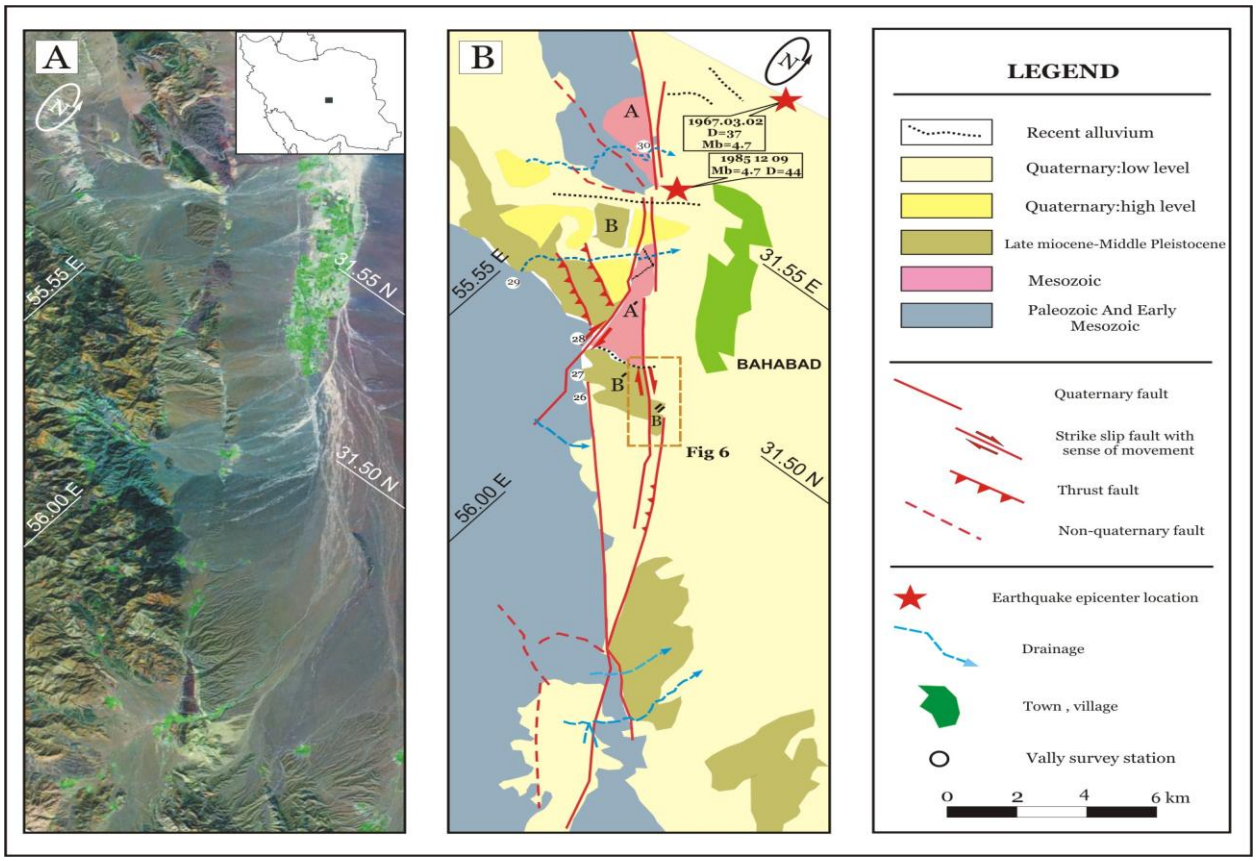

Fig. 3. A) Satellite image of Bahabad region. B) Sketch geological and morphotectonics map of same region

Table1. Epicentral and source parameters of Kuhbanan fault system Earthquakes (Ambrasays and Melville, 1982; Berberian and yeats 1999, 2001; IIEES 2008).

Time	Location	M0 & Mw	I0	Characters
1897.05.27	**Chatroud**	**5.3**	VII	Chatroud and sarasiab destroyed. Ghobe sabz dome damaged.
1875.05.?	**Kuhbanan**	**6**	VII	Vaset village destroyed and Kuhbanan area damaged.
1871.08.04	**Chatroud**	**5.9**	VII	This event caused destroyed Chatroud Qanats
1864.01.17	**Chatroud**	**5.9**	VII	Kerman and Chatroud damaged and many people killed.
1933.03.28	**Bahabad**	**6.4**	VII	This event caused coseismic rapture about 10 km and dextral strike slip equal 0.5 m.
1977.12.19	**Babtangal**	**5.8**	VII	This event caused coseismic rapture about 19.5. 660 people killed and 260 people injured.
1987.04.11	**Bahabad**	**5**	VII	This event caused coseismic rapture about 20 km and dextral strike slip equal 12 cm.
2005.02.22	**Dahuiye**	**6.4**	VII	This event caused coseismic rapture about 10. 700 people killed and 1000 people injured.

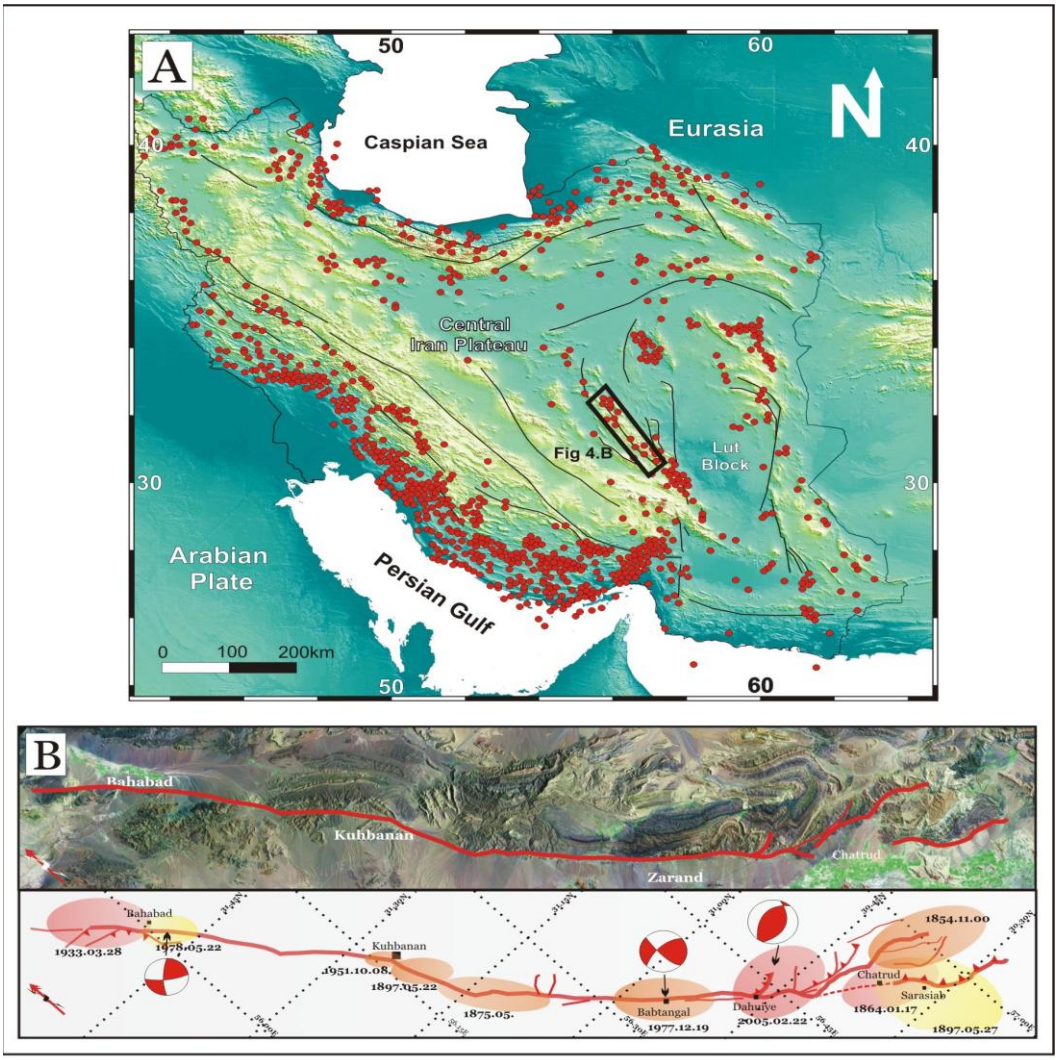

Fig. 4. A) Seismicity of Iran with epicenters from the catalogue of Engdhal et al. (2005). B) Meisoseismal of areas around of Kuhbanan fault system

Table 2. Measured geomorphic Indexes of (S_{mf}) and (%facet) for Kuhbanan fault system in west of Bahabad.

Fault segment	L_s(km)	L_f (km)	S_{mf}	Facet %	Limit(km)
26	14.4	12.25	1.028	85.1	14.7
27	4.95	3.9	1.071	78.8	5.3
28	9.45	7.77	1.034	82.2	9.77
29	2.85	2.45	1.053	86	3
30	7.17	6	1.130	83.7	8.1

3. Discussion and Result

3.1. Estimation of denudation rate in kuhbanan fault system by geomorphic indexes

Denudation rate of Kuhbanan fault system in Bahabad region, calculated by geomorphic indexes of mountain front sinuosity (S_{mf}) and Faceting parameter (%facet), ratio of valley-floor width to valley height (V_f) and morphology of the valley (V) (Keller and Pinter, 1996; Morisawa, and Hack, 1985; Rockwell et al., 1985; Summerfield, 1985; Mayer, 1985) (Tables 2-3).

For determination of denudation rate of Kuhbanan fault system, that divided into 5 segments (S_{26}, S_{27}, S_{28}, S_{29}, S_{30}) by use geomorphic and Kinematics data (Fig 5).
Uses geomorphic and kinematics evidences for this segmentation are:

- Change of geometrical of fault trace.
- Cross point and branching of fault trace.
- Initial of extensional steps and strained bends.
- Change of petrologic characters along fault trace.
- Nature and manner of distribution of seismic events and depths of them.

According to measured value of (S_{mf}) and (%facet), and classification of tectonical activities, Kuhbanan fault indicate very high activity. The mean calculated value of (%facet) is 83.16 which that indicate a high activity region. Base on mean value of calculated of (S_{mf}) , we propose denudation rate of Kuhbanan fault, about 2-4 mm/yr. high dips of Pleistocene – Holocene unites, confirm this suggest. The value of (V_f) indicate Changes between 0.58 to 2.33 (Table 3).

The decrease of V_f value for R28 and R26 valleys manifest maximum denudation rate for this fault segments.
The lowest denudation rate is belonging to R30 valley (Table 3). V shaping of valleys, high deep, and low Wide of valleys; confirm the high denudation rate in R30 valley. Existence of meandering of stream, low deep and high wide for R_{26}, R_{27}, R_{29}, R_{30} confirm the low denudation rate for their segments. The measured geomorphic index values are correlated with topography of studied region. Base on reconstruction of streams and beheaded ridges and shutter ridges, minimum horizontal cumulative displacement of Kuhbanan fault system since 360 ka is 750m and minimum slip rate is about 2-1.4 ± 0.1 mm/yr (Fig. 6).
Applying this horizontal cumulative displacement cause reconstruction of geomorphic markers such as drainages and shutter ridges (Fig. 6C and D).
Cumulative displacement of upper Miocene – Pliocene conglomerate by southwestern branch of Kuhbanan fault system (7km in 11.6 ma) confirm this slip rate.

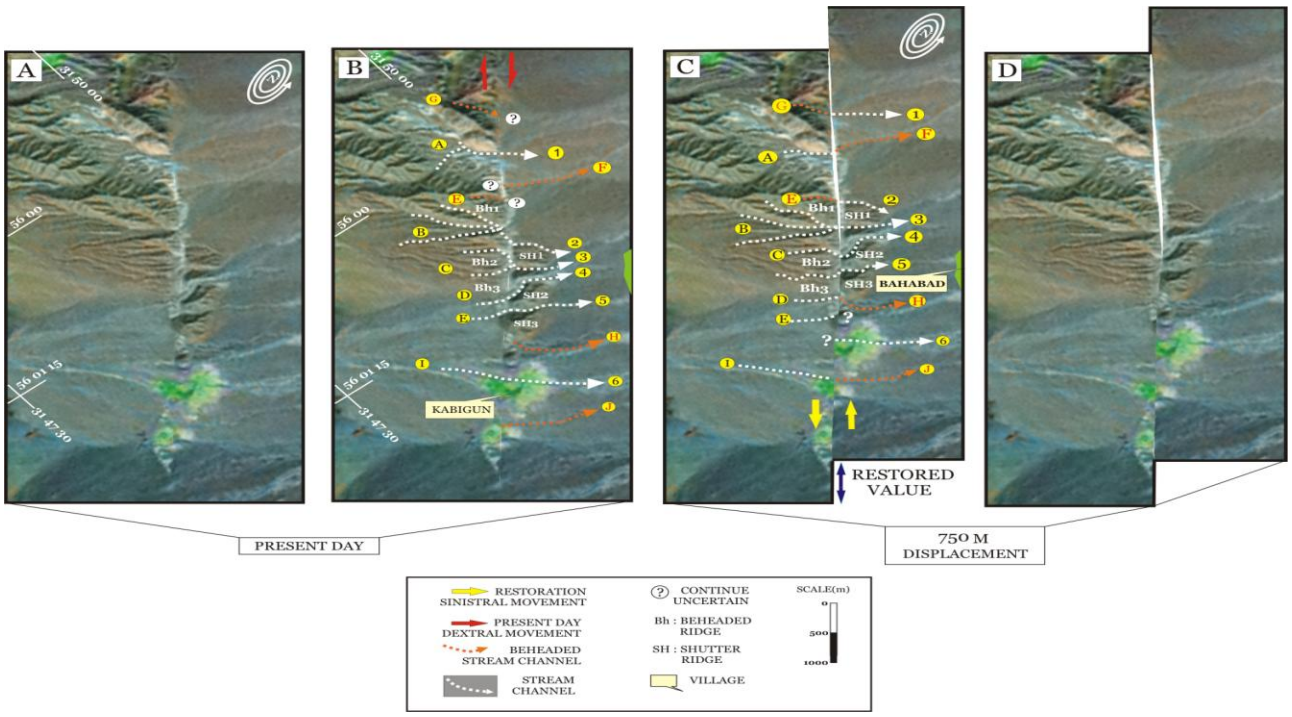

Fig. 5. Histogram of (S_{mf}) and (%facet) values for Kuhbanan fault system segments in west of Bahabad.

Table 3. measured geomorphic indexes of ratio of valley-floor width to valley height (V_f) and morphology of the valley (V) for Kuhbanan fault system in west of Bahabad.

Valley NO.	Erd(m)	Eld(m)	Esc(m)	V_{fw}(m)	A_v(m)	A_c(m)	H	V	V_f
26	2020	2020	1970	70	508250	3927	50	2.1008	1.4000
27	1900	1900	1810	70	26050	12723	90	2.0475	0. 7778
28	2040	2040	1870	100	950	45396	170	0.0209	0.5882
29	2000	2000	1890	90	41250	19007	110	2.1703	0.8182
30	1580	1580	1550	70	7400	14143	30	0.5236	2.3333

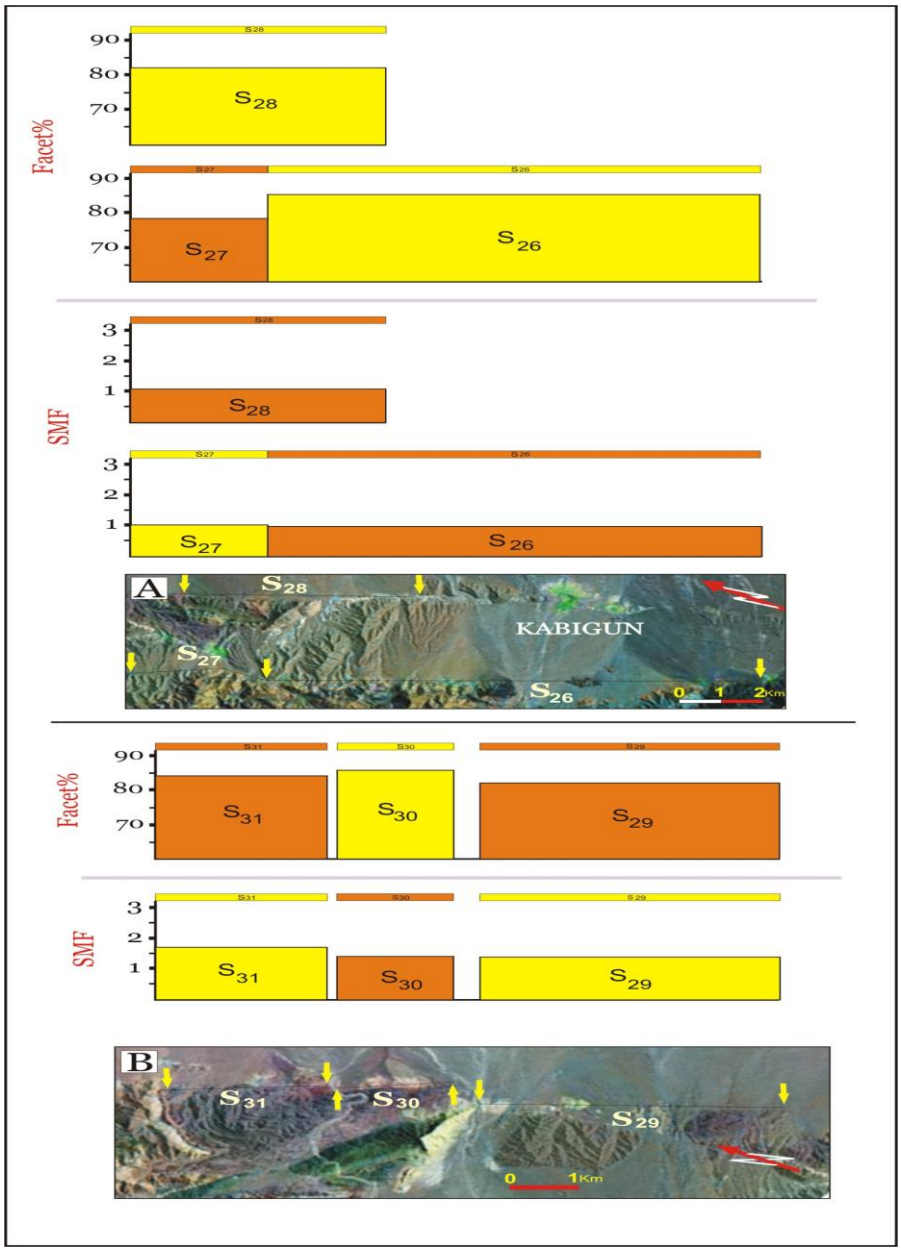

Fig. 6. 750m kinematics reconstruction of Kuhbanan fault system in western branch, west of Bahabad. A and B, now situation of streams. C and D streams situation with 750m restored sinistral strike slip movement.

4. Conclusions

Our studied on Kuhbanan fault system indicate this fault is high active and caused morphotectonics feathers in bahabad region. Rate of mountain-front sinuosity (S_{mf}) for all of the segments is near to 1 and appear a denudation rate for this region. Rates of %faceting with measured mean rate 83.16 refer to high tectonics activities of this region. According to V_f and V rates, maximum denudation rate belong to R28 and minimum belong to R30. We propose mean denudation rate for Kuhbanan Fault system is about 2-4 mm/yr in Bahabad Region. According to age of deposit units in west of Bahabad and assumption Kuhbanan fault affecting and stream erosion, after sedimentation, minimum cumulative displacement for Kuhbanan fault system is 750m for since 360 ka. And minimum slip rate is about 2-1.4 ± 0.1 mm/yr.

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