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Study of Naghshe Rostam Fault in Geoelectrical Approach, Zagros Mountains

Hatam Quanbari[1] , Mohsen Pourkermani [*2], Abdoolmajid Asadi[3], Soheila Bouzari[4], Manoucher Ghorashi[5]

[1]PhD. Student, Faculty of Earth Science, Islamic Azad University, north Tehran branch, Iran,
[2]Professor, Faculty of Earth Science, Islamic Azad University, north Tehran branch, Iran,
[3]Assistant Professor, Faculty of Earth Science, Islamic Azad University, Shiraz branch, Iran
[4]Assistant Professor, Faculty of Earth Science, Islamic Azad University, north Tehran branch, Iran
[5]Associate Professor, Research institute for earth sciences, geological survey of Iran, Iran
pourkermani.mohsen@gmail.com

Abstract

One of the most common methods for investigation of subterraneous layers and condition of alluvium for studying faults is particular resistivity geo electrical surveying methods. The goal of this paper is detecting of the situation of Naghshe Rostam fault by geo electrical method. These studies are shown that Naghshe Rostam fault has dip-slip component in addition to having dextral strike-slip component. This paper reports the data acquisition, graphs, processing, and analysis.

Keywords: Geoelectric; Resistivity method; Geophysics; Fault; Iran.

Introduction

One of the most common methods for investigation of subterraneous layers and the condition of alluvium is geo electrical surveying methods, particular resistivity method. The direct current (DC) or alternating current (AC) used with low frequency (about 1-2 HZ) in this method. The resistance of rocks has relation with their lithology that these variations of resistance are measured on surface.

The current intensity is injected from a source into earth through a pair of electrodes as known the current electrodes with AB distance than each other, then the potential difference is measured between a pair of electrodes called potential electrodes in MN distance from each other.

The large alluvial Marvdasht plain bounded between latitude $29^{\circ}27'$ to $30^{\circ}18'$ N and longitude $52^{\circ}25'$ to $53^{\circ}22'$ E, which is located about 60 km north-east of the city of Shiraz in Fars province in southwest Iran and have area about 7.4 hectare (Fig. 1). It is situated in the Zagros fold-and-thrust belt. The Zagros mountain range is divided into three tectonics zones from the NE to the SW: the High Zagros, the Zagros Simply Folded Belt, and the Zagros Foredeep Zone [1,2]. The study area is located in the Simply Folded Belt (SFB) which has particularly been studied owing to the salt plugs and its structure at south and high Zagros at north.

The study area is covered by young alluvial of quaternary age that it has been covered the geological structure and fractures. In the Basin of Marvdasht, late Quaternary basin fills consist of loess, loess-like sediments and fine- or coarse-textured alluvium [3]. Salinity of the water resources increases downstream towards the salt lakes, whereas water table depth decreases to less than 2 m in the same direction. The shallow water table results from poor natural drainage of heavy textured alluvial deposits, excessive irrigation and seepage from irrigation canals. During the past, groundwater tables have risen as documented for the years 1971 to 1985 as published Nadji 1997 [4]. In the last two decades, they possibly decreased because of the construction of drains and lined canals in combination with excessive extraction of groundwater by wells [3]. Further details on the irrigation system and water quality of Marvdasht plain are given by Ghassemi et al. (1995) [4]. The climate of the area is inland climate. The average annual rainfall of the area is more than 300 mm [5].

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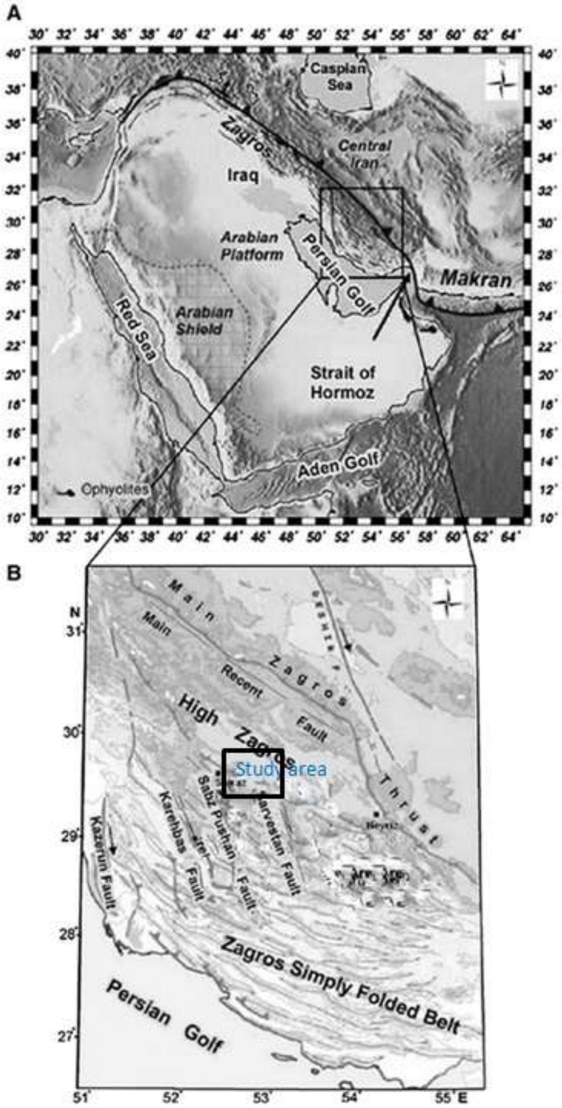

Figure 1: Location of the study area in (A) a map of the Middle East and (B) a schematic structural map of the Fars, Modified after Lacombe [6].

Marvdasht plain has upland, broken anticlines and long synclines with northwest-southeast trend. Hardness and mainly calcareous deposits and Erodible sediments form highlands and Lowlands of basin. Folded Zagros located at south-southwest and high Zagros was at the eastern part of this basin. The strike of main geological structures are northwest-southeast which have been cut by faults with north-south or north northeast-south south west trend. Neyriz formation is the oldest formation belongs to lower Jurassic. It is a clastic formation with lithological composition of shale and quartzite. Khami formation is located on it that has upper Jurassic or early Cretaceous age. This formation is composed of Sormeh, Daryan, Fahliyan and the marly limestone of the Gadvan formations. The other formations are Kazhdomi formation and Bangestan group which is composed of Sarvak and Ilam formations belong to early Cretaceous to late Cretaceous [7,5,8]. In the present paper the authors had made an attempt to find Naghshe Rostam Fault in Marvdasht plain basins.

Materials and methods

Equipments, Techniques and Measurements

Schlumberger array have been used in survey data by Geo Electrical surveying method-resistance assessment that it used in electrical exploration widely. In this method, four electrodes AB, MN are generally arranged in a linear array, respectively. The array is AB ≥ 5MN so that AB should be at least five times MN. The method VES (vertical Electric Sounding) which depth variations of resistivity of subsurface layers can be studied by it are used. If the ground be consist of a series of homogeneous and isotropic, horizontal layers, findings (VES) just revealed variations of resistivity with depth. But in practice, the findings (VES) were affected by non-homogeneous vertical and horizontal resistivity. Therefore, implementation-interpretation and presentation of findings sounding should be as variations of resistivity were recognizable than vertical variations easily [9,10].

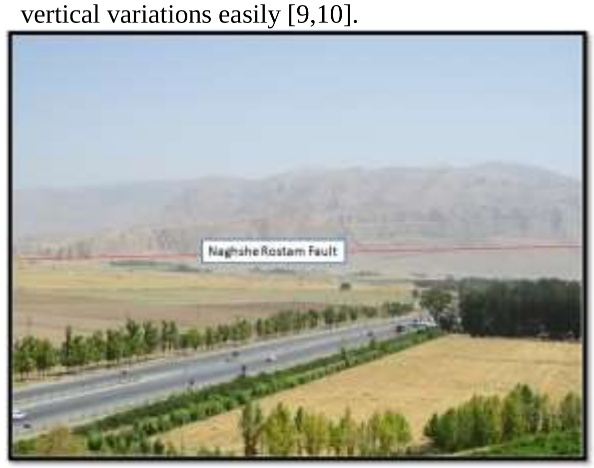

Figure 2: The general view along the Naghshe Rostam fault (view 0°).

The Site selection of survey points has been done for determining of approximate location of fault line by geo electric (resistivity) notice to viewed feature of fault in the field in the studied region, then we achieved the coordinate system of desired location using GPS, we implemented coordinate system of obtained points using a laptop machine

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armed ARC GIS software, in which satellite images implemented, geological and topographical maps that they has been geo referenced in it ,then desired points corrected by created DEM images in ARC SCENE software, then survey of geophysical data has been done by 7 points for creating profile with arrays whose the length of each one is 2000 m in the northern and southern region of Naghshe Rostam fault ,respectively. It should be mentioned it wasn't possible to survey data in another points due to abundant foothills and high topography differences in a broad range of length fault line. Figure 2 which show a picture of Naghshe Rostam fault (view north); Figure 3 shows the region three-dimensional DEM is created by topographic lines with 30 meter precision of desired region in different views [11].

Figure3: The view of passing region of Naghshe Rostam fault on DEM image. (View north)

Results and discussion

Geo Electric - resistivity device PASI GL-16 model is used for survey of data in this course. Figure (4) indicates the picture of mentioned device and Figure (5) shows how establishing the device is. Despite the sites of survey should be flat and lack of intense of topography difference in a wide range of mentioned fault caused that there were many restrictions for performance of geophysical operations so that the range of AB points were limited to 4000 meters in maximum and 200 in minimum for sounding in the region .The UTM coordinate of the survey data in the northern and southern region of fault ,respectively with the long range of AB points for each one 1000 meters, the sites of survey on satellite image of region has been shown in Table (1) and Figure (6),respectively. Then, using IPI2WIN and IX1D (Version 3) softwares relevant data were investigated and their cross sections related to the fault zone were drawn that it is given in the forms of numbers (14) to (19). We used exist well logs for drawing Geoelectric cross sections.

Figure 4: it indicates the geophysical device PASI whose model is GL -16.Contribute a better translation

Figure 5: it shows how establishing the device is

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Table 1. The coordinate system of the sites of survey data

The name of Profile	The name of soundages	Elevation (m)	UTM	
			X	Y
13	P13-1	1588	670807	3304168
	P13-2	1593	671325	3304916
	P13-3	1595	671372	3306100
	P13-4	1594	672392	3306740
	P13-6	1597	673675	3308042
	P13-7	1597	673886	3308069
	P13-8	1600	674970	3309175
	P13-9	1600	675004	3309732
	P13-10	1605	676779	3310524
	P13-11	1607	677370	3311226
	P13-12	1607	678028	3311834
	P13-13	1610	678765	3312717
	P13-14	1612	679478	3313317
	P13-15	1615	680354	3314102
	P13-16	1618	680831	3314637
	P13-17	1619	684449	3315345
14	P14-2	1628	683530	3317537
	P14-4	1632	684828	3319028
	P14-5	1636	685420	3319704
	P14-6	1634	686235	3320427
15	P15-1	1588	669468	3306946
	P15-2	1593	669396	3307339
	P15-3	1594	670142	3308165
	P15-4	1597	671182	3308789
	P15-5	1598	671916	3309605
	P15-7	1600	673055	3310912
	P15-8	1603	673778	3311758
	P15-9	1602	674301	3312362
	P15-10	1604	675174	3313207
	P15-11	1606	675775	3313953
	P15-12	1607	676631	3314572
	P15-13	1611	677116	3315382
	P15-14	1615	677480	3316176
	P15-15	1621	678500	3316695
	P15-17	1620	680073	3318439
	P15-18	1602	680493	3318907
16	P16-1	1596	666408	3308776
	P16-2	1591	667379	3309211
	P16-3	1593	667945	3310196
	P16-4	1595	668786	3310964
	P16-5	1596	669495	3311560

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	P16-6	1596	670099	3312363
	P16-7	1597	670324	3313164
	P16-8	1599	671216	3313580
	P16-9	1600	672097	3314472
	P16-10	1605	672873	3315376
	P16-11	1606	673714	3315968
	P16-12	1608	674154	3316720
	P16-13	1610	674937	3317355
	P16-14	1611	675674	3318306
	P16-15	1614	676406	3319011
	P16-16	1615	677244	3319798
	P16-17	1615	677647	3320517
	P16-18	1614	678534	3321174
	P16-19	1592	679563	3322081
40	P3-3	1573	698558	3293895
	P5-5	1575	694013	3297854
	P6-6	1578	691572	3299737
	P7-6	1583	689559	3301702
	P8-9	1589	687271	3303950
	P9-11	1595	684854	3306034
	P10-11	1600	682665	3307972
	P11-13	1607	681788	3311430
	P13-12	1607	678028	3311834
	P15-11	1606	675775	3313953
	P16-11	1606	673714	3315968
	P17-10	1599	671208	3317955
	p20-9	1601	666964	3321563
	p22-4	1604	664430	3323661
	p24-2	1607	662206	3325907
	p26-2	1609	659754	3327873
	p27-4	1615	657593	3330064
	p29-2	1615	655329	3332098
40	p31-4	1618	652774	3333905
	p32-4	1619	650595	3336208
	p33-4	1625	648217	3338310
	p40-6	1577	695142	3296899
	p40-7	1576	692854	3298864
	p40-8	1579	690601	3300851
	p40-9	1587	688331	3302875
	p40-10	1591	686101	3304908
	p40-11	1598	683700	3306951
	p40-12	1604	681500	3308900
	p40-13	1608	679302	3311100
	p40-15	1605	674697	3314814
	p40-16	1600	672350	3317021
	p40-19	1606	665566	3323053

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	p40-20	1607	663241	3324784
	p40-21	1608	661132	3326956
	p40-22	1609	658964	3328942
	p40-23	1616	656531	3331149
	p40-25	1618	651774	3335333
	p40-26	1622	649639	3337140
41	P8-3	1586	683143	3298870
	P9-5	1592	680172	3301100
	P10-4	1594	678139	3303207
	P11-5	1594	675553	3304789
	P15-4	1597	671182	3308789
	P16-4	1595	668786	3310964
	P17-2	1592	665561	3312437
	p18-4	1594	663798	3314347
	p20-2	1598	661753	3316860
	p41-1	1583	683692	3298104
	p41-2	1587	681368	3300039
	p41-3	1593	679062	3302031
	p41-4	1595	676821	3303927
	p41-7	1595	669933	3309762
	p41-9	1595	665188	3313572
	p41-10	1597	663075	3315692

Figure 6: The geo electrical survey profiles on satellite image.

Profiles 13,14,15 and 16 have a SW-NE trend with 16831,4277,17020 and 19531 meter length and 16,4,16 and 19 soundings, respectivly.whereas two profiles (40 and 41) are perpendicular to other profiles. They have a NW-SE trend with 67652 and 30276 meter lenghth and 38 and 16 soundings. (figure 6) apparent resistivity is low except in surface layers that it is maybe because water in alll of profiles and apparent resistivity is high in the depth becase of different litology in the most of soundings.

The resistivity is low in some soundings why salt water penetration to limestone. The fault zone was investigated by increasing humedity and decreasing the resistivity in region. There is five layers in profiles 13,15 , 16 and 40. The first three layers are alluvium and the fourth and fifth layers are shale, marl and wet limestone (Sarvak formation). There is a fault zone in p13-1, p13-2 ,p13-15 to p13-17 and p13-7 , p13-9, p14-4 and p14-5,p15-4, p15-5,p15-7,p15-8,p15-11,p15,12, p15-14 to p15-17, p16-9, p16-10, p16-5 , p16-6, p16-1, p16-2, p16-11,p16-12, p16-18 , p16-19 , p8-9 , p40-9, p6-6, p40-8, p40-15 , p40-16, p40-20, p22-4, p22-4 , p40-19 , p40-25 , p40- 23, p10-4 and p41-3 , p17-3, p16-4, p41-7, p9-5 according to the obtained data from geophysical surveys and drawn profiles. The variation of apparent resistivity (13.8-47 Ωm is vertically generally, in profile 14. There is three layers in this profile. The first and second layers are alluvium and the third layer is wet limestone. Finally, there is four layers in profile 41. Two first layers are alluvium and third and fourth layers are shale, marl and wet limestone , (figures 7,8).

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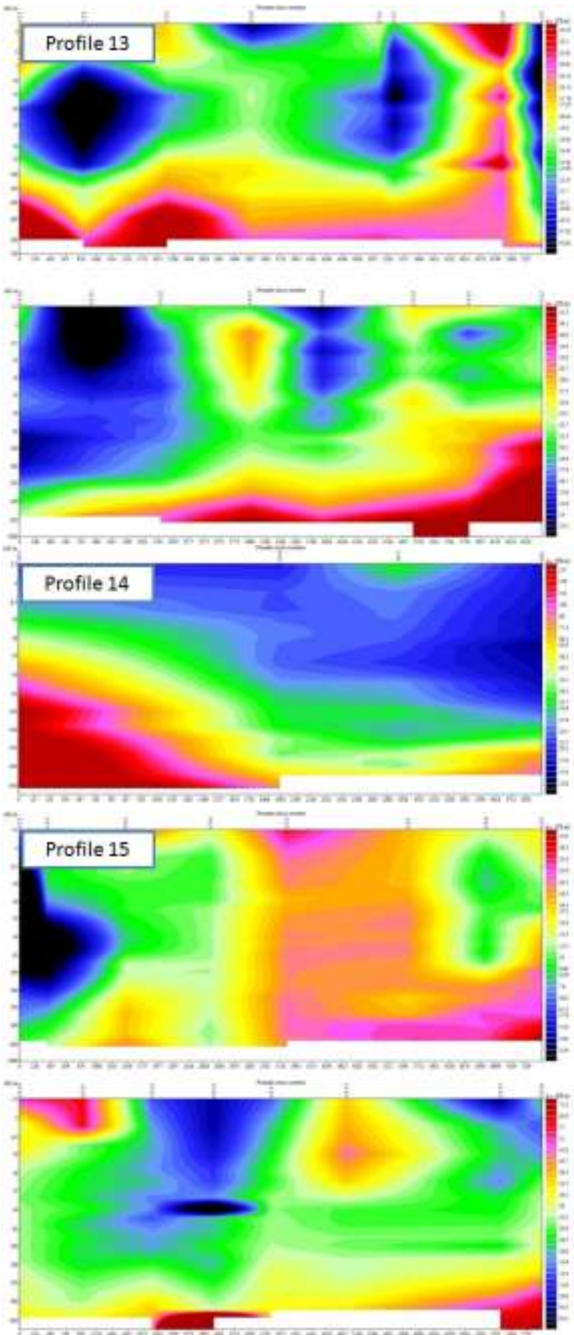


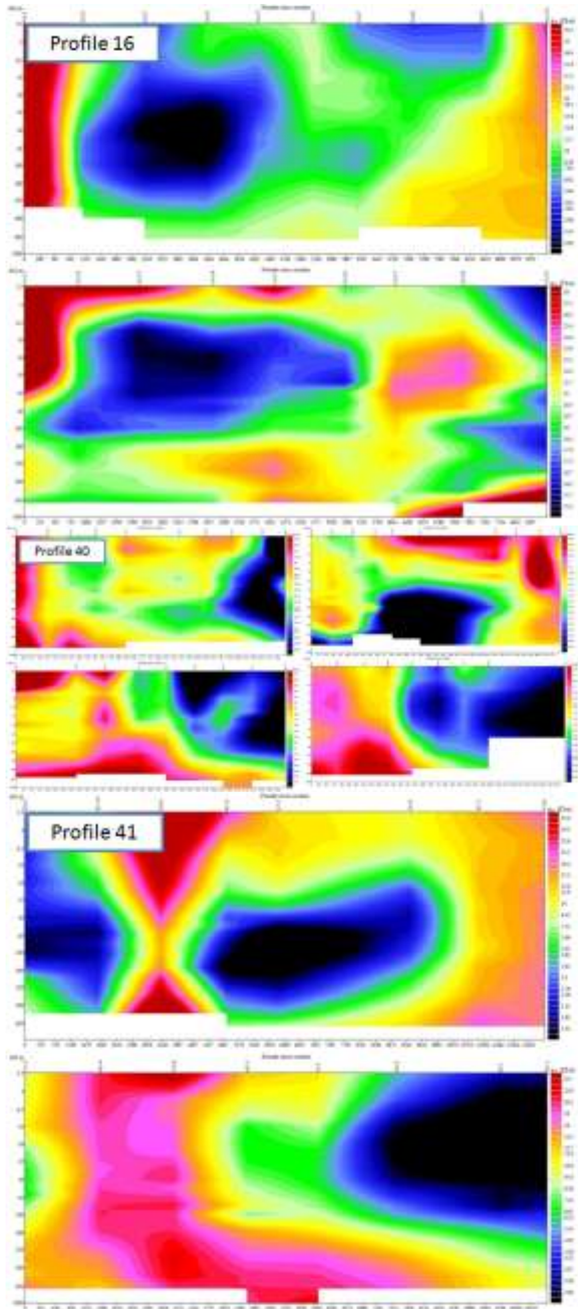
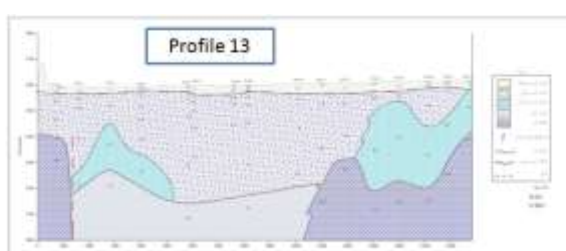


Figure 7: The pseudo cross section of profiles



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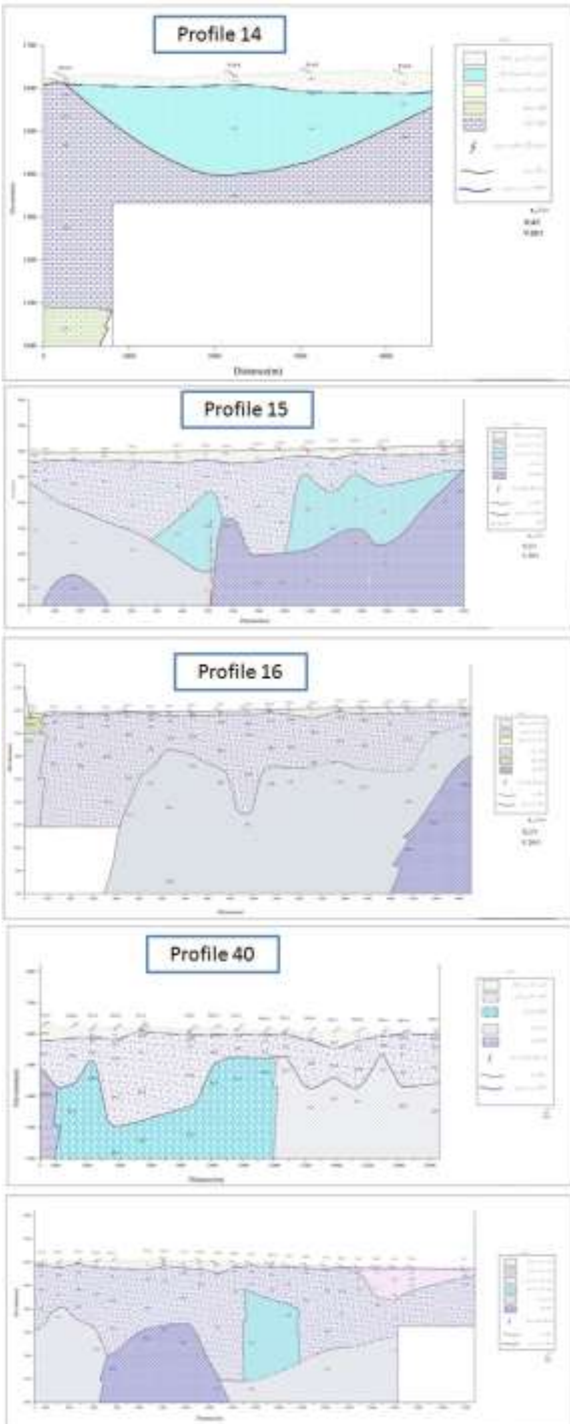

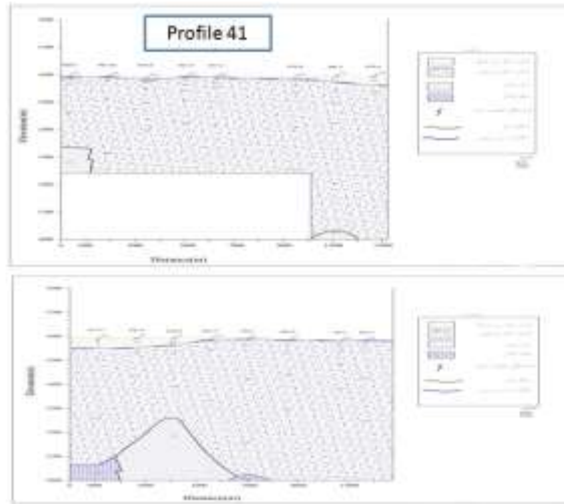

Figure8: The Geoelectric cross section of the section of profiles related to the Naghshe Rostam fault.

We found the passages of Naghshe Rostam fault zone by geoelectrical method in the Marvdasht plain. Then,we probed the surface evidents. There was fault mirror in historical heriastages Naghshe Rostam. We obtained the data of slikensides in 3 points (figure 9) and therefore we haw drawn the fault plane solution, (figures 10 , 11). Other obtained evidents are indicated in figures 12 to 15.

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Figure 9: the position of obtained slickenside data in the length of Naghshe Rostam fault.

Figure10: obtained fault plane solution (27) in the length of fault (view 305°)

Figure 11: obtained fault plane solution (28) in the length of fault (view 335°)

Figure 12: joints in Naghshe Rostam fault surface (view 310°)

Figure 13: new movment because of Naghshe Rostam fault in quaternary alluvium (view 240°)

Figure 14: fault breccia in Naghshe Rostam fault surface (view 305°)

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Figure 15:changing in the passage of Kor river in the length of Naghshe Rostam fault zone (view 310°)

Conclusion

According to the obtained general trend of fault, surface features, DEM models and satellite images, the general trend of fault has interpolated. The general trend of Naghshe Rostam fault zone is N60W in Marvdasht plain as shown in figure 16, (N60W/90°, SE). We found the length of 28 km for it from Naghshe Rostam historical heritage in northeast to Sabz anticline in southwest.

Figure 16: The general trend of fault

Intense topography difference has created due to it in this region. It should be mentioned that the Naghshe rostam fault causes divagation and tilted at the trend of anticlines (Sabz, Rahmat and Husain).

The graphical geo electric Profiles in the northern and southern fault zone in the plain state tectonics movements in the mentioned region. Profiles show that the basement has located in the more depth than the south region in this area.

The results of morphotectonics evidence and Geoelectrical surveys indicated what the Naghshe Rostam fault zone as a normal fault has dextral strike-slip component in addition to having normal dip-slip component. The changing in the trend of three anticlines mentioned above and the Kor River in Marvdasht plain from the passing region through the fault proves it.

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Author Biblography

Hatam Quanbari

He was born in Shiraz, Iran. He is graduated in B.S and M.Sc in tectonics from Shiraz University and Islamic Azad University, Shiraz branch respectively. He is PhD Student at IAU (Islamic Azad University north Tehran branch, Iran). His interested research fields are: Study structural geology (using geometric-kinematic modeling, structural field Studies and statistical data analysis, and analogue modeling); Study geophysics data by (using field work and statistical data analysis and interpretation of reflection seismic profiles); Application of micro geodesy instrument to continental deformation tectonics. Study application of tectonics in the Development and Exploration of Water Resources.
Description upto 100 words
Email:h.quanbari.g@gmail.com

MohsenPourkermani

He was born in 1946, in Tehran, Iran. He is graduated in B.S, M.Sc and PhD in structural geology from the University of Tarbiat Moallem Tehran, University of Montpellier and university of Paris, respectively. He was full professor at Shahid Beheshti University and now is at Islamic Azad University, north Tehran branch, Iran. His interested research fields are the study structural geology, seismotectonics and morphotectonics.
Email:pourkermani.mohsen@gmail.com

Abdoolmajid Asadi

He is graduated in PhD degree in tectonics from the earth science department of the Tehran science and research university, Iran in 2005. He is currently associate professor of structural geology and tectonics at the earth sciences department of the Islamic Azad university Shiraz branch, Iran. his research interests include: (I) the study structural geology (using geometric-kinematic modeling and analogue modeling) ;(II)study geophysics data by (using field work and statistical data analysis and interpretation of reflection seismic profiles) ;(III)seismic earthquake rejection (using fractal methods).
Email:asadi.abdolmajid@gmail.com

Soheila Bouzari

She is graduated in PhD degree in tectonics from the earth science department of the Tehran science and research university, Iran. She is currently associate professor of structural geology and tectonics at the earth sciences department of the Islamic Azad university north Tehran branch, Iran. Her research interests include: (I) the study structural geology (using geometric-kinematic modeling and analogue modeling) ;(II) Micro tectonics ;(III) Geodynamic and salt tectonics.
Email: s_tectonic@yahoo.com

Manoucher Ghorashi

He was born in 1941, in Iran. He is graduated in B.S, M.Sc and PhD in structural geology from Tehran University and London University, respectively. He was Associate Professor at Research institute for earth sciences, geological survey of Iran. His interested research fields are neotectonics and seismotectonics.
Email:ghoroshi_manoucher@yahoo.com