Structural Analysis Of Fracturing In Sinjar Anticline Using Remote Sensing Technique

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Abstract

Mountain Sinjar represents Counter asymmetrical lines within Pleat located in the northwest of Iraq, it forms the southern boundary of the builders are distinct folded in the first degree. Attitude structural analysis for the distribution of the effects of fractures and cracks explain on the air using images Landsat satellite maps and the effects of installation, pointing out cracks through different types of graphs. The study revealed that the direction of the effects of breakage characteristics vary with the different sectors of the structural lines , and can be obtained on the correlation between image and the effects of geological fracture and had been mapping of joints and cracks explain of this study also showed that the aerial photographs and remote sensing can be an effective tool in the investigation based primarily on the fracture and impact analysis folds.

Keywords*: mountain sinjar , structural lines, geological fracture, remote sensing.*

I. Introduction

The term fracture is generally conceived as break in the physical or mechanical consistency of rock mass .It can also indicate a plane or zoom pf failures along which the rock eventually breaks apart, (De Sitter 1964) .The occurrence of fracturing is often ascribed to the Taconic forces or stresses actins on rock mass . However, jointing has been observed in rock formations which show no apparent signs of Scratching. It is believed that joints and faults have a comma origin in deformities stress which acts on the rock mass. Joints may develop into faults throw a gradual transition (De Sitter 1964). Macro fractures can may widely in size; they range from a few continuers to several land sis kilometres. They also occur in all direction out usually preferred orientation within a specific structural province.

Latten 1953 and Ranting ton 1975 have defined a fracture or a lineament as the images of a natural linear feature, consisting of topographic, drainage, vegetation, soil or rock tonal alignment on air or space photograph . They believed that fracture traces present surface manifestation of joints, or groups of joints or small faults and lineaments are faults or shear zones .All the features studied in the present investigation are fracture traces as defined by Lattman and Huntington. The recognition interpretation and statistical analysis of fracture traces and lineaments detectable on air and space photos is regarded as photographical method which in commonly used in structural investigations that involve folded and fractured bedrocks (Zwain 1986).

Formative, Iraq is divided into three major zones, nappy zone folded zone and unfolded zone .The huge jebel singar is located at the southern bounder of folded zone (Fig. 1) it is an asymmetrical doubly plunging anticline fold trending east-west, with 40 kms long and 13 km wide . The southern flank of the anticline is gentler than the northern flank,(fig.2) .The aim of this study is to analysis the directional distributions of fracture traces and lineaments occurring in different structural sectors of Singar anticline and also to correlate fracture traces and lineaments detected on air and space photographs with ground-observed joints and faults in Sinjar area.

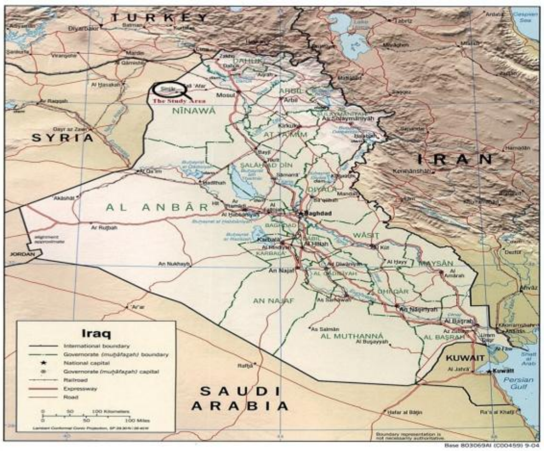

Fig. 2 Tectonic Zones of Location of Singar Anticline

II. Data Collection and Processing

The interpretation of fracture traces has been carried out on air photographs at a scale 1/50000 and on a Landsat colour composite image at a scale 1/250000 .At first a preliminary examination of photo layout, individual photos and Landsat image was made with unaided the eyes in order to accurse a regional geological picture at the study area and to detect large fracture traces. Later a detailed interpretation of air photographs and Landsat image for fractures and bedding traces was executed, and the geological data were drown on transparent overlays. The interpretation were confined to central parts of air photos so that the topographic distortion effects largely were avoided .In the end , the air photos and land sat image were re-examined for final checking of fracture data so that to reduce the problem of subjectivity involve in photointerpretation

. After the interpretation was completed all geological data were transferred to topographic base map at a scale 1/100000 for air photo data and to a base map at a scale 1/250000 for land sat image data. As results two fracture trace maps and a bedding trace map were produced. The processing of fracture data began with digitization of fracture trace maps by which all fractures were transformed into numerical data using computer programs to process and azimuthally rose diagrams were drawn by means of computer graphics. For the purpose of structural analysis of fracturing occurring in different parts of the structure. The anticline was divided into nine sectors or remains. They are E north sectors W plunge, W and E centre, W and E north flank. Three types of rose diagrams were used in this study. These are (a) the density (length percentage) rose diagram (b) the frequency (number percentage) rose diagram and (c) the average density (length average percentage) rose diagram .The azimuth class of the rose diagram 10° degree , measured clockwise from the north axis . Therefore the fracture data classified into 18 azimuth classes.

III. Directional Analysis Of Fracture

Twerenbold (1961) has carried out a photographical study of fracture pattern of three anticline structures in southwest Iran. He interpreted the fracture traces as shear fractures related to the main folding stress or anticline arching. McMullan (1973, 1974) studied fracture pattern on Asmara anticline, southwest, Iran, and divided the anticline into several structural realms (sectors). He described the fracture sets as shear and tension fractures related to the main compressive stress . .

The fracture trace map (Fig.4) shows all fractures which have been interpreted on air photos. The total number of these fractures is 920. (Fig. 6) display the fracture traces observed on landsat image, their total number is 96 fracture. The results of directional classification of these fractures depicted in several densities(Length percentage) rose diagram placed in the structural sectors as shown in figure in5and 7.

The terms" rose maximum" and "rose minimum" indicate the relatively high and low percentage directional classification as depicted by rose rays. Where there is more one rose maximum, the order of their importance corresponds to the order of the lengths of the rays represent. Therefore, the terms "primary" "secondary " and "tertiary" were adopted will be used to indicate the Giza and relative importance of rose maximum Fracture sets trending N-S are well developed in sinjar structure**.** They are represented by primary and secondary maximum with azimuth ranging between N5W-N5E; appearing presciently in the E and W sector .E and W south flank, and E plunge represented by primary maxima (fig.5). Also they can be seen in E plunge and center sectors of figure 8, representing fracture set observed in Landsat image. These fractures oriented perpendicular to anticline axis and parallel to the compressive stress**.** Thy can be related to tension fractures caused primarily and arching of anticline. The obliquely oriented fracture sets are distributed unevenly over all anticline sectors. They are represented by primary and secondary of oblique maxima ranging N35W-N60W and N45E – N55E. They most prominently in the E and W north flank, E south flank, and E plunge at ranging between N35E to N45E. (FIG.5). In figure 7 the primary oblique maximum occur in E plunge while secondary maxima shown in centre and W plunge. The oblique fracture sets can be related to shear failures caused directly or indirectly by compressive stress acting on the Singar anticline. Figures 8 and 9 show two sets of rose diagrams depicting the azimuthally classification of total fracture traces interpreted on both air photos and land sat image each set comprise these rose diagrams of different types , they are frequency rose diagrams (fig.8a,9a) density rose diagrams (fig.8b,9b)and average density rose diagrams (fig.8c,9c) . The main common feature in the frequency and density rose diagrams is the long maxima trending N5E and N5W representing strongly developed fracture traces striking N-S. The average density rose diagrams (figs. 8c, 9c) exhibit E-W fracture sets which are absent in other types of rose diagrams. These fractures represented to primary maxima trending N85E, and may be described as longitudinal tension fractures striking parallel to structural axis**.** They could be related to compressive stress oriented perpendicular to this fracture Alubnidi (1978) studied fracturing of sinjar , during his field work he surveyed 322 fracture in duding major and minor faults, joints, veins and fissures occurring in the central, E plunge and W plunge sectors of the anticline .In the present study we have used these fractures as ground-observed data **,**so that to correlate them with the photographical fracture traces .figures 10,11 and 12 are frequency rose diagrams representing ground-observed fractures ,air photo fractures and land sat image fractures respectively .The common features in these diagrams is the N-S maxima (N5W and N5E)indicating the occurrence of N-S transverse fractures in field as well as in air and space photos **.**The oblique fractures are represented by the primary and secondary maxima with bearing ranges N25E-N45E and N25W-N35W.The remarkable N85E maxima in fig . 10 indicate the presence of longitudinal fractures striking E-W parallel to the anticline axis. Although such maximum does not axis in the frequency and density diagrams of fractures observed on air and land sat photos , but it appears in the average density rose diagrams figs.8c and 9c ,since these fractures are short and relatively few when the were observed in air and space photos. They are generally regarded as tension fractures.

IV. Discussion and Conclusion

The density rose diagrams shown in the structural sectors of the anticline (fig. 5, 7) exhibit significant primary maximum trending N-S. They represent tension fracture sets occurring predominantly in the central part, southern flank, and western plunge of the anticline. Whereas the oblique shear fractures depicted in oblique maxima occur almost all over structural sectors, with varying density and azimuths .However, they are quite prominent in north flank and east plunge of anticline. There is a good correlation between field –observed N-S fractures as represented by N5E primary maximum in frequency rose diagram (fig.10) and photo geological fracture traces with similar azimuth, while the oblique shear fracture sets show poor correlation . As regards the E-W fracture trace, they are depicted only in average density rose diagrams (fig.8c, 9c) as N85E primary maxima. They can be well correlated with similar maximum appearing in frequency rose diagram of ground-observed fractures. This study has shown that broad correlation can be made between field-observed fractures and fracture traces observed on air photos and land sat imagery. It is also found that the intensity and directional characteristics of the fracturing can vary according to their occurrence in different structural sectors of the anticline .Thus, directional analysis of fracture traces interpreted on air photos and space imagery can be an economic and rapid method of structural investigation in folded rock regions.

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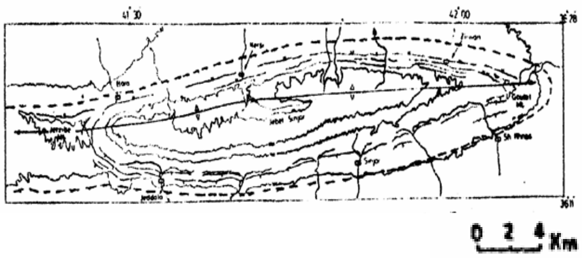

Fig. 2 Map Showing Bedding Traces and Topographic Features in Sinjar Area (Interpreted From Air Photos).

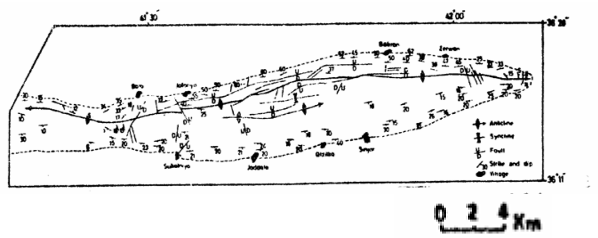

Fig. 3 Structural Map of Sinjar Anticline (Modified after K.A. Maala . 1977).

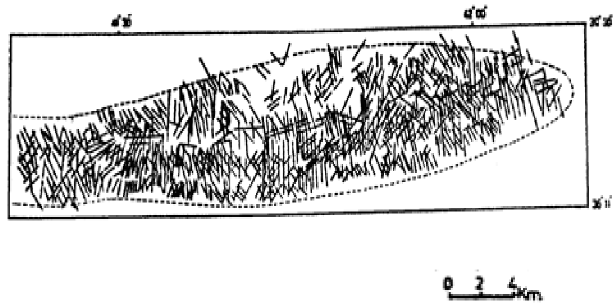

Fig. 4 . Frocture Trace Map of Sinjar Anticline (Interpreted from photo).

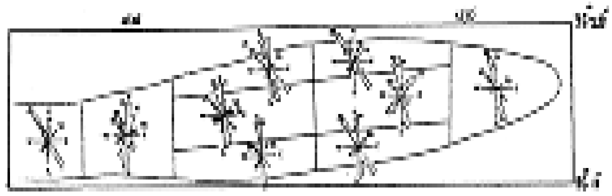

Fig 5 Density Rose Diagrams of Fracture Traces in Sinjar Anticline (Interpreted from Air Photographs)

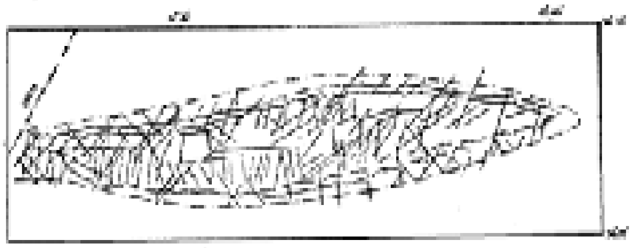

Fig. 6 Map Showing Fracture and Bedding Traces in Sinjar Anticline (Interpreted from Landsat Image)

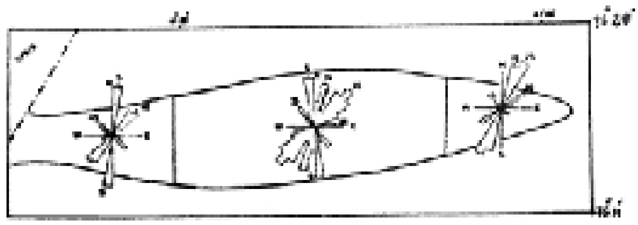

Fig 7 Density Rose Diagrams of Fracture Traces in Sinjar Anticline (Interpreted from Landsat Image)

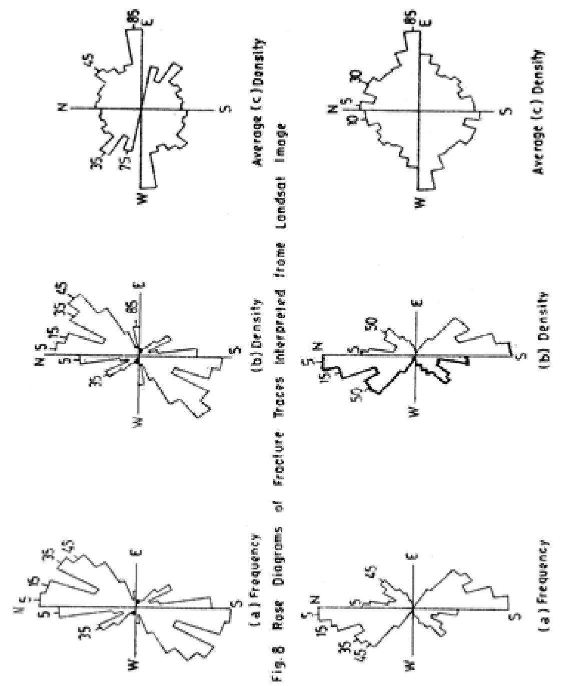

Fig. 8 Rose Diagrams of Fracture Traces Interpreted frome Landsat Image

(a) Frequency (b) Density Average (c) Density

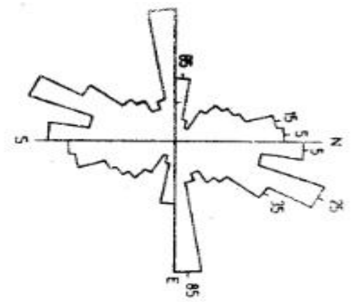

Fig.10 Frequency Rose Diagram of Mapped Joins and Faults

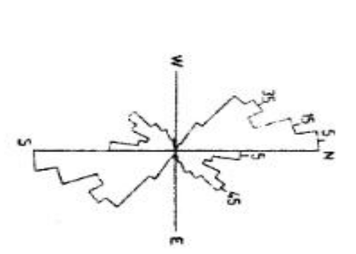

Fig.11 Frequency Rose Diagram of Fracture Traces Interpreted from Air photos

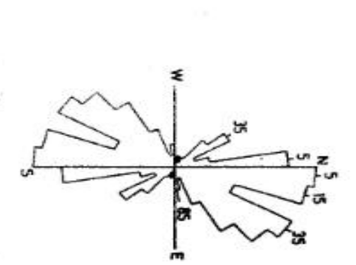

Fig.12 Frequency Rose Diagram of Fracture Traces Interpreted from Landsat Image