

III. DATA PROCESSING

Landsat-7 ETM+ of 30m resolution 2005 which was downloaded from (GLCF) website and used for extraction lineaments in the study area. Various techniques have been used for determined the linear features in the study area such as manual extraction technique (visual interpretation) and automatic extraction technique. Various image processing enhancement have been applied for manual lineament extraction by using Erdas Imagine2014 software. Various image processing technique have been used for filtering operations (Suzen and Toprak, 1998; Chang et al. 1998; Mah et al. 1995), Principal Component Analysis (PCA) (Qari, 1991; Nama, 2004) and the false color composite is the most commonly used ones and will be applied in this study to smooth and remove the noise in the image. Lineament extracted automatically by using various parameters for edge enhancement and edge sharpening enhancement technique which gives the best result of lineaments that are not recognized by human eyes using the module line of Geomatica which extracted linear features from a single image and record the output as polyline with vector segments. Extracted lineaments statistically analyzed to determine lengths, density, intersections of the lineaments, generate rose diagram, lineament density map and lineament intersections map. Extraction lineaments have been plotted in Rockwork15 as rose diagram to show the direction/orientation of the lineaments. Arc GIS 10.2.2 has used for overlying, mapping, visualization and calculate different parameters.

IV. RESULT AND DISCUSSION

A. Geological setting

The geological set-up of an area comprises rocks dating from Mesozoic to Recent which show in (fig.2&table 1).

Table 1: geological unit of the study are

| Age | Geological Formation | Lithology |
|------------|----------------------|--|
| Quaternary | Alluvium | Sand, Silt, Clay, Gravel, Conglomerate |
| Paleocene | Jiza | shale |
| | Jawl | Limestone |
| | Umm er Rdumah | Limestone |
| Cretaceous | Tawilah | Sandstone |

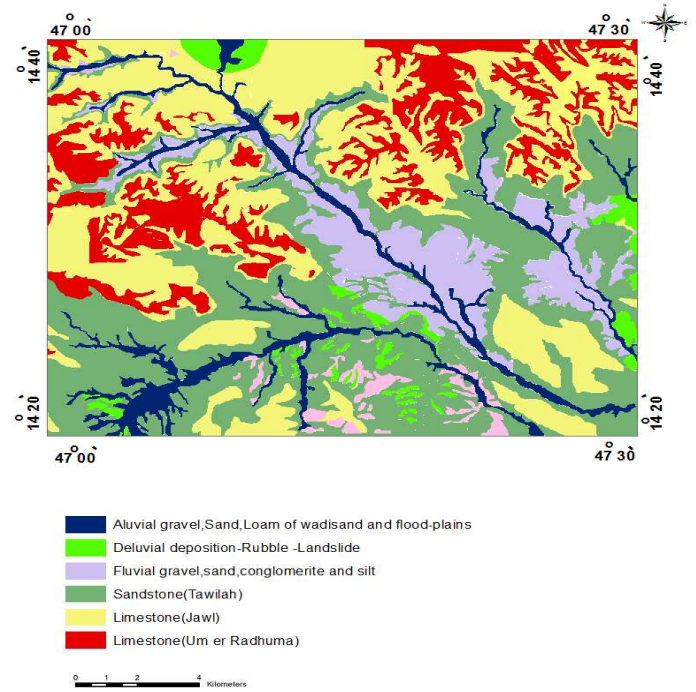


Fig.2: Geological map of the study area (Derived from SOY geological map D 38-59)

B. Lineament extraction

There are two common methods for extraction of lineament from satellite data:

(1) Manual Extraction

Digitize the lineaments by user directly from the geological map either satellite data by using directional or non-direct filters such as the laplacian directional filter edge and sobel directional filter edge which make more enhancement then the lineaments are digitize manually. The visual extraction is mainly depending on the quality of the image and the proficiency of user. In the study area lineaments digitize manually from false color composition (FCC) image as showing in (fig.3), soble 3*3 and laplacian 3*3 filters technique (fig.4 A&B), and geological fault map (fig.4 C).

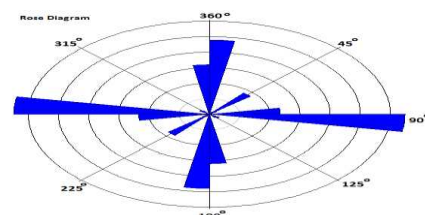
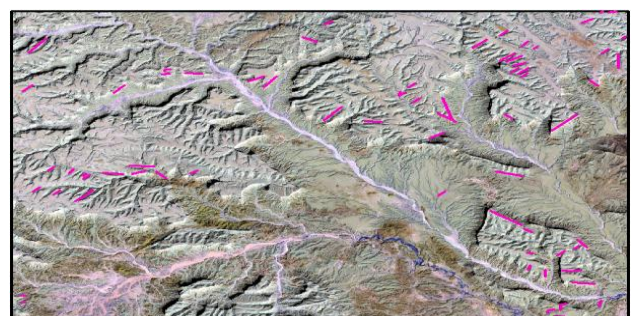
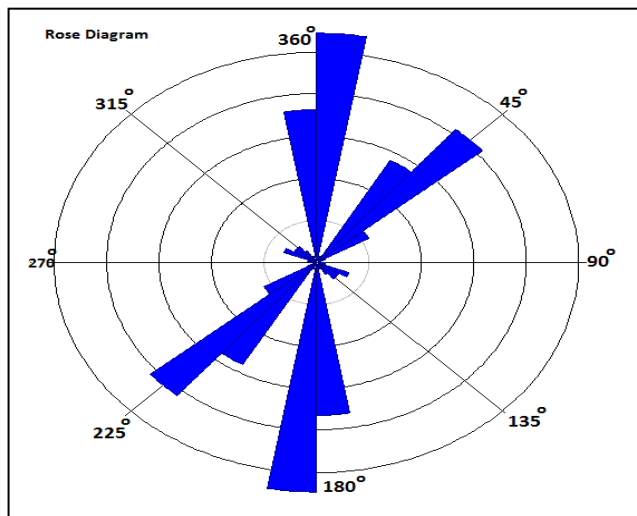
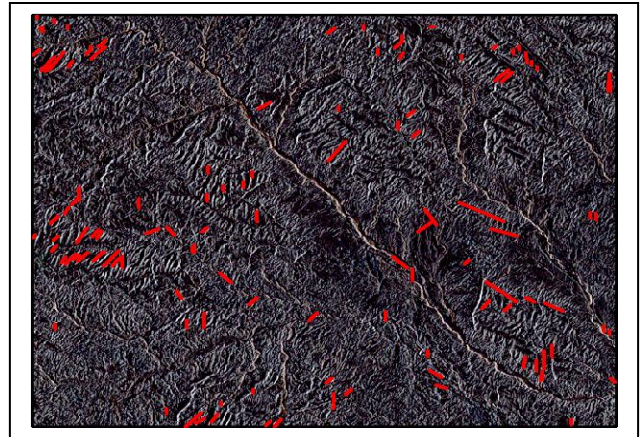
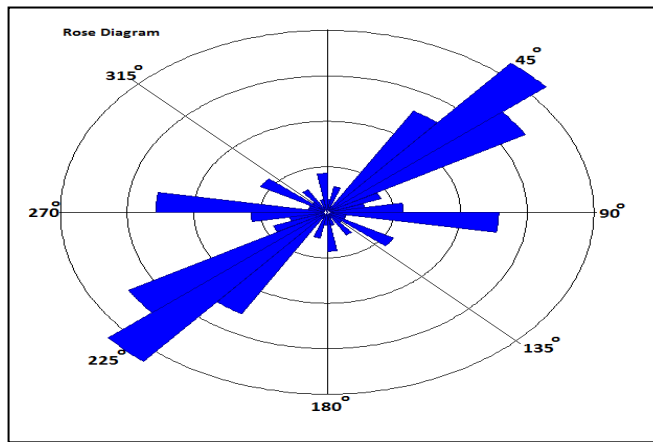
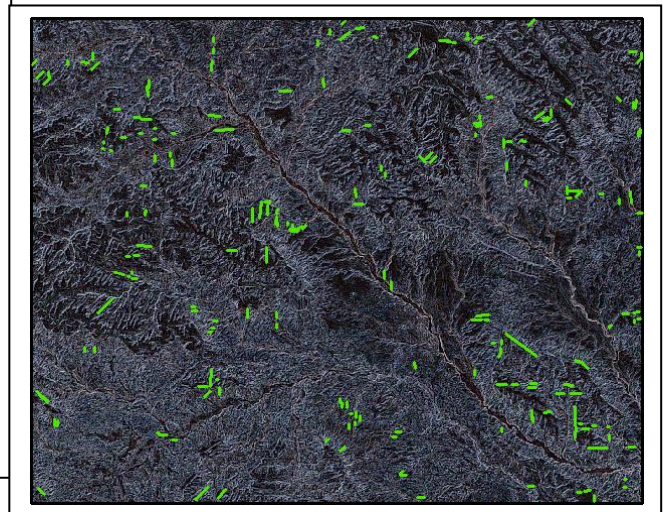


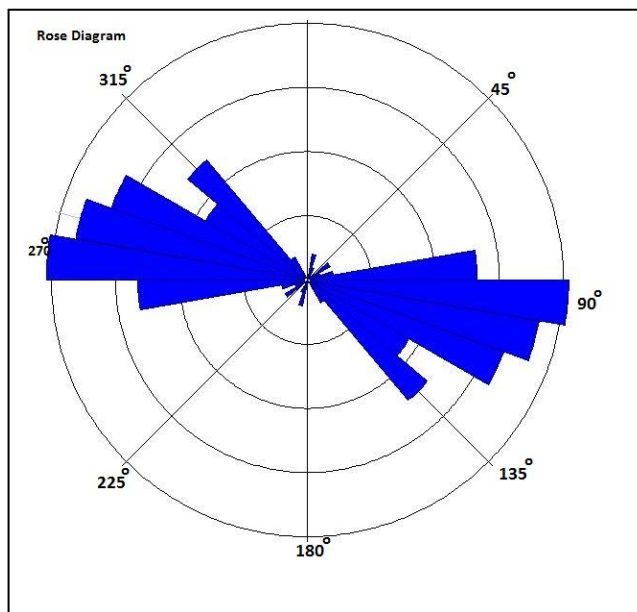
Fig.3: FCC lineament map with rose diagram of the study area.



A.



B



B.

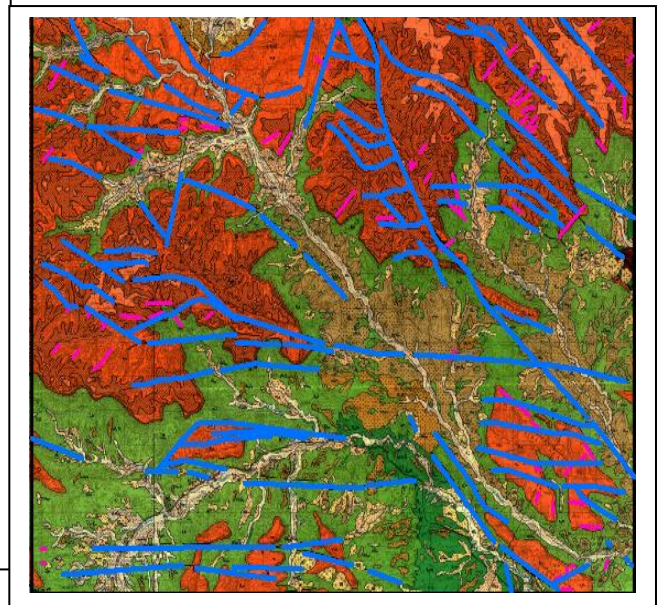


Fig. 4: A&B: Sobel and laplacian filtering lineaments map with rose diagram C: geological faults map with rose diagram.

(2) Automatic extraction

Lineament extracted automatically by using the module line of Geomatica which extracted the linear feature from a single image of PCA best band and record the output as polyline with vector segment. Various parameters control automatic extraction of the lineament process for more enhancements. These parameters are performed in a short time (Sarp et al 2005). In the present area lineaments extracted automatically from Landsat ETM+ after applied principle component analysis (PCA) technique for more enhancement as showing in (fig.5).

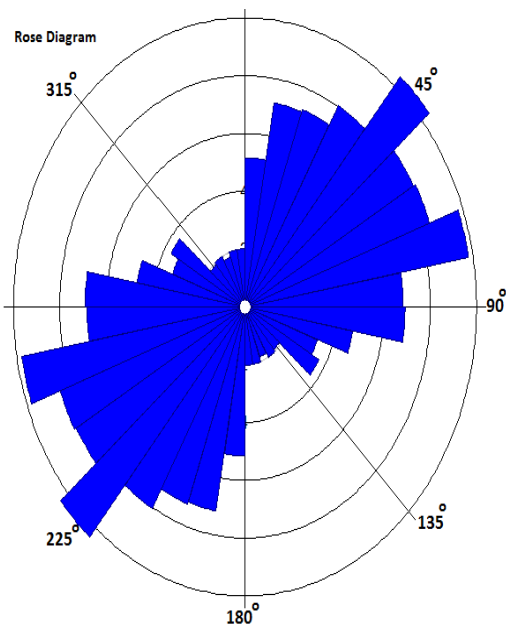
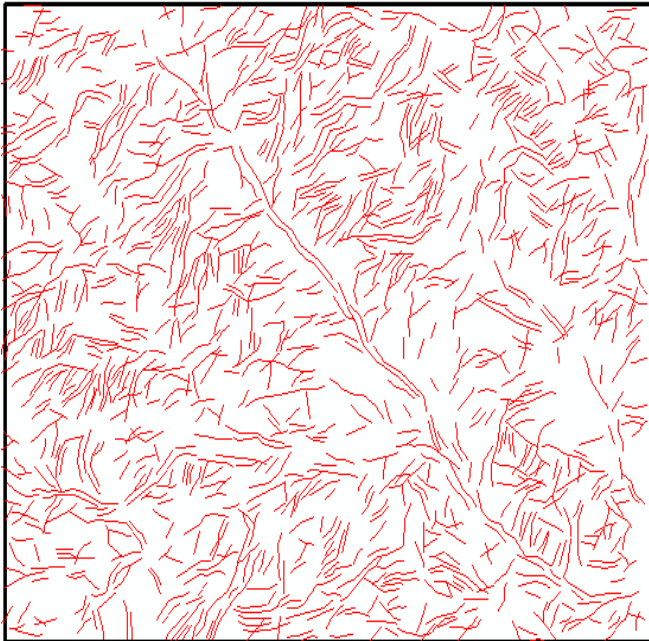


Fig.5: Automatic lineament map with rose diagram of the study area

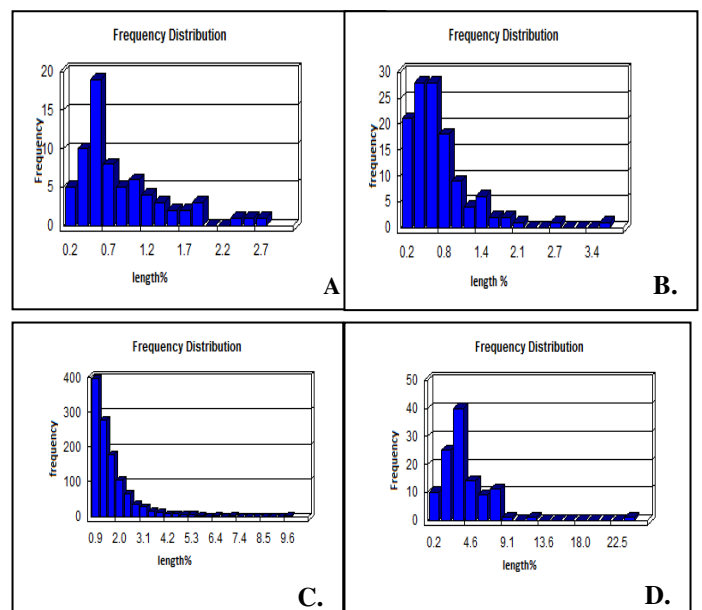
C. Geospatial analysis

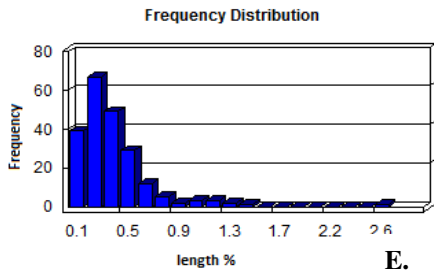
(1) Length of lineaments

Length of lineaments is a total length of all demarcates lineaments divided by the area under of interest. Lineaments length is considered as one of the most important characteristics for interpreting lineament map. Length analysis has been applied on the both manual and automatic extracted lineaments of the study area. Parts of Al-Rawdah basin contain lineaments length 79.6km for sobel lineaments map, 94.8km for laplacian lineament map, 66.6 km for FCC lineaments map and 499km for geological fault map which have been calculated digitally by using Arc GIS 10.2.2 and show lineament of automatic extraction was highest value as showing in table 2. whereas total length manual and automatic maps after superimpose are 1978km and 740km respectively table 2. Frequency distribution in whole Al-Rawdah demonstrated in (fig 6&7). The basic statistics analysis of manual and automatic extraction is show in table 3.

Table 2: basic statistics of the manual and automatic lineaments map and fault map

| Variable | Manual lineament map | | | | Automatic lineament map |
|------------------|----------------------|------|----------------------|---------------------|-------------------------|
| | Soble filtering | FCC | Geological fault map | Laplclian filtering | PCA |
| NO. Lineament | 121 | 70 | 112 | 213 | 1143 |
| Max. length(km) | 3.7 | 2.68 | 24.9 | 2.68 | 9.7 |
| Min. Length(km) | 0.1 | 0.2 | 0.18 | 0.10 | 0.9 |
| Total length(km) | 79.6 | 66.6 | 499 | 94.8 | 1978 |
| Mean (km) | 0.80 | 0.95 | 4.4 | 0.44 | 1.7 |
| Std. length(km) | 0.52 | 0.5 | 3.0 | 0.28 | 0.8 |





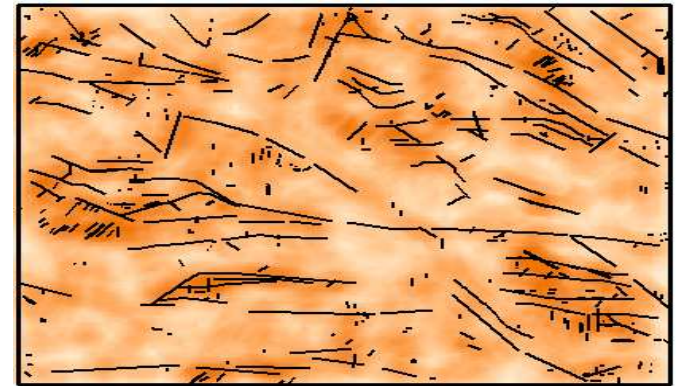
E.

- A: Sobel 3*3
- B: Laplacian 3*3
- C: FCC
- D: Geological fault
- E: Landsat PCA

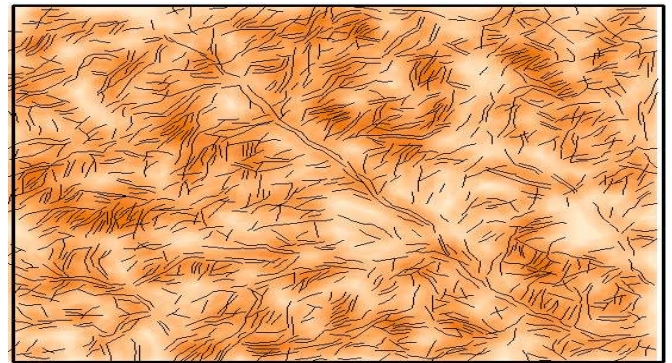
Fig.6: frequency distribution of manual and automatic extraction lineaments

Table 3: basic statistics of total manual and automatic extracted lineament map

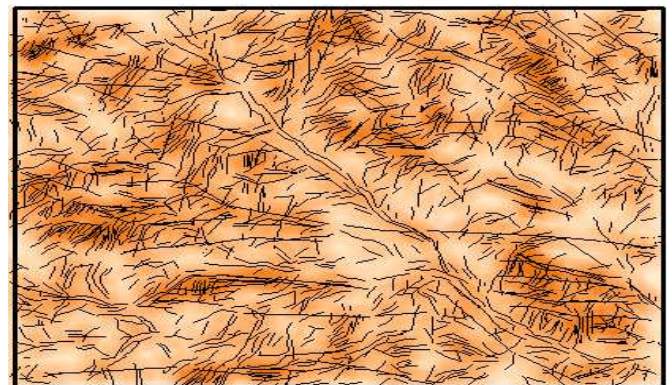
| Variable | Automatic lineaments | Manual Lineaments |
|------------------|----------------------|-------------------|
| NO. Lineament | 1143 | 516 |
| Max. length(km) | 9.7 | 9.4 |
| Min. Length(km) | 0.9 | 0.10 |
| Total length(km) | 1978 | 740 |
| Mean (km) | 1.7 | 1.41 |
| Std. length(km) | 0.8 | 1.8 |



A.

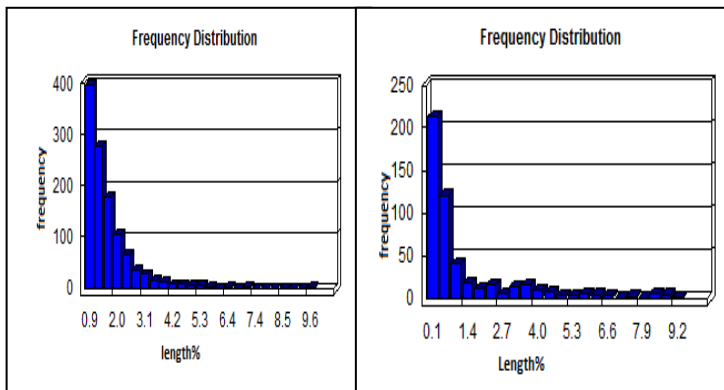


B.



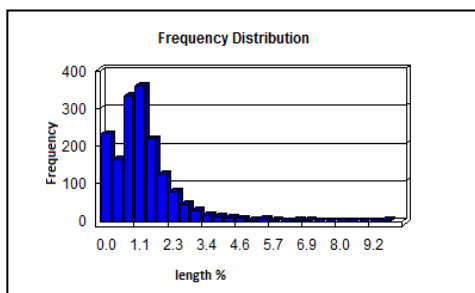
C.

Fig.8: Density maps of A. all manual lineaments, B. Automatic lineament C: Superimpose all manual and automatic lineaments.



A.

B.



C.

Fig.7: Frequency distribution of total A: Manual lineaments, B: Automatic lineaments and C: Superimpose both manual and automatic lineaments

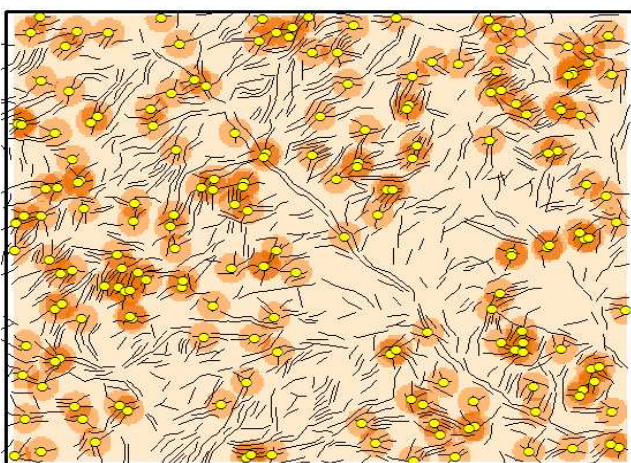
(2)Density of lineaments

Lineament density map is become another method to analysis the extract lineament which refers to the length of lineaments per unit area (Cosford et al 2013). The lineament density is created by spatial analyst tool in ArcGIS10.2.2 software by

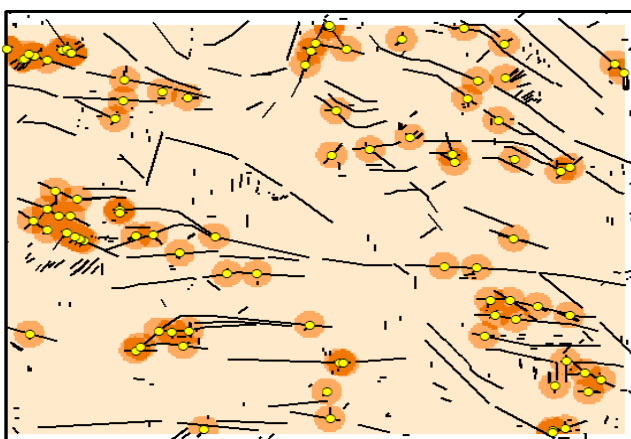
(3)Intersection density analysis

Manual and automatic extraction of lineaments from multispectral image in part of Alrawdah, Shabwah, Yemen by using remote sensing and GIS technology

Lineament intersection density is defined as map showing the frequency distribution of intersections lineaments that occur in a unit area (Sarp et al 2005) which purposed to estimate the areas of diverse lineament orientation (Gulcan Sarp and Vedat Toprak). If the lineaments don't intersect in an area, the result map will be represented by a plain map with almost no density contours and the lineaments almost parallel or sub parallel in an area (Hassan et al 2014). The lineament intersection map of study area indicates high and very high intersection in the same areas where there is very high density of lineaments. The zone of high lineament intersection over study areas is feasible for various sources. Other purpose of use intersection density map is to estimate the areas of divers lineament orientation (Hassan et al 2014). In the automatic intersection density, the highest intersection densities show in NE&W of the study area whereas highest intersection densities in all manual density map is indicated in NW-SE of the study area (fig 9.A&B).



A.



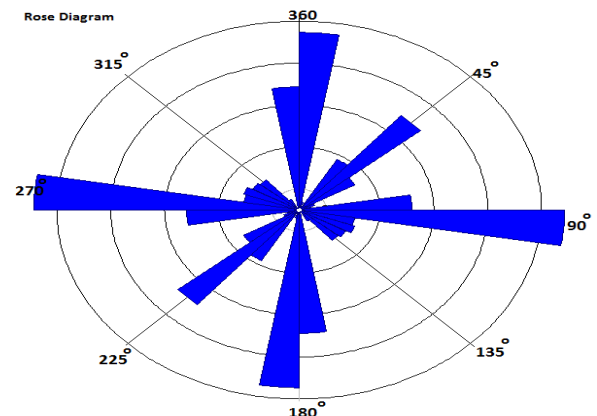
B.

Fig.9: The lineament intersection density map of A. automatic and b. manual extraction.

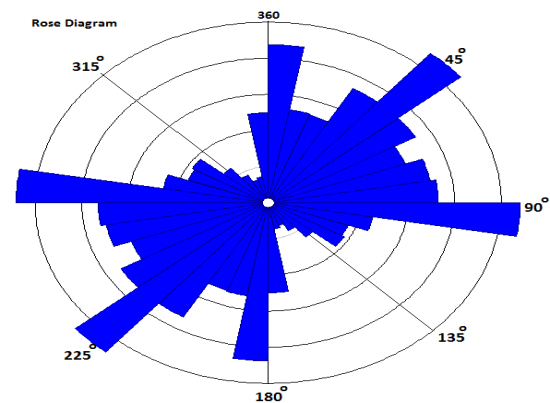
(3) Orientation of the lineaments

Lineaments orientation (azimuth) is considered as one of the most important characteristics for different purpose such analyzing dominant lineaments trends. Orientations of the lineaments have been analyzed by rose diagrams which display lineaments length by using rockwork15 software. The rose diagram shows NE&SW direction for

automatic lineaments (fig.5) whereas NW-SE for manual lineaments (fig.10.A) respectively. Superimpose all manual lineaments map mostly at NE-SW (fig.10.B).



A.



B.

Fig.10: Rose diagram of total A: Manual lineaments and B: Superimpose both manual and automatic lineaments

V. CONCLUSION

Remote sensing and GIS technology become a good technique for study various geological application. Lineaments have been extracted manually and automatically successful in part of Al-Rawdah, Shabwah, Yemen. Digital image processing has been carried out for enhancement different themes. Four geospatial analysis have been analyzed the lineaments which is length, orientation, lineament density and lineaments intersection density.

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