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LINEAMENT ANALYSIS OF QATAR PENINSULA BASED ON LANDSAT IMAGERY

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ABSTRACT

Photo-interpretation of Landsat MSS images of Qatar Peninsula reveals several surface lineaments of different types, extentions and trends. Some of these photo-lineaments are of structural nature while others represent various geomorphological features that are developed in linear trends on the land surface. They include the extension and configuration of the coastline, sand dune belts, drainage lines, depressions, escarpments, and others. In this paper, the delineated lineaments are investigated and analysed both qualitatively and qauntitatively. Emphasis is given to the structural lineaments which presumably represent the traces of major faults or fractures that regionally extend as relatively straight lines. The major structural lineaments are extending in two major trends of NE-SW and NNW-SSE directions, which represent the regional tension fracture systems formed during the uplift of Qatar arch.

INTRODUCTION

Lineaments are among the conspicuous regional features appearing on space images obtained for the Earth's surface from remote sensing satellites. They may be originated through tectonic and geologic processes or as man-made cultural features that appear in lineal arrangement. In his length classification of lineations, El-Etr (1976) considered "lineaments" as descriptive and nongenetic term to be used for a natural linear feature of a length ranging from 10 Km to 100 Km. If the lineament originates through geologic processes, it is often a fracture (fault or joint) or a linear expression of fracture system or shear zone (Houston *et al.,* 1977). Some lineamnets are readily recognized on satellite images, while others may be suggested by discontinuities of geologic structures, or by the alignment of some geomorphologic features. In this sense, Brockmann *et al.,* (1977) considered lineaments to include all structural and topographic alignments, vegetatinal linears, shapes and lithological boundaries or contacts between physiographic units.

The synoptic view of the Landsat satellite images (185Km x 185 Km) facilitates delineating the lineaments of regional extent that cannot be recognized by field observation work or it would need extensive work for tedious interpretation of an overwhelming number of aeral photographs. On the basis of distinct geological criteria, structural lineamnets could be interpreted as fault scraps, fault lines, linear channels, linear outlines connecting zones of weakness or fracture zones. The alignments of some large geomorphologic features could be easily recognized on satellite images as lineaments, such as linear depressions, longitudinal and transverse sand dune belts. Other lineaments detectable on the space imagery for the Earth's surface are the result of human activities such as graded roads, highways and fence lines. Among the general references including lineament analysis based on Landsat images are those of Verstappen (1977), Siegal and Gillespie (1980), Short and Blair (1986) and Drury (1987). For Qatar Peninsula, some of the major linear features have been discussed in some recent geological and geoporphological studies that used remotely-sensed data, e.g. Yehia, Harhash and El-Horouni (1982), Ashour and El-Kassas (1984a & b), McCullough, Baker and Nelson (1986), El-Kassas and Noweir (1987), and Noweir and El-Kassas (1988a & b).

In the present work, direct interpretation of Landsat images was carried out to delineate various lineaments appearing on the whole surface of Qatar Peninsula. Two Landsat-1 scenes Nos. 1168-08353 and 1168-06350 (Path 175, Row 42 and 43) of 7th January 1973. covering north and south Qatar respectively, have been used in this study. The available images are black and white prints of the three Landsat-MSS bands 4,5 and 7, their false-color composite and a color-sliced image of MSS band 5. All these images are on scale 1:1,000,000, with some sectors enhanced to scale 1:250,000 for some areas with remarkable linear features.

GEOGRAPHIC AND GEOLOGIC SETTING OF QATAR PENINSULA

Qatar Peninsula cover an area of some 10,600 km^2 between latitudes 24° 40' and 26° 10'N, and longitudes 50° 45' and 51° 40'E, at the northeastern edge of the Arabian landmass (Fig. 1). It is elongated in a N-S trend for a length of about 180 km, while its maximum E-W width in the central part does not exceed 85 km. The Peninsula is surrounded by the Arabian Gulf from the west, north and east, while its southern land lies at the borders with the Kingdom of Saudi Arabia.

The land surface of Qatar Peninsula is generally of low relief with a maximum height of 103m above sea level at Tuwayir Al-Hamir in the southwestern hilly part, and a minimum of 6 m below sea level in the Sabkha flat east of Dukhan

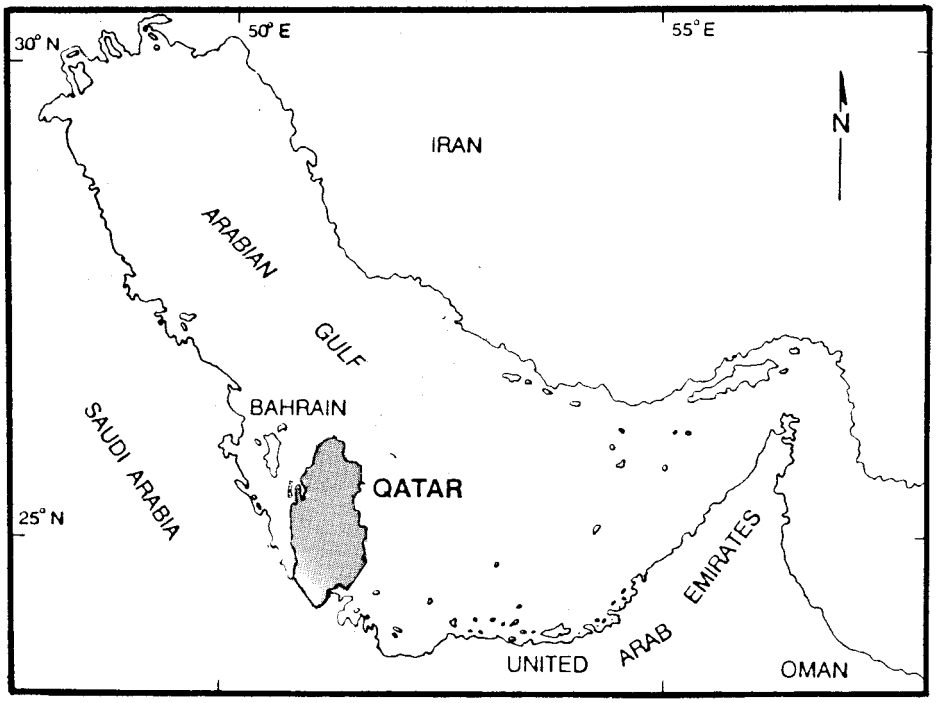

Fig. 1: Location map of Qatar Peninsula, Arabian Gulf.

ridge. The major part of the peninsula has an average elevation of less than 40 m above sea level. It has a slightly undulating rocky surface covered by thin sheet of intact gravels, and stippled by a large number of scattered shallow depressions. The greater part of the Qatar land consists of a remarkably uniform limestone horizon which is in places eroded to a thin veneer and is breached to reveal the underlying older rocks. In other places, the limestone is overlain by younger strata that form a number of the mesa-type hills, breaking the monotony of the desert surface. Eolian sand accumulations of different types cover a considerable area of the surface of Qatar Peninsula, particularly in the southern part and along the northeastern corner. These sands occur in the form of thin sheets, brachan dunes which may be modified into various shapes, or the large dune fields south of Umm Said. Sabkha deposits, of saline flats or plays with fine silts and calcareous sands, are widespread along the coastal margins of Qatar Peninsula, especially along the eastern coast from south of Umm Said to Khor El-Udeid. Extensive inland

sabkhas are found east of the Dukhan ridge and along the southern frontiers with Saudi Arabia.

Climatologically, Qatar is classified as being among the world's most arid desert regions. It lies in the northern desert belt, characterized by a scanty rainfall, high temperatures, hot dry summer winds, and a high relative humidity for the greater part of the year. The rainfall is characterized by its irregularity and variability in both time and space. However, it is usually concentrated in the winter and spring periods (October to May) with an annual average of 50-80 mm.The mean annual temperature is 25-26°C, with a mean minimum of 21°C and a mean maximum of 31 °C, occasionally reaching 40-45°C and it may reach as high as 50°C in some summer days. The geographical position of Qatar in the Arabian Gulf results in a high relative humidity, particularly in the hottest summer months of July and August. It ranges from 45% to more than 95% with a mean of 70% decreasing during winter to 45-55%. Potential open water evaporation ranges from a minimum of 2 mm/day in December to 10 mm/day in June. The prevailing wind, locally, known as Al-Shamal, is blowing from NNW to NW direction, while about 20% of the blow from various directions mainly the SE, S and SW.

The channels formed from the rainfall and runoff water over the Qatar Peninsula are the only features of surface drainage. Most of these channels are generally short, shallow and of interior drainage. However, in the hilly country to the south and west, the massive ridges of El−Nakhash and Dukhan are dissected by some long, deep runnels and wadis of different types. The Rodah soils are formed from the runoff as water accumulates through short wadis into depressions where silts and clays are deposited. On the other hand, some of the long wadis drain the hilly country in the sounthwest towards the western coast of Qatar, into the Gulf of Salwa.

The geology of Qatar Peninsula is dominated by formations entirely of Tertiary to Quaternary age, where about 80% of the surface is formed of Tertiary sedimentary sequence and the rest 20% is covered by Quaternary deposits. Table (1) summarises the lithostratigraphic sequence of the main rock exposures in Qatar Peninsula, after the works of Cavakier (1970), Seltrust Engineering Limited (1979 and 1980) and Eccleston and Harhash (1982). The Rus Formation of Early Eocene age, representing the oldest rock exposure, is mainly formed of chalky limestone with some gypsum and anhydrite veinlets. It is followed by the Dammam Formation (Middle Eocene) which is divided into a lower shaley subformation and an upper dolomitic limestone

subformation. The overlying Dam Formation of assigned Middle Miocene age comprises two subformations, the lower one is formed of marls and sandy limestones, while the upper subformation is dominated by limestones with evaporites. This is followed by the Late Miocene Hofuf Formation, mainly

Table 1

Lithostratigraphic Sequence of the Main Rock Exposures in Qatar Peninsula.

Age			Formation		Lithology
QUATERNARY	Holocene				– Sand dunes and eolian sands – Beach sands and bioclastics – Sabkhas with salt crusts – Depressions muds and silts
	Pleistocene				– Conglomeratic and Pseudo-oolitic limestones (milliolites)
TERTIARY	Pliocene		Hofuf Formation		– Residual gravels of conglomerates and siliceous sandstones
	Miocene		Dam Formation	Upper	– Clayey limestones with gypsum
				Lower	– Marls, clays and limestones
			UNCONFORMITY		
	Eocene	Middle	Dammam Formation	Upper	– Abarug dolomitic limestones and marls – Simsima dolomites and limestones with thin marls and shales
				Lower	– Dukhan Alveolina limestones – Midra Shales and marls – Fhaihil Velates limestones
		Lower	Rus Formation		– Dolomitic and chalky limestones and marls, with gypsum beds in the lower parts.

composed of conglomeratic limestones and siliceous sands. Quaternary and Recent surficial deposits are widely distributed on the surface of Qatar Peninsula. They consist mainly of Pleistocene conglomeratic and pseudo-oolitic limestone beds, and Holocene deposits including depression soils, sabkhas with salt crusts, beach sands, sand dunes and other eolian sand accumulations.

Structurally, the major part of Qatar is formed of a broad N-S trending anticline. This is separated by a syncline from the pronounced narrow elongated Dukhan anticline trending almost in the same direction. To the west, the Dukhan anticline is bordered by another syncline of a general NNW-SSE trend, which is occupied to a large part by the Gulf of Salwa.

LANDSAT DATA

The available Landsat data include multispectral scanner (MSS) images, basically in three spectral bands in the visible and near-infrared portions of the electromagnetic spectrum (bands 4,5, and 7). The main characteristics of these bands, as related to the present study, can be summarized as follows:

MSS-band 4 (0.5-0.6 μm) the green band, emphasizes the distribution of sediment-laden water, submerged coastal features, and delineate areas of shallow water such as reefs, shoals and other sub-marine phenomena.

MSS-band 5 (0.6-0.7 μm) the red band, emphasizes many topographic, geomorphologic and geologic features, as well as land use pattern, such as dune belts, rocky hills, highways and settlements.

MSS-band 7 (0.8-1.1 μm) the near-infrared band, provides the best penetration of atmospheric haze and emphasizes vegetation, the boundary between land and water, landforms and rock exposures.

Careful interpretation of individual black and white images of these bands permitted indentification and delineation of various geological phenomena includidng lineaments on the surface of Qatar Peninsula. Standard false-color composite images, prepared by exposing the three black and white MSS-bands through different color filters onto a color film have also been investigated. On these false-color composites, green vegetation appears in red, clear water

Fig. 2: Image mosaic of Qatar Peninsula, from Landsat-MSS band 5 scenes E-1168-06353 and E-1168-06350 of 7th January 1973 (Original Scale 1:1,000,000).

appears black, sediment-laden water is powder blue, settlements and urban areas appear bluish to grey, sand dunes are obiously shown in light yellow color. Since Landsat MSS band 5 usually gives the best general-purpose view of the earth's surface, its original data has been digitally processed using the color slicing technique. In this method, the slicing procedure has been expanded to include color enhancement to emphasize linear features and other geomorphological characteristics.

All of these images have been eavilable as separate prints of scale 1:1,000,000 for the two Landsat scenes covering Qatar Peninsula, or as mosaics of the same scale (Fig. 2). Moreover, some sectors from these Landsat images have been prepared on scale 1:250,000 for certain areas of particular interest.

LINEAMENTS ANALYSIS

A lineament, in its simple definition, is any large-scale linear feature on the surface identified on an aerial photograph or sattelite image. Lineaments may appear as aligned tonal contrasts, as linear topographic features such as valleys, stream channels, ridges or straight coastlines, or as recognizable geological linear features such as faults, joints or contact between different rock types. Lineaments range in length from several hundreds of meters to some tens of kilometers, and may be continuous or intermittent. The dimensions of detected lineaments depend upon the scale of the aerial photograph or sattelite image on which they are recognized. Some lineaments can be related to geological features when ground-truth information exists but some others, particulary those of large dimension, cannot be related to any obvious surface features and may thus reflect deeply buried structures. Although lineaments are presumed to natural, other artificial (man-made) linear features could be identified on low-resolution satellite images as lineaments, e.g. highways, graded roads and fence lines.

The investigated Landsat imagery (scale 1:1,000,000) of Qatar Peninsula reveals numerous lineaments of different types, extensions and trends. They are well distributed all over the land in different patterns and intensities (Fig. 3). Accordingly, these lineaments could be of various origin or mode of formation, and they represent the surface expression of different features. Based on the manner on which the lineaments are displayed on the Landsat images, the spatial relationships, frequency, magnitude, continuity and their relationship to other geological features, the lineaments are grouped into three categories; structural, morphological and cultural.

STRUCTURAL LINEAMENTS

These include the delineated lines chosen from Landsat images on the assumption that they originate through geologic processes, and they may represent fractures (faults or joints) or the linear expression of fracture systems or shear zones. Where there are a large number of massive joint blocks and where the joints are tight, monolithic masses resist deep weathering and erosion. The outlines of these large masses, in plan, are determined by prominent joints which paralllel major regional tectonic trends or lineaments that represent the major regional trends also play a significant part in determining the detailed sculpture of limestone masses that constitute the majority of land surface.

The interpretation of lineaments delineated from Landsat images indicate the presence of two major trends of structural lineaments predominating in theNNW-SSE and the NE-SW directions. They represents large fractures or joint systems of tension type that have been formed during the uplift of Qatar arch. Yehia, Harhash and El-Harouni (1982) considered the major NNW-SSE structural line, coinciding with the fold axis of Salwa syncline, to be a fracture zone. The extension of this zone to the south of Gulf of Salwa through Qatar-Saudi Arabia border is remarkably obvious on Landsat images (Fig. 4). The other trend, NE-SW, represents some major fractures and faults, which also conicide or parallel to the axis of major folding system. However, some fractures of this set deviates to NNE-SSW or ENE-WSW where there instersections form a radiating pattern as shown in the southern part of Qatar Peninsula (Fig. 3). This pattern of intersecting lineaments can be generally attributed to fundamental shear networks inherited from the earlier history of the Peninsula, and revived or re-exposed at different geological events (Fig. 5).

Some other curvilinear and broadly sinuous features are also observed on satellite images of Qatar Peninsula, mainly in its northwestern part. These features have a general E-W to ENE-WSW trend and they are considered as structural lineaments where they have been formed through geologic processes. They are found to consist of smooth extensive cherty limestone pavements, semi-parallel and at regular intervals in the generally non-linear desert surface. Seltrust Engineering Limited (1979) linked these features to ancient (Eocene) syn-sedimentary strand lines, while Eccleston and Harhash (1982) related them to the Oligocene period of sub-aerial dolomitization (Fig. 6). On the other hand, El-Kassas and Noweir (1987) considered these curvilinear and sinuous lineaments, as paleo-stream traces.

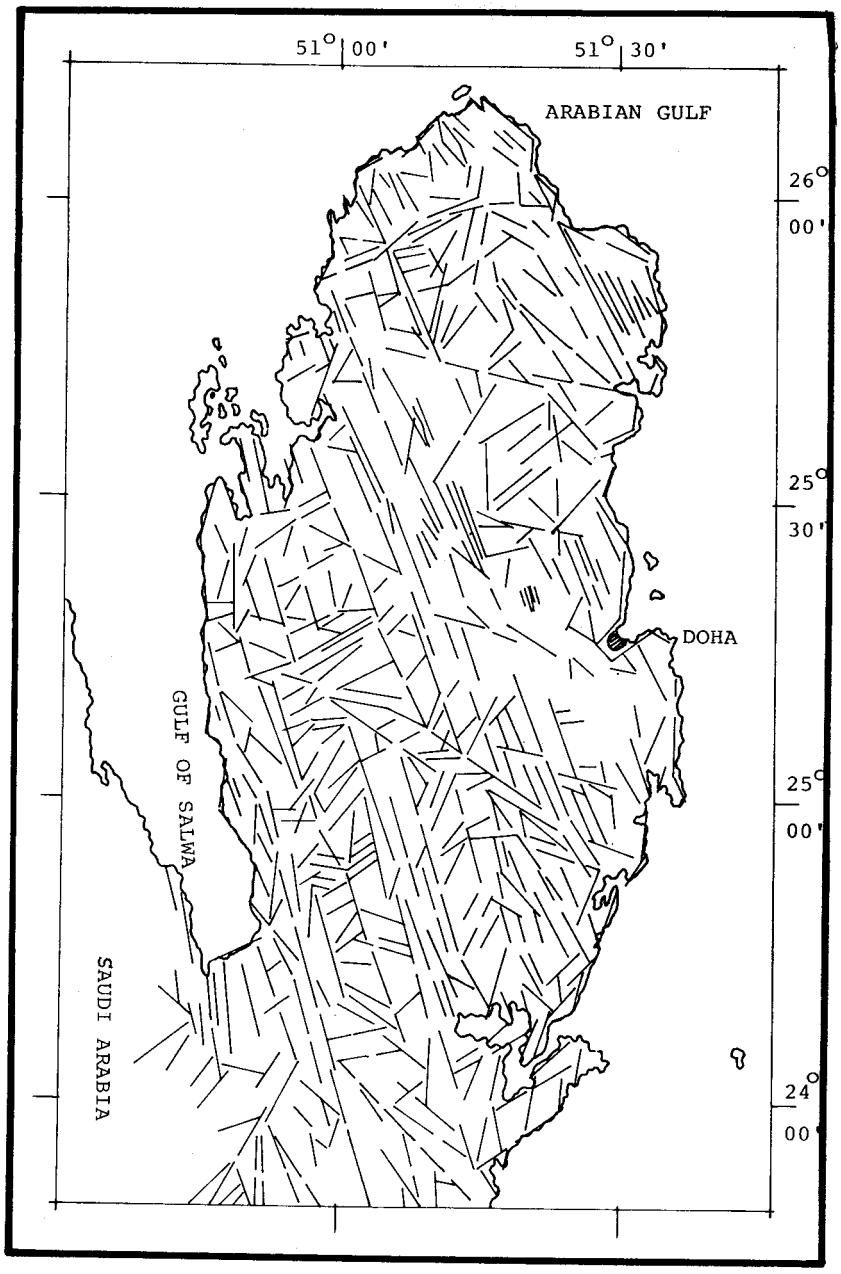

Fig. 3: Lineament Map of Qatar Peninsula, interpreted from Landsat-MSS images.

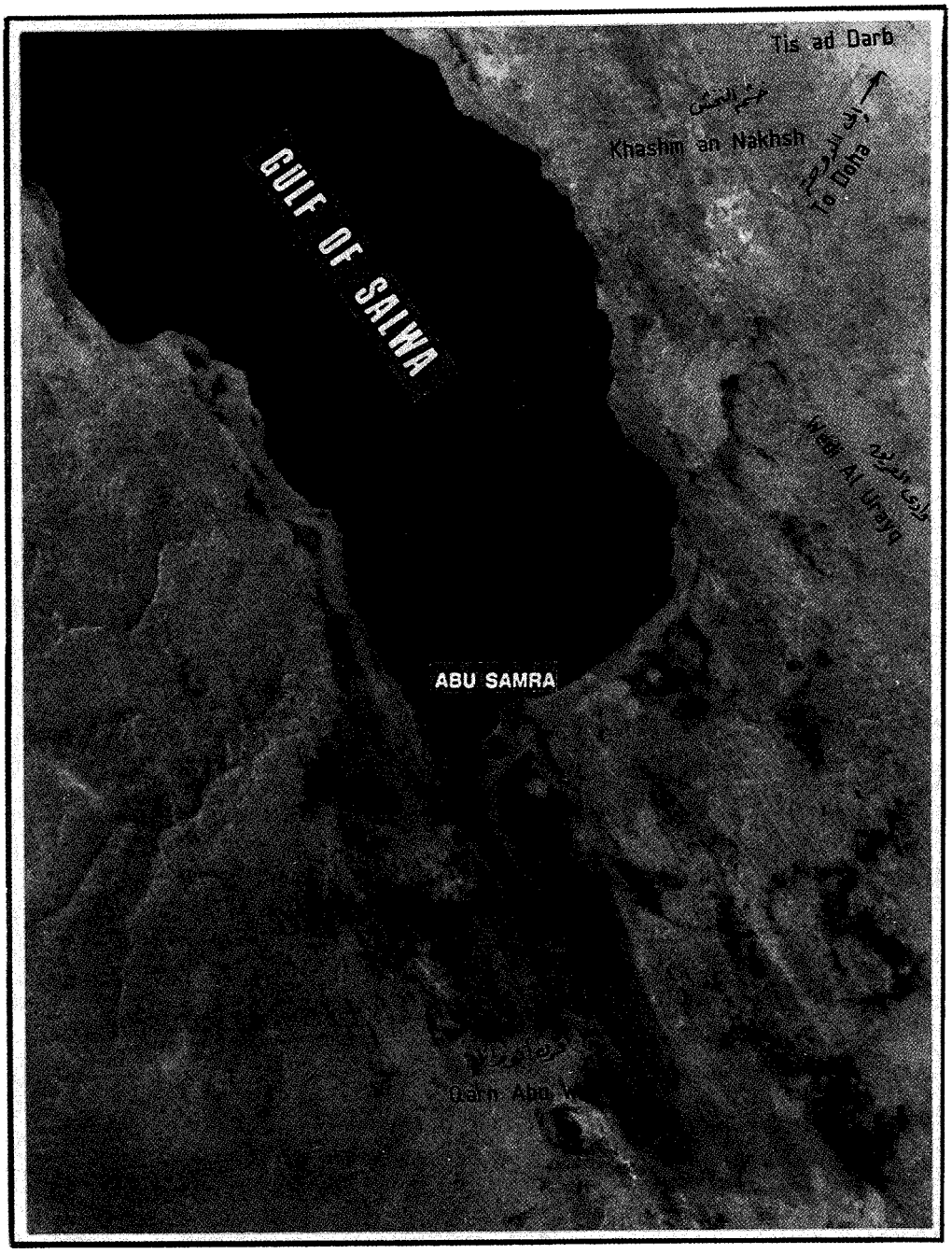

Fig. 4: Enhanced subscene of Landsat-MSS band 5 showing a spectacular example of structural lineaments representing a major fracture zone in the soutern part of the Gulf of Salwa, Southwestern Qatar.

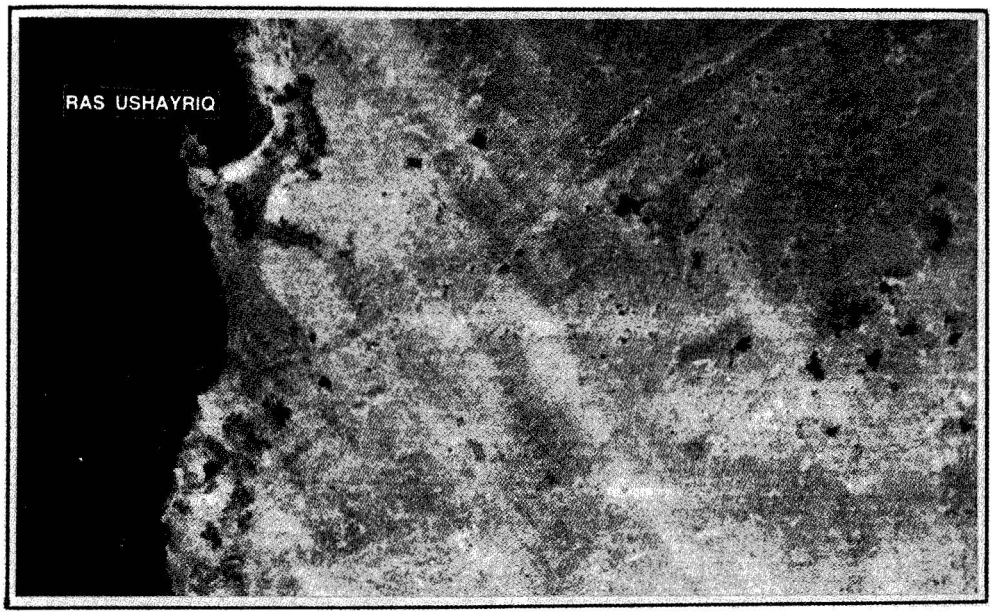

Fig. 5: NE-SW trending paleo-stream intersecting with NW-SE lineaments, east of Ras Ushyriq in northwestern Qatar. Also, linear parts of the coast are oriented NNW-SSE and NE-SW.

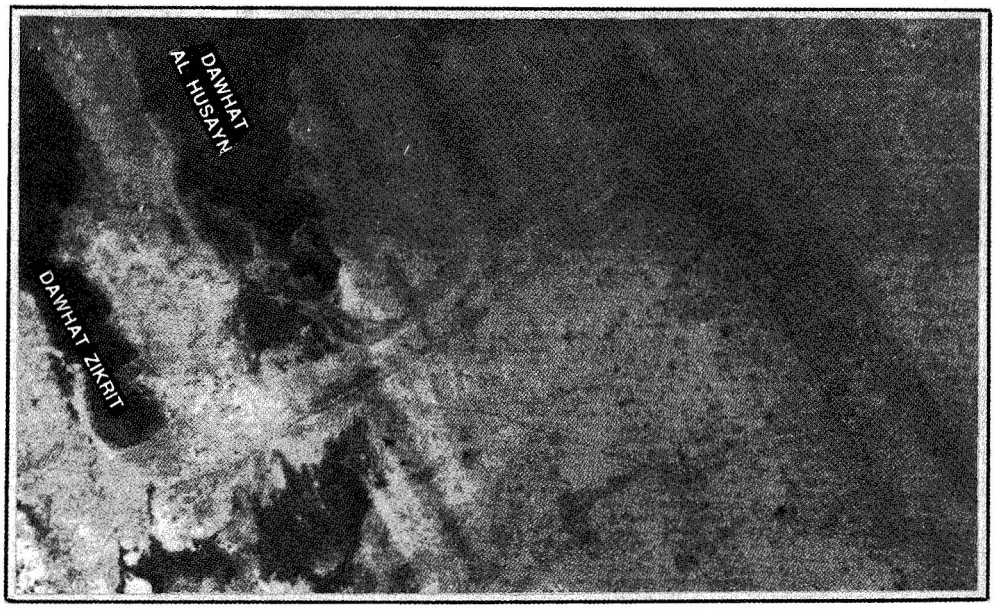

Fig. 6: Some Curvilinear structures, south of Dawhat Al-Husayn in midwestern Qatar. The northeastern linear extension is obscured by the darker NW-SE lineament.

MORPHOLOGIC LINEAMENTS

Many of the lineaments delineated on Landsat images of Qatar Peninsula are found to be related to various morphologic features, including coastal, eolian, drainage and relief features.

1. Coastal Lineaments

Qatar Peninsula has a long coastline which is gently emergent and characterized by an eneven outline with numerous inlets, capes, bays and other morphologic features, Landsat images of MSS band 4 have been found very useful to identify the coastal and shallow marine features around the Qatar Peninsula. This is mainly based on the sharp tonal contrast between land and water. Measurements on Landsat mosaic shows that the coastline has a length of 610 km, where the west coast measures 285 km and the east coast measures 325 km. The coastline on both sides is generally irregular in orientation, extension and shape.

However, several parts on both sides appear on Landsat images with some conspicuous linear trends. Most of these coastal lineaments are straight or gently curvilinear, and they are evenly represnted on both sides by elongated parts of the coast. A total of 127 coastal lineaments, measuring a length of 245.5 km have been statistically studied (Table 2, Fig. 7). They vary in length

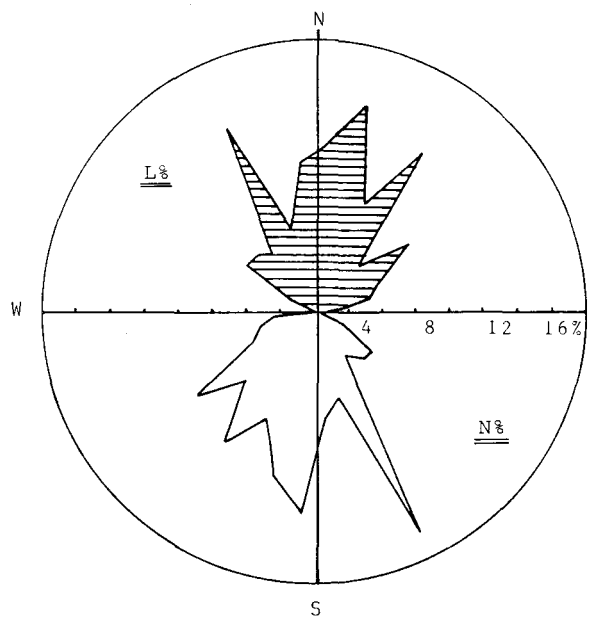

Fig. 7: Rose diagrams for the relative frequency distribution of length (L%) and number (N%) of coastal lineaments, Qatar Peninsula.

from 500 m to 6.5 km with an average of 1.93 km. They are oriented in various directions with predominant NNW-SSE and NNE-SSW trends, i.e. slightly deviated from the general N-S trend of the Peninsula. The east coast shows two significant linear trends: the dominant one of the NNE-SSW direction includes 43% of the total lineaments on this side and represents 48.9% of its total length, while the other trend in the NNW-SSE direction includes 10.8% of the lineaments number and 11.3% of their length. On the western side, the dominant trends are the NNW-SSE (17.7% of number and 12.6% of length), and the NE-SW (14.5% of number and 14.9% of length).

Table 2
Frequency Distribution of Linear Coastlines of Qatar Peninsula Delineated from Landsat Images.

Trend	West Coast				East Coast				Total			
	Number		Length		Number		Length		Number		Length	
	N	%	Km	%	N	%	Km	%	N	%	Km	%
N80-90W	–	–	–	–	–	–	–	–	–	–	–	–
N70-80W	–	–	–	–	–	–	–	–	–	–	–	–
N60-70W	1	1.6	2.00	2.0	1	1.5	1.50	1.1	2	1.6	3.50	1.4
N50-60W	1	1.6	0.75	0.7	4	6.2	11.00	7.6	5	3.9	11.75	4.8
N40-50W	2	3.2	4.50	4.4	3	4.6	6.75	4.7	5	3.9	11.25	4.6
N30-40W	1	1.6	1.75	1.7	3	4.6	8.00	5.5	4	3.1	9.75	4.0
N20-30W	11	17.7	12.75	12.6	7	10.8	16.25	11.3	18	14.3	29.00	11.8
N10-20W	4	6.5	6.75	6.7	3	4.6	5.50	3.8	7	5.5	12.25	5.0
N 0-10W	4	6.5	12.25	12.2	4	6.2	8.75	6.1	8	6.3	21.00	8.6
N 0-10E	6	9.7	7.75	7.7	9	13.7	16.00	11.1	15	11.9	23.75	9.7
N10-20E	5	8.1	9.25	9.2	8	12.3	22.00	15.2	13	10.2	31.25	12.6
N20-30E	5	8.1	5.75	5.7	4	6.2	10.75	7.4	9	7.1	16.50	6.7
N30-40E	5	8.1	6.00	5.9	7	10.8	22.00	15.2	12	9.4	28.00	3.4
N40-50E	3	4.8	4.00	4.0	3	4.6	4.25	2.9	6	4.7	8.25	3.4
N50-60E	9	14.5	15.00	14.9	2	3.1	1.75	1.2	11	8.7	16.75	4.2
N60-70E	3	4.8	7.00	6.9	2	3.1	3.25	2.2	5	3.9	10.25	4.2
N70-80E	2	3.2	5.50	5.4	2	3.1	2.75	1.9	4	3.1	8.25	3.4
N80-90E	–	–	–	–	3	4.6	4.00	2.8	3	2.4	4.00	1.6
Total	62	100	101.00	100	65	100	144.50	100	127	100	245.50	100

The most significant linear part of Qatar coastline is that of Dukhan - Umm Bab area on the west coast, boundidng a mountainous region along the Gulf of Salwa (Fig. 8). This and similar lineaments are topographic expressions of sharp change in relief, as a transient feature of a coastal plain. However, their significance is different, where some may represent structural features such

as faults or zones of intense jointing. On the other hand, some of the smoothly curved coastlines are found at the intersection of some short lineaments of various trends.

Among the other factors influencing coastal lineaments are the tidal range and the long-shore currents mainly created by wind action. The predominant NNW/NW winds, locally known as Al-Shamal, produce long-shore currents moving southwardly on both coasts of Qatar Peninsula. The bioclastic carbonate and dolomitic materials derived from the extensive offshore coral reefs at the northern tip of the Peninsula are transported southwards and deposited to form many parallel, linear elongated cheniers, bars and spits. This sedimentation continued to accumulate fine-grained carbonate material between successive cheniers and spits which straightened the coast (Shinn, 1973). These features have been recorded in several areas along the coasts of Qatar Peninsula, particularly in the northeast at Al-Khor, Al-Dhakhira and Ras Umm Sa' (Noweir and El-Kassas, 1988a).

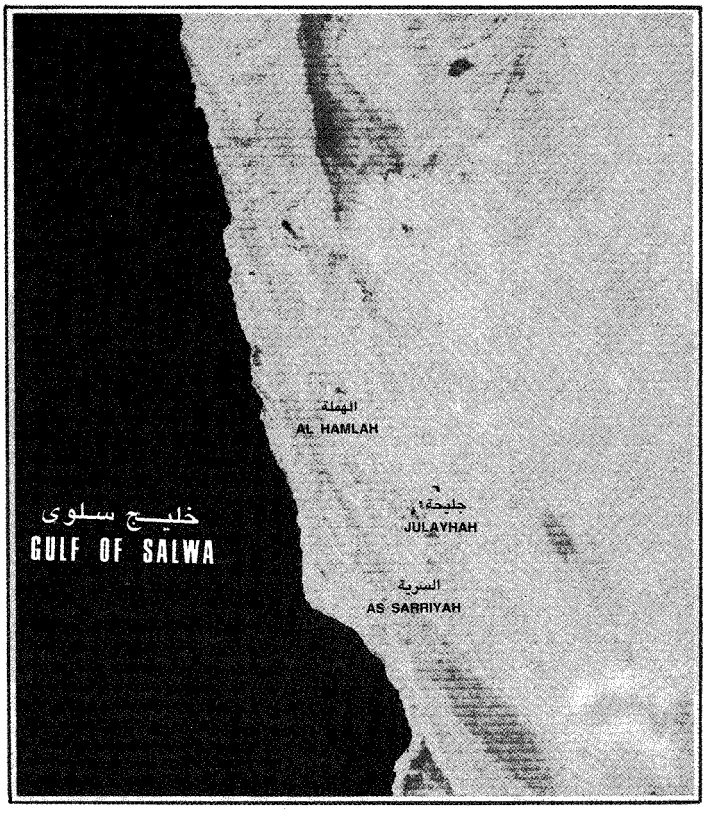

Fig. 8: Conspicuous coastal lineament of Dukhan-Umm Bab stretch, along the western coast of Qatar Peninsula, as shown on Landsat image.

2. Eolian Lineaments

Eolian features are among the most conspicuous features appearing on Landsat images of Qatar Peninsula.Embabi and Ashour (1983) published a comprehensive study on the various types of sand dunes and other sand accumulations, using normal aerial photography as base maps for field work. Later, Ashour and El-Kassas (1984) carried out photo-interpretation of some eolian features in Qatar using Landsat images and aerial photographs, on lwhich 320 sand dunes have been mapped and statistically analyzed. The present work is dealing mainly with the linear arrangement of eolian features on the surface of Qatar Peninsula as depicted from the interpretation of Landsat imagery. The studied features include sand shadows, sand sheets, sand dunes and other sand accumulations, mainly found in the northeastern side and in the southern part of the Peninsula. They form some discernible dominant lineaments of a general NNW-SSE trend in the northern area, where they are mostly related to the prevailing wind "Al-Shamal" of the same direction (Fig. 9). However, statistical studies carried out on the measurements of the delineated sand dune belts show that they constitute two different groups of different types and trends (Fig. 10). The first group comprises mainly crescentic sand dunes and sand shadows in central Qatar where they extend in a NNW-SSE trend (N30°E - S30°W).

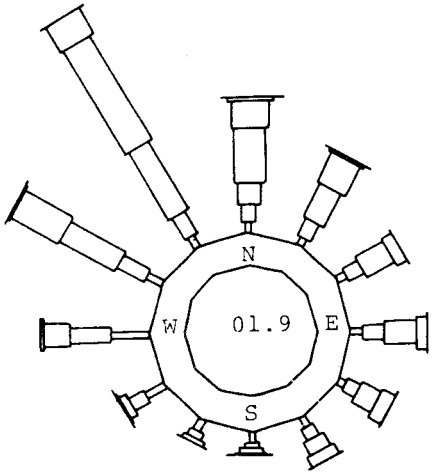

Fig. 9: Wind rose for the frequencies of the annual average speed of surface wind measured at Doha International Airport (Figure in circle is the frequency of calms).

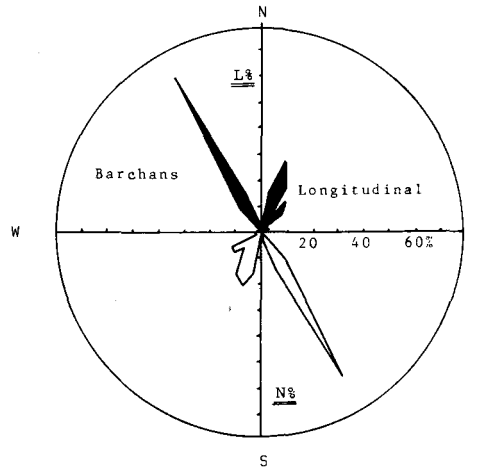

Fig. 10: Rose diagrams for the relative frequency distribution of lentgh (L%) and number (N%) of linear sand dune belts in Qatar Peninsula.

3. Drainage and Relief Lineaments

The channels formed from the rainfall and runoff over Qatar Peninsula are the only features of surface drainage. They are mainly developed in the hilly country to the south of Qatar which is characterized by the presence of massive ridges and elevations with low-lying runnels. There are three major drainage lines on the surface of Qatar, namely: Wadi Galal, Wadi Dhiab and Wadi Al-Jah.

Qatar Peninsula is generally considered as a very slightly undulating desert plain with some scattered depressions and few rocky ridges. The relief declines generally from about 100 m in the south to about 50 m in the north with a N-S linear ridge of about 75 m in elevation bordering the western shore. In the north the surface is nearly flat and in the south the surface becomes uneven where sand dunes, sandy hills and rocky hills are found formed on a rocky limestone surface. The movement of loosened rock fragments from their place of origin over substratum causes some corrosion linears on the uniformly bedded limestone rocks forming most of the land's surface. The mechanical action of the rock waste is increased by the rainfall and run off water, and by the force of the prevailing wind causing removal of weathered material from the NNW to the SSE. Such mechanical wearing of the surface by rock waste in transit is clearly observed on Landsat images. This features is expressed by dominant NNW-SSE linear scratches which are particularly evident on the north-western coast near El-Zubarah, in the central part of the Peninsula (Fig. 11) and in the south eastern side parallel to the pronounced linear sand train.

Fig. 11: Pronounced NNW-SSE linear scratches in the central part of Qatar Peninsula, as shown on Landsat image.

CONCLUSION

On Landsat imagery, lineaments can be emerged with remarkable clarity, especially in desert regions such as Qatar Peninsula, because geology and relief could be combined to enhance tonal contrasts. The synoptic view of such satellite images is found useful in delineating the lineaments of regional extent that cannot be recognized by field work or it would need extensive and tedious interpretation of overwhelming number of normal aerial photographs. The avialability of Landsat images in the different spectral bands, their false color composite and color sliced image of band 5, provided a potential tool for two-dimensional approach to interpret various lineaments that could be delineated on the images.

In this paper, numerous lineaments have been detected, identified and accurately traced from careful investigation of Landsat images (scale 1:1,000,000) covering Qatar Peninsula. Based on the spatial distibution of the mapped lineaments, their frequency, magnitude, continuity and relationship to other regional geological features, the lineaments are grouped into three main categories namely structural, morphologic (coastal, eolian, drainage and relief), and cultural (man-made). Each of these categories has its characteristic spectral signature on the various images depending mainly on their texture, pattern, geometry and tonal contrast with the adjacent features. Many linear features mapped on the surface of Qatar Peninsula are not of geologic origin. This is mainly due to the low resolution of Landsat images and the tremendous number of potentially significant linear features apparent on a single image. Moreover, since Landsat is a sun-synchronized satellite, the images are ordinarily generated in the morning with a sun-azimuth that establishes a bias toward northeast striking linaer features. These factors have a serious effect on the mapping of linear features and may cause erroneous identification of potential stuctural lineaments. These could be better recognized by use of high resolution images corroborated by field work to verify their geological and economical significance.

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تحليل التخططات من مرئيات القمر الصناعي « لاندسات » لشبه جزيرة قطر

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يعتمد هذا البحث على التفسير الجيولوجي لمرئيات القمر الصناعي لاندسات (مقياس رسم ١ : مليون) حيث تم رسم عدد كبير من التخططات السطحية ذات أنواع وامتدادات واتجاهات مختلفة . وقد أجريت عليها دراسة تحليلية نوعية وكمية حيث تم تصنيفها إلى ثلاثة أنواع رئيسية وهي تخططات تركيبية ، تخططات مورفولوجية ، وتخططات صناعية من عمل الانسان .

وقد وجد أن التخططات التركيبية الكبيرة بشبه جزيرة قطر تمتد في اتجاهين رئيسيين وهما شمال شرق ـ جنوب غرب ، شمال شمال غرب ـ جنوب جنوب شرق ، اللذان يمثلان اتجاهات كسور الشد الاقليمية التي تكونت خلال رفع تقوس قطر . كما وجدت أيضاً تخططات منحنية وملتوية ، بعضها يمثل مسار محاور بعض الطيات الكبيرة والبعض الآخر يمثل امتداد سطح طبقة من الحجر الجيري الصواني المقاوم لعمليات التعرية .

وبالنسبة للتخططات المورفولوجية فهي تشمل الامتدادات المستقيمة لاجزاء من الساحل القطري المتأثرة بالفوالق والكسور ، والكثبان الرملية الطولية والمستعرضة وغيرها من أشكال التراكمات الرملية الممتدة في اتجاه الرياح السائدة بشبه الجزيرة خاصة رياح « الشمال » والتي تسببت أيضاً ـ على مر الزمن ـ في تكوين خدوش سطحية تظهر بوضوح على مرئيات القمر الصناعي مكونة تخططات ممتدة في اتجاه شمال شمال غرب ـ جنوب جنوب شرق . كما أن هناك بعض الأودية والمنخفضات الضحلة والحواف الصخرية تظهر على هيئة تخططات واضحة على المرئيات نظراً لتباين انعكاساتها الطيفية عما حولها .