# LINEAMENTS ON LANDSAT IMAGES-DETECTION MAPPING AND TECTONIC SIGNIFICANCE IN NORTH –WESTERN DEPRESSIONS OF SYRIA

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## ABSTRACT

The objective of this investigation was to determine the feasibility of mapping lineaments on Landsat images of El-Rouge, and Al-Ghab depressions, north-west of Syria, and to determine the tectonic significance of these lineaments in order to evaluate the capabilities and limitations of spaceborne data to prove that El-Rouge depression is the extension of Al-Ghab depression and both of them in line with the African-Lebanon-Syrian rift system.
The depressions are situated in the marginal part of the Arabian platform in the zone of the rift system. The investigations were carried out on the basis of multispectral data of Landsat-5 Thematic Mapper. Regional analysis of the images allows rapid evaluation of the structures. The surface expression of lineaments have been mapped and analyzed in terms of their style of deformation, thickness, size and potential influence. Digital masking was used to eliminate ambiguities due to water and shadows. Contrast Enhancement, involves a contrast stretch of the row digital information, and band rationing have been shown to be a useful tool for mapping structural unites and minimized the differences in illumination due to topographic slope changes. Principal components analysis has been utilized in statistical processing of data. The method produces new variables which are linear combinations of the original variables. Field identifications have been carried out to judge the effectiveness of the different spectral bands and of the digital processing of the data.

## 1 INTRODUCTION

The amount of data has increased from MSS to TM Thematic Mapper because of an increase in the number of spectral bands ( 4-7 ), in radiometric resolution ( 64-256 digital levels ) and in geometric resolution ( 80-30 m ). Using of Remote Sensing techniques shows the pronounced margin of the tectonical traces which can be traced clearly. The aim of this study was to evaluate the benefit of Landsat imagery in the mapping of tectonical phenomena in the Al-Ghab and El-Rouge depressions north-west of Syria. In particular, the work aimed to compare TM data with older Landsat MSS data from the same area, and the utility of space photographs in tectonical applications and evaluation of several landscapes.

## 2 AREA OF INVESTEGATION

The area of investigation is located north-west of Syria ( Figure 1 ) and includes an area of about 5000 km² sedimentary and volcanic rocks occupy most of the area. The age of the basalts was determined to be Quaternary. The age of sedimentary rocks is Jurasic, Cretaceous , Paleogen, Neogene, and Quaternary(Figure2).
The area under study El-Rouge and Al-Ghab depressions is situated in the marginal part of the Arabian platform in the zone of the rift system which stretches from the Red sea across the Golf Aqaba, the Dead sea and the Jordan valley. It is limited from the west by jabal El-Wastani horst-anticline and from the east by Jabal Azzawiy range and from the north by Jabal Barisha horst-anticline. The geological study of north-western part of Syria was started by M.Blanckenhorn. According to this investigator, the stratigraphic systems became obsolete in many respects but his paleontological tables retain their significance up to now. E.Vaumas studied early volcanism in the region of Al-Ghab, El-Rouge, and Jabal Az-zawiy. He marked all the volcanic bodies known in this region. E.Vaumas performed a geomorphological subdivision of the north-west of Syria. He has forward interesting ideas about neotectonic movements and the idea about the young age of the Al-Ghab depression, in particular. The age of the lacustrine sediments filling Al-Ghab depression, according to E.Vaumas, in Upper Pliocene and Quaternary. The growth and development of the uplift in connection with the movements along the Lebanon-Syrian fault were of irregular character and this is illustrated by the arrangement of the facies and thicknesses of the Upper Cretaceous and Tertiary sediments on both limbs of the structure. It is known that the movements along the eastern fault of the Dead sea graben were reflected in the distribution and mode of occurrence even of the lower Cambrian deposit .

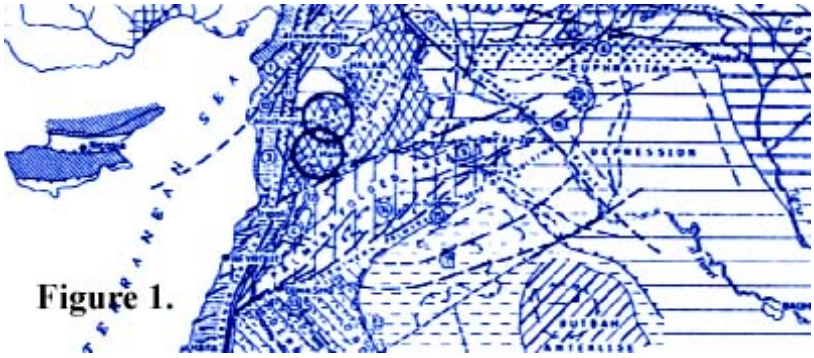


Figure 1. Shows the location of the area under study north-west of Syria

## 3 THEMATIC MAPPER INVESTIGATIONS

The investigations were carried out on the basis of multispectral data of the Landsat MSS,TM, which covers the investigated area. The interpretation of space data shows that El-Rouge depression represents a flat depression with a closed drainage covered on the surface with Quaternary sediments. In the north the depression is divided into two branches with the Jabal Barisha horst-anticline situated between them, the latter is similar to the Jabal El-Wastani structure and composed of lineaments. The Jabal Barisha horst-anticline enters the region of the explorations only by its southern periclinal closure. The Jabal El-Wastani horst-anticline is a fold with an echelon-like squeeze of the bend to the south-east of the village of Darkoush. The fold has a gently sloping, almost horizontal arch and steeply dipping limbs. The dip of the beds on the limbs reaches in the southern up to 45°. The anticline is dissected by a system of longitudinal ( submeridional ) and diagonal faults, along which individual blocks composed of lineaments were uplifted at various heights. The conjugation with the neighboring trough a steep bend of beds and accompanied by faults. This indicates a horst nature of the structure. Its apex as a whole gently dips to the north. In the south it terminates with a steep periclinal closure at the branching of the Al-Ghab depression.
The visual interpretation of space images MSS and TM Landsat-5 presents good results, because the human eye is able to discriminate much more colors than Grey tones. Figure (3) shows a geometrical representation of the RGB space, where one color can be specified by its three-dimensional coordinates, however , the color display coordinate system can also be defined by three independent and orthogonal parameters, named Intensity ( I ) Hue ( H ), and Saturation(S). In this case, Intensity considers the total energy of the image ( brightness ), Hue is the color sensation wavelength (average ) and saturation is the relative index of the color purity ( percentage of white light ). The attributes of IHS express another type of color perception since they can be manipulated in a controlled way providing a quantitative image interpretation. Being so, it is necessary to decompose the IHS attributes of the image, considering them individually, in opposition to the RGB space, which allows only simultaneous changes at the IHS parameters. In this paper, the triangular coordinates were used ( Hayden et al 1992 ) to test the usefulness of the IHS transformation (figure 4.)

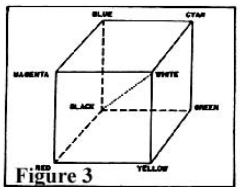


Figure 3

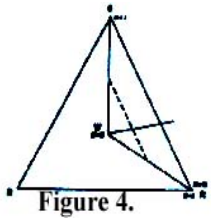

Figure 4.

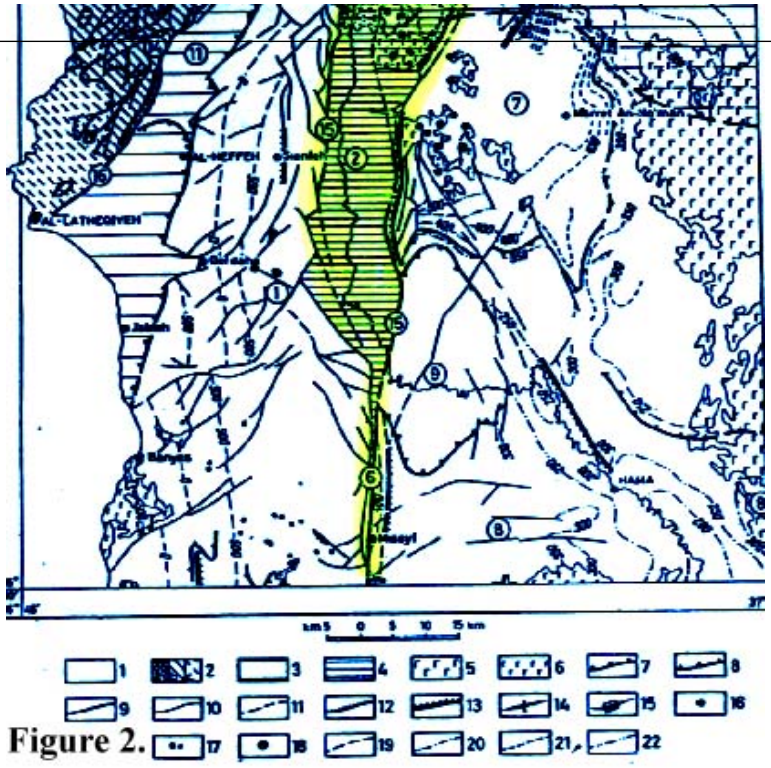


Figure 2.

Figure 2. shows :

1-region of relatively stable uplift ( the uplift of An-Nusseiriyeh and the North – Western Syrian block) ; 2- region of the marginal part of the platform disturbed by Alpine movements with possible allochthonous occurrence of rocks belonging to the ophiolitic formation ( the bassit block : a Jurassic-Cretaceous sedimentary complex , b – the ophiolitic formation, c- rock complex of Upper Cretaceous-Paleogene age ) ; 3- Neogene depressions filled with marine deposits ; 4- Pliocene troughs filled with continental deposits ; 5- Upper Miocene basalts ; 6- Pliocene basalts and tuff breccias ; 7- boundaries of depressions and troughs ; 8- contours of anticlines and synclines ; 9- fualts of deep-seated occurrence ; 10- faults ; 11- faults supposeddly seated under Pliocene deposits ; 12- overthrusts ; 13- flexures ; 14- anticline folds ( linear, asymmetric) ; 15- coffer-shaped anticline folds, horst-anticlines ; 16- volcanoes of pliocene age ; 17- stocks of Pliocene basic rocks ; 18- volcanic vents of Upper Jurassic-Lower Cretaceous age ; 19- structure contours along the floor of Cretaceous age ; 20- structure contours along the floor of the Campanian ;21- structure contours along the floor of Middle Eocene deposits ; 22- structure contours along the floor of Helvetian layer deposits

Key to figures on the map ( in circles ) :

1- the western limb of the An-Nusseiriyeh uplift ; 2- the Al-Ghab depression; 3- the Jabal El-Wastani horst-anticline ; 4- the El-Rouge depression ; 5- the Jabal Barish horst-anticline ; 6- the Missyaf graben ; 7- the Ma'arret An-No'man anticlinal projection ; 8- the Hama anticlinal projection ; 9- the Asharneh trough ; 10- the Idlib depression ; 11- the Nahr ( river ) El-Kabir depression ; 12- the Qesel Dagh peridotite massif ; 13- the Bassit massif of peridotites ; 14- the south –eastern massif of peridotites ; 15- the Lebanon-Syrian fault ; 16- the Lattakia fault .

### 3.1 LINEAMENTS MAPPING

Lineaments reflecting the regional tectonic trend were all clearly displayed on the Landsat-TM imagery as straight to curvilinear topographic breaks. These lineaments are associated mainly with ridges, valleys, and drainage features. It was found that terrain elements were, in general, more readily distinguishable on the TM imagery than with MSS data, although, almost all the same features could be detected on both types imagery. According to these investigations, the viewing geometry of spaceborne is an important consideration in discrim-inating the lineaments and structural features on Remote Sensing imagery.

Compared with MSS-data, the TM-data gives more information about structures less than 5 km in length. This means that TM ( Figure 5 ) can provide considerably more information about Lineaments than MSS. The fact that TM has more spectral bands than MSS means that certain structural features are more easily detected than by conventional

MSS-analysis (Figure 6 ). The MSS image resolution is so low that it is impossible in many cases, to distinguish between valleys eroded along foliation zones and valleys developed along fractures or faults.
The linear features derived from TM scenes appear to offer a more satisfactory approach to this type of study. In addition, the TM multispectral mode offers additional data of considerable use to geologists.

**Figure 5**

Figure 5. TM image Landsat-5,July,20,1996, color composite bands 4+5+7, covers the area under study

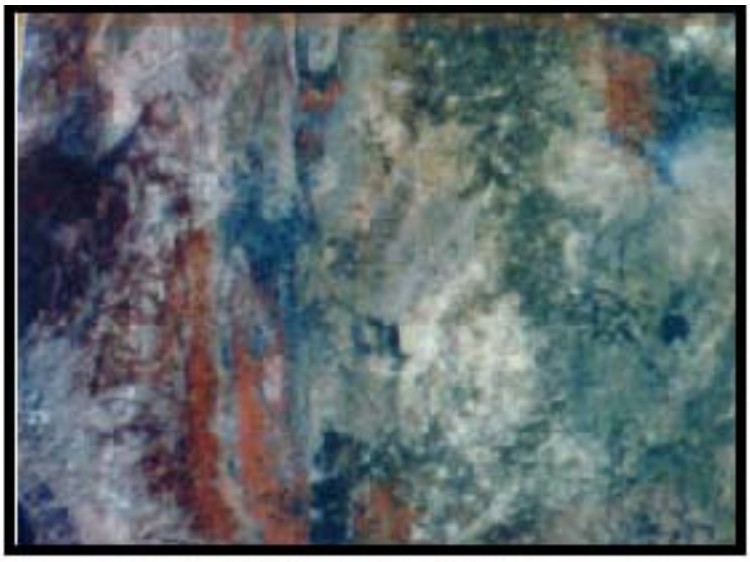

**Figure 6**

Figure 6. MSS Landsat-3, July, 22,1982, color composite bands 4+5+7, covers the area under study

## 4 CONCLUSIONS

The analysis of the MSS and TM imagery indicated that El-Rouge depression is the extension of Al-Ghab depression and in line with the African-Lebanon-Syrian rift system and the El-Rouge depression is a graben and separated by a linear fault which is accompanied by a series of step-like faults parallel to the master fault. The graben is separated by

a system of faults trending north-west and south-east. The final results of this study are represented as tectonical components and deferent levels of spatial resolution in El-Rouge graben (Figure 7 ).

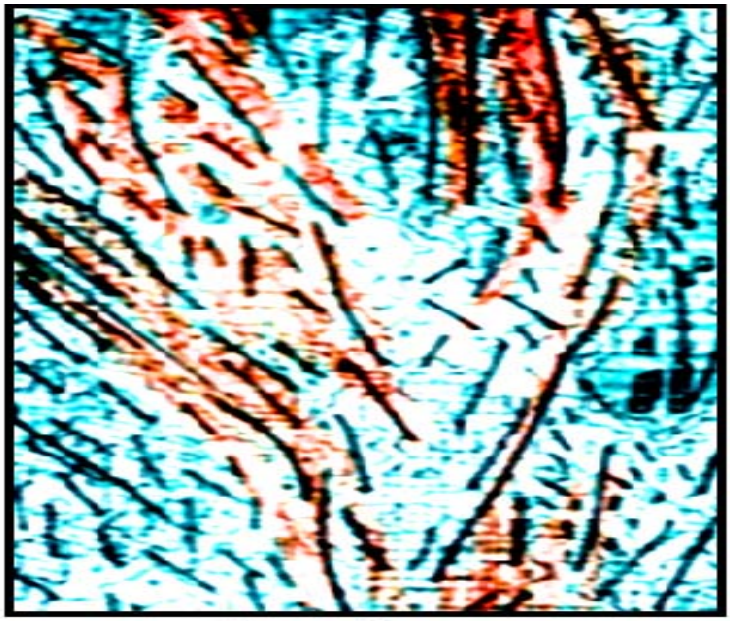

Figure 7

Figure 7. Tectonic components resulting from the interpretation of TM and MSS images

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