Chapter 5

Mapping

Structural Geology

Email: moshaver1380@yahoo.co.uk
5-1- General Statement

The Zagros Structural Belt began to form about 70 m.y. ago, when the Tethys Ocean (precursor to today's Mediterranean) started to close as the African Plate moved northward against the Eurasian sets of plates (Falcon 1974). The orogeny climaxed in the late Cenozoic and is still active.


Space imagery is well-suited to the recognition and interpretation of the types of distortions of layered strata that produce geological structures such as folds, faults and lineaments. Large faults and folds are easily recognized on satellite imagery as well as in outcrop level. The emphasis for the mapping of thrusts, faults, folds and lineaments

Email: moshaver1380@yahoo.co.uk
in the Zagros Structural Belt (i.e. Dezful-Brojerd) was carried out considerably using Landsat ETM, 9-Nov.-2002 of bands 4-3-2 FCC (Fig. 5-1). The use of satellite imagery enable easy mapping and focus on a large area for structural interpretations. In addition to this, DEM of the study area was extracted within the GIS environment. Utility of DEM was to generate the 3-D of the Zagros Structural Belt and increase the accuracy of the interpretation on the image.

The Zagros mountain belt is supposed to be the best exposed fold-thrust belts in Iran as well as in the world. In this regards, little is known about the structures of the Zagros Structural Belt. The Zagros Structural Belt has undergone structural evolution in response to subduction followed by plate collision of the Arabian and Iranian plates. The initial collision resulted in development of thin skin tectonic in the supracrustals. The strain in the Zagros Structural Belt under this workout is expressed as folds, faults and lineaments.

In the present study the selective ground verification of the structural elements was carried out to understand the structural behaviour and related movements. The purposes of this study are (1) to show the applicability of the remote sensing data in structural geological study (faults, folds and lineaments) in the Zagros structural Belt, (2) to produced different FCC images by several enhancement techniques for structural mapping, (3) to prepare updated structural map based on the remote sensing data interpretation, (4) capability of the GIS techniques in structural mapping of the Zagros Structural Belt.

Email: moshaver1380@yahoo.co.uk
5-2- Structural Mapping & Interpretation

The study of the structural elements in the Zagros Structural Belt using remotely sensed data integrating with GIS techniques provide interesting result for interpretation of structural and tectonics.

Faults, folds and lineaments interpreted from remotely sensed data are often used as indicator of major fractures in near surface (Juhari and Ibrahim 1997). Many workers mapped and interpreted the structure of a region based on the information extracted from aerial photographs and satellite images. The benefits of using digitally processed satellite data for structural mapping and interpretation are carried out and shown by several workers such as Rowan et al. (1974), Siegel and Abram (1976), Blodget & Brown (1982), and Rothery (1985).

These mountains consist mainly of elongate folds, which arch upwards as anticlines and downwards as synclines. The anticlines here make up distinct landforms as high hills with central ridges that taper at either end (a condition referred to as a closed fold).

Faults, folds and lineaments mapped in the field are registered on the satellite image and DEM viewed on the screen. High-resolution digital topography, spectral and spatial characteristics have guided for structural mapping.

Email: moshaver1380@yahoo.co.uk
5-2-1- Methodology

Recently geologists are interested in tracing lineaments from satellite images. Faults, folds and lineaments can easily be traced on the image using different bands. Insofar, faults, folds and thrusts are digitally mapped on the basis of the photographic and geotechnical elements such as tone and vegetation respectively. Structural map is created using field data and input data.

In order to represent the relationship between the topography and drainages patterns of the area with faults, folds and lineaments the topographic data viewed as a grey scale image (Fig. 5-2) is digitally extracted using ER-Mapper6.1 and ENVI 3.5 softwares. This is the vector representation in GIS environment in which each vector recorded from the satellite image using remote sensing techniques. The raster image of study area is defined as a layer. The digitizing techniques of remote sensing and GIS provide the possibility to draw the structural features on the image. For this reason digital image processing is carried out. The lines represent the length, which can directly be measured in remote sensing and GIS software. These lines define a coverage in GIS environment for further analysis. The advantage of this type of analysis is to measure the length of faults, lineaments and fold amplitude. Topographic data (Fig. 5-2) provide an easy way to visualize the structure of the study area across the satellite images and field data.

Based on ISO block division, the 3-D image of the study area was split into two, Dezful and Khurramabad blocks (Fig. 5-3 and Fig. 5-4). The Landsat-7 ETM-2002 scene (Fig. 5-1) covers part of the Zagros Mountains along the southwest of Iran. In

Email:moshaver1380@yahoo.co.uk
this new work thrusts, faults and major lineaments and folds are overlaying on the 3-D image of the study area for better understanding in structural and tectonic interpretation.

Data processing and image products are carried following a number of processing techniques (Jensen, 1986). The contrasts of six bands data are digitally enhanced. The images of all the bands are compared in terms of contrast and definition of structural features. As a result of visual evaluation, Landsat ETM band-4 data which record the information at the wavelength between 0.75-0.90 micrometers were selected for this study, since it shows good contrast and display structural features like folds, faults and lineaments as compared to the other bands.

To enhance the geological structural information further, filtering techniques such as Laplacian and directional convolution filters are applied to Band-4 Landsat ETM data. The result shows that the number of filters of the following values produced very good images enhancing the characteristics of folds, faults, lineaments and thrusts of the area.

In this study different False Color Composites like the FCC 4-3-2 and FCC 7-4-1 are used for reorganization of folds, faults and lineaments on the images and generation of structural map (Fig. 5-5).

The folds, faults and lineaments in the study area are seen through different enhancements and filtering on images and some are only seen in a directional filtered images. The reorganization of folds, faults and lineaments on the images are based on
vegetation linearity, tonal changes in the images, drainage pattern, topographic
breaks, landscapes and discontinuity in the same lithology, tectonic landforms such as
klippe, nappe, fenster and scarps.

Fig.5-1) Landsat ETM FCC 4-3-2 imagery-2002, ZSB SW-Iran

Email: moshaver1380@yahoo.co.uk
Fig. 5-2) DEM of the study area in the Zagros Structural Belt SW Iran shows the structural elements.

Fig. 5-3) 3-D of structural interpretation of Landsat ETM FCC 4-3-2 in Khorramabad Block of ZSB, SW Iran. Approximate Scale: 1:450,000. Field photograph at right side of the figure illustrates slickensided surface around Tang-e-5 to Tang-e-7 station and showing related movement along the fault plane.

Email: moshaver1380@yahoo.co.uk
Fig. 5-4) 3-D of structural interpretation of Landsat ETM FCC 4-3-2 in Dezful Block of ZSB, SW Iran. Approximate Scale - 1: 450,000

a. Non-directional filter (Laplacian convolution filter)

0  -1  
1    4  -1  
0  -1  0

b. Directional filter

1  0  1  -1  -2  -1  
2  0  2  0  0  0  
1  0  1  1  2  1  
(north-south)  (east-west)

2  -1  0  0  -1  -2  
1  0  1  1  0  -1  
0  1  2  2  1  0  
(northeast-southwest)  (northwest-southeast)

Email: moshaver1380@yahoo.co.uk
5-2-1-1- Mosaic & 3-D Of The Area

The mosaic of the two blocks namely Dezful and Khurramabad block was made. The DEM of the two blocks are made using ER-Mapper6.1 and ENVI 3.5 softwares by introducing the X, Y and Z attributes. For creating the 3-D of the study area (Fig. 5-4) two same coordinate system images are made from the landsat ETM-2002. DEM of the Dezful and Khurramabad blocks are merged. For the extraction of the 3-D image, input parameters like vertical exaggeration, pixel size, image resolution and aggregate are introduced.

Email: moshaver1380@yahoo.co.uk
5-2-2-Folds

In the Zagros Structural Belt, where compression is high, complex folding occurs. Many anticlines and synclines are seen in the study area, which could be depicted by remotely sensed data. The folds in the Zagros Structural Belt follow convergent dip isogons (Rangzan 1983). The ground data and space imagery suggest that on the basis of close spaced in folding, they are classified as open and gentle fold.

The folds in the study area exhibit periodic asymmetrical and symmetrical waves. The amplitudes of the fold reported from the Zagros are of the order of 1-10 Km and 5-20 Km wavelengths (Falcon, 1974). The high compressional forces in the Zagros Fold Belt created complex folding styles (Fig 5-12), seen in Tang-e-5 and Tang-e-7 stations from the study area (Fig 5-3).

In the present research work the field data calibrated with remotely sensed data show that the compression within the fold belt is manifested by a series of large, doubly-plunging folds the verge to south-west. Overlaying the spatial data extracted through digital image processing from the ETM imagery FCC 4-3-2, 2002 (Fig 5-1), on the DEM indicates that the central Zagros is exhibited close spaced folds and faults followed by the topography in the region. The spatial distribution of the axial traces of the structures like anticlinal folds and synclinal folds has been made under remote sensing interpretation and GIS techniques.

Email: moshaver1380@yahoo.co.uk
Fold wavelengths are on the order of 10 km with amplitudes of up to 2 to 3 km
(Colman-Sadd 1978). The field checks suggested that the amplitude of the folds
started from few centimeters for megascopic folds to over 700 meter for macro folds.

Most of the folds in the study area have larger backlimb and shorter forelimb (•)
like Shahkarami anticlinal fold near to Durood police station (i.e. about 4-5 km).
The plunge of the folds is mostly towards NW-SE direction and also following the
Main Zagros Thrust Fault. Therefore, folds and thrusts are the results of two opposite
forces from Iranian and Arabian plates.

Fig. 5-6) Field photograph showing asymmetrical folds of the Zagros Fold Belt SW
Iran. Location around Oliya village.

Email: moshaver1380@yahoo.co.uk
The field data as well as satellite data show that folds have got variable tightness in the eastern and western parts of the study area which reflects the responsible for the tectonic regimes as well as the cover sediments to the movement of the Arabian plate, synchronous with the opening of the Red sea (Berberian 1976).

In erosional point of view it has been realized that the folds are eroded and their physiography is controlled by variation in the resistance of different sedimentary strata and lithology.

5-2-3- Thrust Faults and Major Lineaments

Other features usually easy to recognize on space imagery are the faults. A fault is a fracture in the Earth's crust along which there has been some relative movement of two blocks of rock. This appears as some form of displacement or offset of once contiguous units.

Faults in the Zagros Mountains are widely spaced along which there is relative sliding movement of the blocks. Most of the lithotectonic units have responded to crustal shortening by brittle failure. The important faults in the study area have been named after settlement features developed in the neighborhood of the failure surfaces.

Faults in the study area are commonly: 1- thrust fault, 2- strike faults, 3- normal faults (Fig. 5-7) and 4- reverse faults (Fig. 5-8). The thrust faults in the study area are Main Zagros Thrust, Razan Thrust, Hoor Thrust and Khorramabad Thrust, which are shown in Figure 5-3.

Email: moshaver1380@yahoo.co.uk
The development of thrust (Fig. 5.9) is seen in the various parts of the satellite image (Fig. 5.1) very easily. The directional correlation in the orientation of the major thrust and fold axes trending roughly NW-SE is suggested that the thrusting and folding are dynamically related to crustal shortening in the Zagros Structural Belt. It has been seen that the thrusting in the study area is across the Imbricate Zone and other parts of the Zagros, which are picked up in Landsat ETM image (Fig. 5.1).

The thrusts mapped on the Landsat ETM images have been designated as the Main Zagros Thrust, Khorramabad Thrust, Hoor Thrust and Razan Thrust. The Main Zagros Thrust separates the Sanandaj-Sirjan Zone from the Imbricate Zone.

The Khorramabad Thrust and Razan Thrust are southwestern extension of the Main Zagros Thrust, which separates the allochthonous lithotectonic units from the autochthonous lithologies. The Hoor Thrust is an imbricate thrust, which has resulted due to the piling up of the allochthonous lapel (turn) in Khorramabad klippen.

An isolated erosional remnant of the Main Zagros Thrust sheet by erosion, like Khorramabad klippen, piled up to generate the Hoor thrust and many other small thrust faults. The other tectonic landforms such as fenster and scarp are evidences to prove the presence of thrust on the Landsat image as well as in the field.

Razan Thrust appears on the Landsat ETM (FCC) as curvilinear trace with strike of the failure surface varying from 140° N to 280° N. The Razan Thrust possibly represents the folded remnants of the Main Zagros Thrust whose physical continuity

Email: moshaver1380@yahoo.co.uk
with the Main Zagros Thrust has been punctuated by deep erosion, which has exhumed the “in situ” lithology and eroded the thrust in the Dareh Bidad window.

Fig. 5-7) Normal fault in Kashkan formation.

Fig. 5-8) Strike Fault in Kashkan formation of ZSB SW Iran, Reverse fault. Looking northeast. Location near Chalanchoolan police station.

Email: moshaver1380@yahoo.co.uk
Fig. 5-9) Development of thrust in north 25km Khorramabad. Looking southeast. (Location illustrated in figure 5-1).

The Khorramabad Thrust forms the southwestern limit of the Khorramabad klippen and the fault plane dips northeast. The Razan Thrust and Khorramabad Thrust (Fig. 5-9) in southwest represent fault traces of the main Zagros thrust failure surface, whose physical continuity has been punctuated by the later pile along the Hoor Thrust.

Hoor Thrust is developed as an imbricate structure, which has piled up the sediments in the Khorramabad klippen. The Hoor Thrust exists in the tectonic sequence and it indicates that to be younger than the Khorramabad Thrust.

The structural mapping on the Landsat ETM imagery supported by field data shows that generally the trend direction of the thrust faults are about N 120° to N 140°
Generally the trends of the strike-slip faults vary from N 35° to N 89°. Where as Shahbazan strike-slip fault (Fig. 5-4) of Dezful block picked up from FCC imagery trends about 70° N. It has been seen that the two strike-slip faults near Khorramabad city follows the trend of N 77° and N 72°.

Fig. 5-10) Showing the general trend of the Zagros Mountains.

Fig. 5-11) Aerial Photograph of the ZSB, SW Iran showing fault in the area.
The Asmari formation, which is the part of the Zagros mountains of south west Iran shows (Fig. 5-110) a sharp fault trace running NE-SW through the Gachsaran formation of the same belt. It is composed of folded sedimentary strata. The block of Gachsaran formation on the north side has shifted sub-horizontally to the west, the corresponding segment of mountains to the south. This is a type of strike-slip fault.

On Landsat ETM-2002 image the faults in the study area are easy to identify because of topographic offset (as well as equivalent parts of the strata and sedimentary rock units) and displaced drainage. The aerial photograph also shows the fault in the area of the Zagros Ranges of the Zagros Fold Belt of Lorestan province, south west Iran. The fault here shows a small scarp or cliff.

A lineament is defined as a large scale linear feature, which expresses itself in terms of topography of the underlying structural features. Qurashy and Hinz (1989) have defined lineament as a regional scale linear or curvilinear feature, pattern or changes in patterns that can be identified in a data set and attributed to a geological formation or structure.

In this study structural features such as faults and major lineaments extracted using photographic and geotechnical elements as interpretational techniques of space image (Landsat-7 ETM, 2002, FCC 7-4-2) (Fig 1-5). Lineaments are mapped and classified into three regimes on the basis of density (lineament density).

1- The major lineament distribution in terms of high and low exhibit correlation with variable response of the Zagros Structural Belt supracrustal to the

Email: moshaver1380@yahoo.co.uk
compressional tectonics. The Zagros Fold Belt comprises high density of the major lineaments where closed spacing fold is generated. The area above the Shahbazan and Balarood faults shows high density of lineaments, which may be subjected by high stress and strain.

2- Sanandaj-Sirjan Zone comprises older lithology than the Zagros Fold Belt. The structural map extracted from the satellite image shows lower density in lineaments than the Zagros Fold Belt. Foliation has been seen in the study area. This foliation is exhibited by schists.

3- The southern part of the study area was also structurally mapped and it is seen that this zone also has low density in lineaments. This zone is coinciding with Molasse Cover Sequence which is less fractured and deformed as compared to the northern part of the Zagros Structural Belt. So it reveals that the area is not subjected to the compressional forces (Alavi 1980, Blanc et al. 2003) like the Zagros Fold Belt.

The study shows that major lineaments commonly are opened up and enlarged by erosion. Some have even become small valleys. Ground water percolated into the fragmented rocks causing periodic dampness, which is observed in the field and interpreted through satellite data. Vegetation is well developed in this moisture-rich soil, which at certain times of year enhanced the linear features.

Email: moshaver1380@yahoo.co.uk
5-3- Dezful Embayment

The Dezful embayment is in the southern part of the study area. In the Dezful embayment ( ), Petroleum is associated with detachment folds and faults, which are relatively widely spaced in some parts of the study area. A similar pattern of hydrocarbon can be seen in the Kirkuk (Iraq) (www.ipagroup.com).

The nature of folding and thrusting differs and is changed. These changes are seen in the Dezful embayment. Folds over here are mostly asymmetrical and thrust faults are clearly traceable.

In the north west of the Dezful embayment massive Kabir-Kuh anticlinal fold which extends for over 120 Km along strike is a main fold of Lorestan Zagros Fold Belt. The folds are 'detachment-folds' that have decolled along the Gachsaran formation. The Middle and Upper Cretaceous sediments of the Dezful embayment form one of the richest petroleum systems in the Middle East, which consists of the Khazdumi source rock, the Sarvak reservoirs and the sealing Gurpi shales (Frans et al. 2002). The sedimentation here is also affected by tectonism.

The top of Sarvak and Ilam formations show that the sedimentation is controlled by the tectonic relict topography. The Gurpi formation is also entirely controlled by the creation of the foreland basin (Frans et al. 2002).
5-4-Evolution of a Fold Belt In the Zagros Structural Belt

Some of the most striking landscapes on earth can be found in regions that have been folded by a collision between tectonic plates. The Zagros is a young (~5 million years) and still existing active fold and thrust belt.

Zagros Structural Belt is a foreland portion (Alavi 1980) of Zagros side orogeny in south west Iran, resulted from Alpine type continental collision between Arabia and Eurasia during Mesozoic and Cenozoic. In other words by the end of Cretaceous i.e. after the initial collision between the Arabian and Iranian plates, the present NW-SE trend of the Zagros deformation belt had been initiated (Sephr et al. 2001). This fault zone is still a topographical front and coincides with the present zone of seismicity along the Zagros.

Dynamically the tectonic activities in a series of a period in the Zagros Structural Belt developed the complex folds, which are mainly symmetrical and asymmetrical in nature (Fig 5-12).

The anticlines (Fig 5-13) in kinematics are dominantly thrust related and are trending generally NW-SE in the study area, but changes to E-W in Lorestan. The Lorestan portion of the belt is located in transitional zone.

Email: moshaver1380@yahoo.co.uk
Fig. 5-12) Development of complex folds in the ZSB shows asymmetrical folds.

Railway line, before Tang-5, SW, Iran

Finally the Zagros follows the classical build up of a thrust belt with thin skin tectonic propagating in front of a thick skin deformation, which induces basement shift and large folded structures higher in the sedimentary pile (Jean et al. 2000).

Fig. 5-13) Sardasht fold in the ZFB. Location: north of Dezful city

Email: moshaver1380@yahoo.co.uk
5-5-Structural Domain of the Sanandaj-Sirjan Zone

The Sanandaj-Sirjan Zone is the metamorphic core of the Zagros orogen in southwestern Iran. It is formed in the Late Cretaceous, during closure of the Neo-Tethys, and when Afro-Arabian Continent collided with central Iran (Chapman et al. 2005). The Sanandaj-Sirjan Zone is located NE of the Main Zagros Thrust ( ). It was first recognized as a separate linear structural feature by who named it as Sanandaj-Sirjan Range, later by . Sanandaj-Sirjan Structural Belt is separated from the Zagros Active Folded Belt by narrow zone (up to few km) of deep thrust and high angle reverse fault (Zagros Thrust Zone) (Berberian 1976). All the metamorphic rocks of this belt were previously considered to be Precambrian in age and were termed basement outcrops (Glasser 1953; NIOC 1989; British Petroleum 1964). Even Haynes and McQuillan in 1974 considered the whole metamorphics of this belt as a stable block and the Hamadan-Sirjan a basement high of Precambrian age.

Sanandaj-Sirjan Zone has been structurally deformed due to tectonic activities of Lower Cretaceous and Triassic. These activities have resulted in different structural features such as folding, faulting, lineation, foliation ( ), fracture and lineament features are the highlighted among them.

The field visits show that the trend of fold axes are following by the same tectonic activities and compressional forces in Zagros Fold Belt, where trend is about 120° N. The compressional forces have resulted fractures, which also are followed by the

Email: moshaver1380@yahoo.co.uk
same tectonic process in the Zagros Structural Belt, and trend of conjugate fractures
(www.neic.usgs.gov/neis/epic/epic.html) domain evaluated as N30°E and S95°W
( ).

Therefore it is suggested that the major distinguishing features of this zone (i.e.
Sanandaj-Sirjan Zone) from Zagros Fold Belt are:

A) The consistent Zagros Fold Belt

B) Late Triassic as well as Tertiary granite and diorite intrusion, unknown in the
Zagros Fold Belt, which is important in the Sanandaj-Sirjan Zone

C) Completely different lithology of Zagros Fold Belt from Sanandaj-Sirjan Zone

D) Sanandaj-Sirjan Zone consists of smoother topography whereas the Zagros
Fold Belt is rather rugged topography.

5-5-1- Foliation

Many term such as foliation (In Whitten 1969), rock cleavage (Mead. 1940, Billings
1987), fissility (Van Hise 1896, In Whitten 1969), flow cleavage, fracture cleavage
(Leith 1923), axial plane cleavage (Ramsay 1967), slaty cleavage (DeSitter 1954),
schistosity (Harker 1932) have been used in literature to describe planer tectonic
anisotropy in tectonics.

Email: moshaver1380@yahoo.co.uk
The rock samples are collected in the field and the thin section study indicates the planes of mechanical inhomogeneity that have been described under the general term foliation, which represent planer structures defined by the preferred orientation of component grains or fragments in deformed rocks and designated as "ZS" planes. Depending upon their mutual cross-cutting and temporal relationships, the different "ZS" planes are designated as ZS0, ZS1, ZS2 and ZS3 in conformity to the norms of nomenclature where Z stands for Zagros.

**ZS1 and ZS2 Foliation:**

The thin section study indicated that the ZS1 foliation in the Sanandaj-Sirjan Zone is developed as slaty cleavage in which mechanical rotation, shearing and slip have been predominant over recrystallization. The bedding and foliation exhibit mutual cross-cutting relationship. In the Sanandaj-Sirjan Zone it has been seen that the sheet minerals such as biotite and muscovite have been oriented parallel to the plane of the mechanical inhomogeneity and that is defined as ZS1 foliation in the rocks. The location for this study was picked up around the Brojerd city. The thin section study shows that the first folds (ZF1) in the Sanandaj-Sirjan Zone have been coaxially refolded whose axial planes are defined as ZS2 foliation. Superimposed folds namely ZF1 and ZF2 are coincident in the Sanandaj-Sirjan Zone, so the two planes of mechanical in homogeneity can be distinguished.

Email: moshaver1380@yahoo.co.uk
Fig. 5-14) Schistosity with superimposed folding in the SSZ. Location 20 km NE of Brojerd.

**ZS3 foliation:**

Morphologically the ZS3 foliation in the Sanadaj-Sirjan Zone has the same expression as slip cleavage (White 1949) and (Brace 1953). The ZS3 foliation developed parallel to the axial planes of puckers (Fig. 5-16) for which ZS1 foliation has acted as form surface in Sanandaj-Sirjan Zone (Fig. 5-16). The development of ZS3 foliation in the Sanandaj-Sirjan Zone has been controlled by the flexural movement due to layer parallel strain in the initial stages of deformation.

Email: moshaver1380@yahoo.co.uk
Fig. 5-15) Photomicrograph and its facsimile exhibiting superimposed folding. Note the development of coaxial folds of ZF1 and ZF2. Location in Sanandaj-Sirjan Zone around Brojerd city.

Fig. 5-16) Photomicrograph and facsimile showing the development of links/puckers. Location in Sanandaj-Sirjan Zone around Brojerd city.

Email: moshaver1380@yahoo.co.uk
5-6- Discussions

The combine methods used in the structural analysis indicate that the behavior of different lithotectonic units of the Zagros Structural Belt is not unique and uniform. It is seen that the tight folding and intensive faulting in the Imbricate Zone may indicate the intensity of the deformation at initial stage of tectonic collision which has generated several thrust faults parallel to the Main Zagros Thrust. The Zagros Fold Belt with large amplitude of folds and thrust faulting together is suggested that the long deformation of stress on folding generates thrust faulting, mostly in southern flank of faults. On the other hand the parallel mechanism of folding has resulted in differencing of fold styles in the surface and subsurface of the study area.

Remote sensing and GIS techniques could be used successfully to extract the structural-geological information, generally in the Zagros Structural Belt south west Iran. The Landsat ETM (FCC) 4-3-2, 2002 (Fig. 5-1), and Landsat TM (FCC) 7-4-1, 1991 are the best to enhance the structural features of the study area.

This study shows that the contrast stretched of Landsat ETM band 4 was found to be the best in displaying the structural features on the image. The utility of the digital remote sensing data and GIS techniques confirm most of the previous structural map. In addition many other structural features could be depicted. The result of this type of study is useful to help further detailed geological mapping.

The structural interpretation reveals that orientations of the lineaments in the study area have systematic meaning (i.e. parallel to sub parallel to the main trend or perpendicular to the main trend of Zagros), that in a region, joint planes may lie in

Email: moshaver1380@yahoo.co.uk
spatial positions having several limited directions relative to north and to horizontal.

Studies on the Landsat ETM -2002, images combined with field visits indicated that the area is activated to exhibit faults and complex folds. This significant is seen by fresh slickensided surfaces ( ), high fracture density near Tang-e-5 and Tang-e-7 ( ) station in the Zagros Fold Belt to prove the presence of related movements and structural features. The high density of the lineaments in the study area is expressed and guided to assess the intensity of deformation and tightness structures. It has been seen that the interesting features of the structural history of the Zagros Structural Belt, is variable tightness of the folds and faults in the eastern and western of the study area which reflects the response in tectonic regimes as well as the cover sediments to the movement of the Arabian plate, synchronous with the opening of the Red sea. It has also been seen that there is strain partitioning in the NE (Lorestan), between the right-lateral strike-slip and NE-SW compressional strain on the folds or thrusts, indicated by both the orientation of fold axes and fault-plane.

However, the density of the structural features depict that the south of the study area is less affected by tectonism as the other parts of the Zagros Structural Belt. It may be due to presence of thick evaporite sequence of Gachsaran Formation.