CONTRIBUTION TO THE STRUCTURAL EVOLUTION OF THE SHARI PLAYA – CENTRAL IRAQ

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ABSTRACT

Shari playa is an elongated N–S depression located about 35 km NE of Samarra city, central Iraq. A combination of the bands 2, 3 and 4 of the Landsat imagery was used to study the structural lineaments and water seepage analysis. Three sets of principal lineaments were detected. They are oriented in NW – SE, NE – SW and N – S; they may reflect faults or fault systems. The NW – SE direction is affected by the nearby Hemrin Mountain and also by the Pre – Miocene deep seated faults. The NE – SW direction is parallel to that of Greater Zab and Lesser Zab Rivers which are also parallel to the Amij – Samarra – Halabcha deep seated fault, which intersects Shari playa. The N– S direction is parallel to the proposed Tigris Fault. These fault systems are responsible for the water seepage in the playa. The stresses applied in the region probably activated movements along old lineament systems, resulted in the formation of a graben structure in Shari playa area. The estimated age of the playa is about 6000 – 6500 years B. P.

مساهمة في التطور التركيبي لمملحة الشارع – وسط العراق

رافع زائر جاسم و يحيى توفيق الراوي و حبيب رشيد حبيب

المستخلص

مملحة الشارع منخفض طولي باتجاه شمال – جنوب يقع على مسافة 35 كم شمال شرق سامراء في وسط العراق استخدمت توليفية صور لاندسات 2 ، 3 و 4 لدراسة الظواهر الخطية و توضيح العيون والنضوحات في داخل المملحة . تم تحديد ثلاثة مجاميع رئيسية من الظواهر الخطية و اتجاهاتها هي شمال غرب – جنوب شرق ، شمال شرق – جنوب غرب وشمال – جنوب . الظواهر الخطية باتجاه شمال غرب - جنوب شرق تأثرت بتركيب جبل حمرين المجاور وكذلك لها نفس الاتجاه لفوالق ما قبل المايوسين العميقة في المنطقة . المجموعة التي هي باتجاه شمال شرق – جنوب غرب موازية لنهري الزاب الكبير و الزاب الصغير و التي هي أيضا موازية لفالق عامج – سامراء – حلبجة العميق الذي يتقاطع مع مملحة الشارع. المجموعة الثالثة والتي هي باتجاه شمال – جنوب موازية لفالق نهر دجلة المقترح. إن تقاطع مجاميع الظواهر الخطية هو السبب الرئيسي الذي أدى الى تكون العيون و النضوحات في داخل المملحة. إن الجهود المسلطة على المنطقة ربما جددت الحركة في الفوالق القديمة مما أدى إلى تكون تركيب منخسف (graben) أدى الى تكون مملحه الشارع. العمر المقدر لبلايا الشارع هو بين 6000 – 6500 سنة قبل الآن.

INTRODUCTION

Shari playa is longitudinal depression of N–S direction (Fig. 1) supplied by water and sediments by ephemeral streams from north and east. The playa is characterized by seasonal salt deposit reaching in thickness to about 10 cm, underlain by recent sediments wedging out from the center to the periphery. The highest thickness of these sediments reaches about 6.5 m, these sediments overlie

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the Pleistocene (?) sediments, which continue outside the playa margins. The sedimentological and mineralogical developments of the recent sediments within the playa are characterized by facies changes laterally and vertically from sand to clay, as well as the gradual growth and change of the evaporite minerals with the increase of the solutes inside the playa, in the same manner indicate sedimentation during subsidence of the basin.

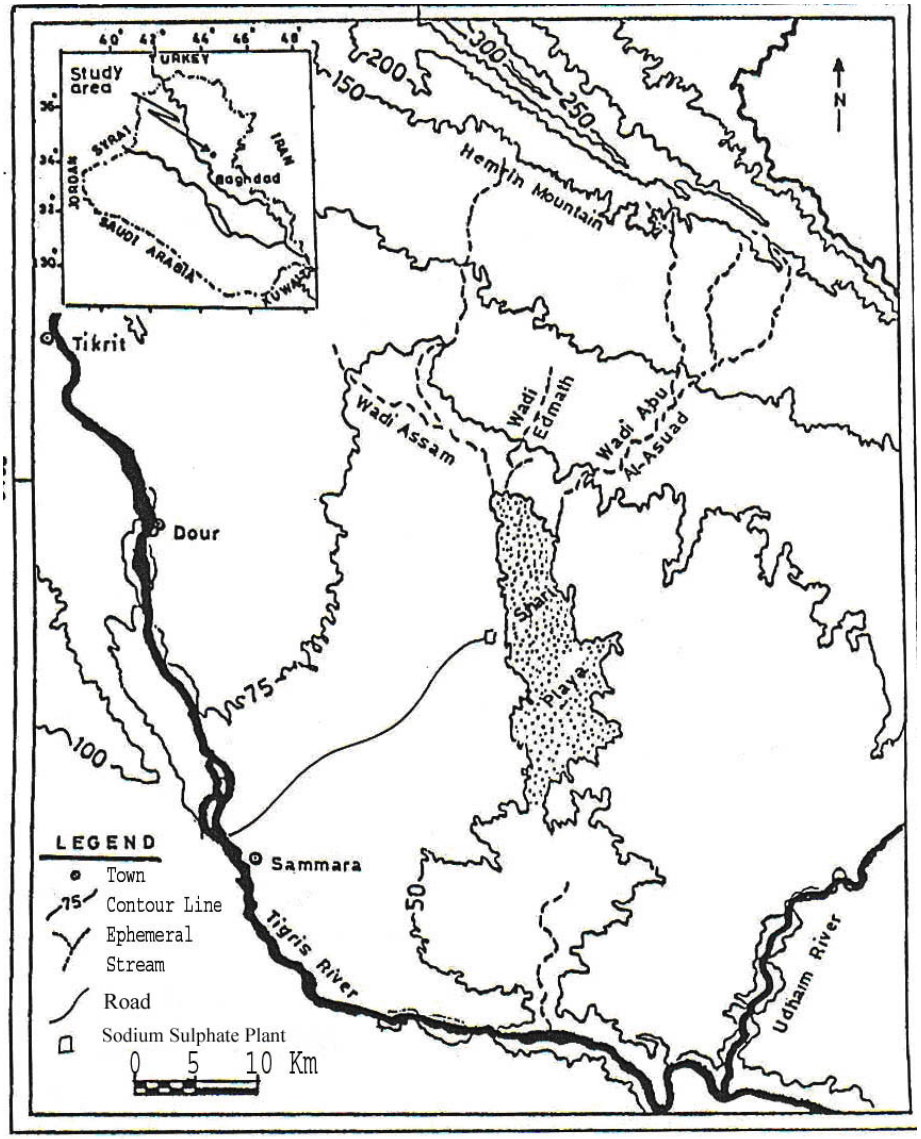

Fig.1: Location map of Shari Playa

LANDSAT IMAGES INTERPRETATION

A combination of the bands 2, 3 and 4 of the Landsat imagery was found to be the best combination for the purpose of structural lineaments detection and enhancement, and for water seepages study. Imagery views, which cover Shari playa (Baiji area, path 169 and row 36) in two different seasons, were used in the structural analysis. The first image was taken on 20th of July 1988 (Fig. 2) and the second on 28th of March 1990 (Fig. 3). Analysis of the imagery was carried out in the State Establishment of Space Research and Physics using M 70 image processing unit type IS with main HP 3000 computer, for bands gathering, enhancement of the image, lineaments detection and rose diagram construction for the detected lineaments.

LINEAMENTS

Lineament detection on the Landsat image of July 1988, bands 2, 3 and 4, revealed the detection of three sets of principal lineaments, oriented in NW–SE, NE–SW and N–S directions (Fig. 4). These lineaments may reflect faults or fault systems. A rose diagram constructed from the detected lineaments on Shari playa (Fig. 5) shows that about 50% of the detected lineaments have a NW–SE direction. The NW–SE direction is the same as that of Hemrin Mountain and other major surface structures in the area. They also have the same direction of the Pre–Miocene deep seated faults mentioned by Al-Kadhimi et al. (1992). About 25% of the lineaments have a NE–SW direction, which is parallel to that of Greater Zab and Lesser Zab rivers. This set of lineaments is also parallel to the Amij – Samarra – Halabcha deep seated fault, which intersects the Shari playa at its southern part (Buday and Jassim, 1987). The rest of the lineaments, which represent 25% of the total lineaments have N–S direction. These lineaments are parallel to the proposed Tigris Fault (Buday and Jassim, 1987).

Stresses in the region, probably activated the movements along old fault systems resulting in the formation of a graben structure in the Shari playa area. The Shari playa orientation reflects the major effects of the N–S lineament system. Similar to Shari playa, Tharthar depression has the same N–S trend of the Tigris Fault, indicating regional N–S trending block movement. Therefore, this system might be responsible for the formation of the graben which explains the longitudinal shape of the playa, in an almost N–S direction. The western margin of the playa is probably the most prominent and direct expression of these structural lineaments. The slight deviation of its orientation at the northern part and that of the lake to the NW is probably the result of modifications imposed by the NW–SE lineaments. The neotectonic map of Iraq shows neotectonic activity and regional subsidence (Sissakian and Deikran, 1998). Also the structural study carried out by Deikran (1998) on Tharthar – Samarra area revealed that Shari area was subjected to subsidence during late Upper Pliocene and Quaternary period leading to the formation of the depression.

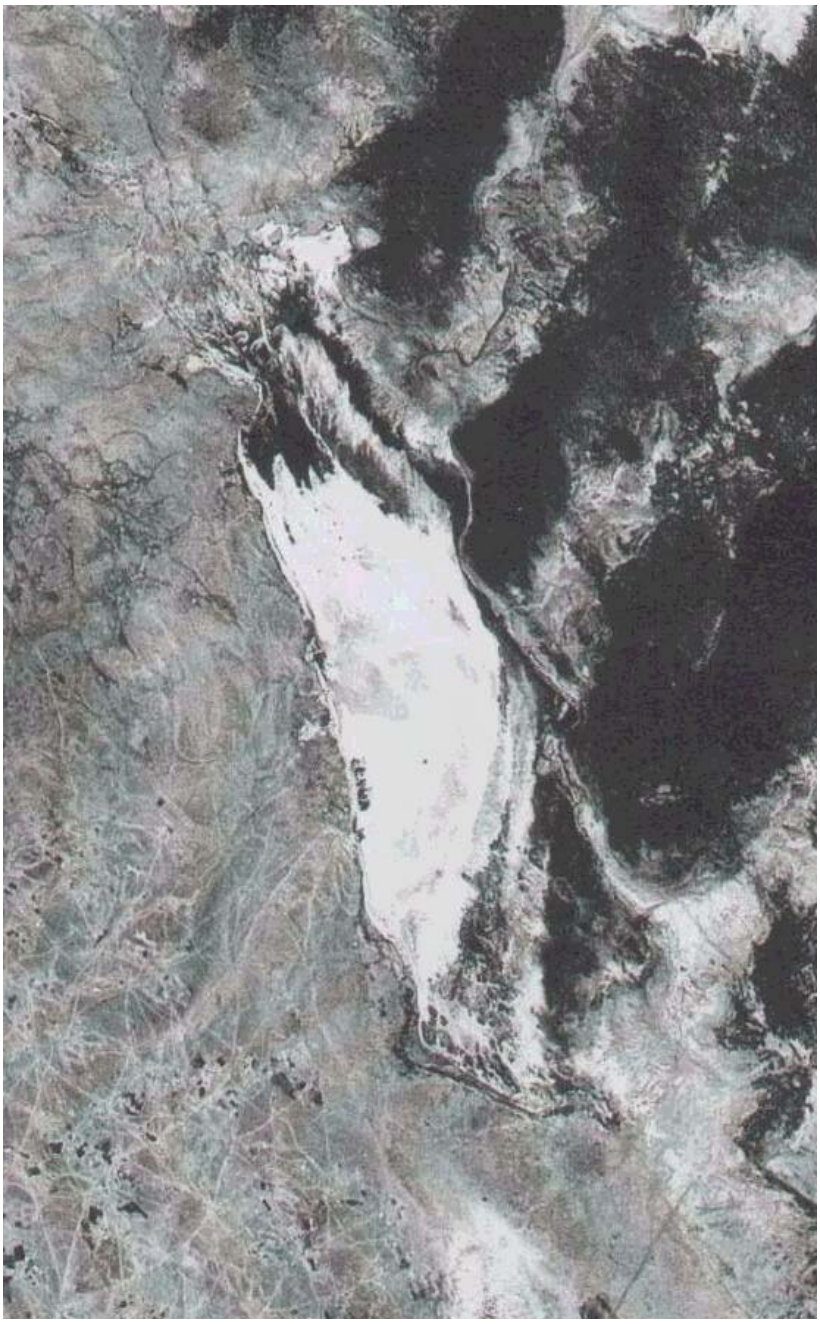

Fig. 2: Landsat image of the Shari playa taken on 20th of July 1988

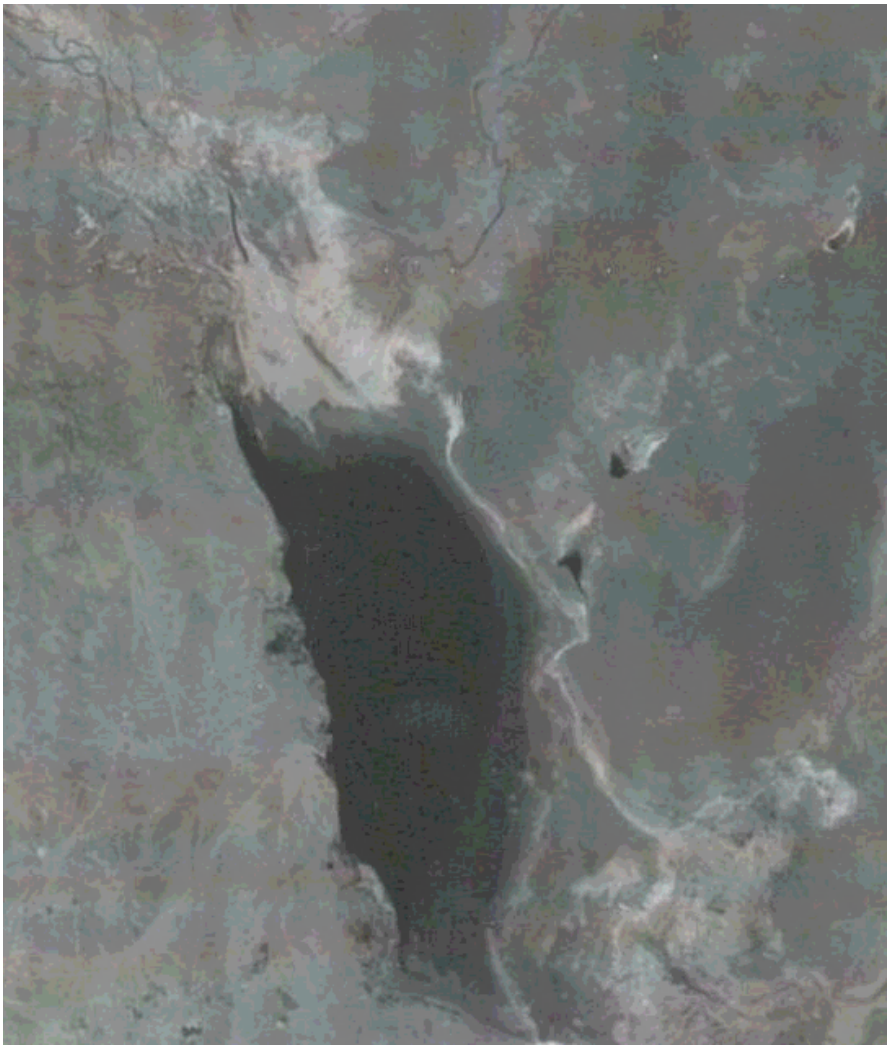

Fig. 3: Landsat image of the Shari playa taken on 28th of March 1990

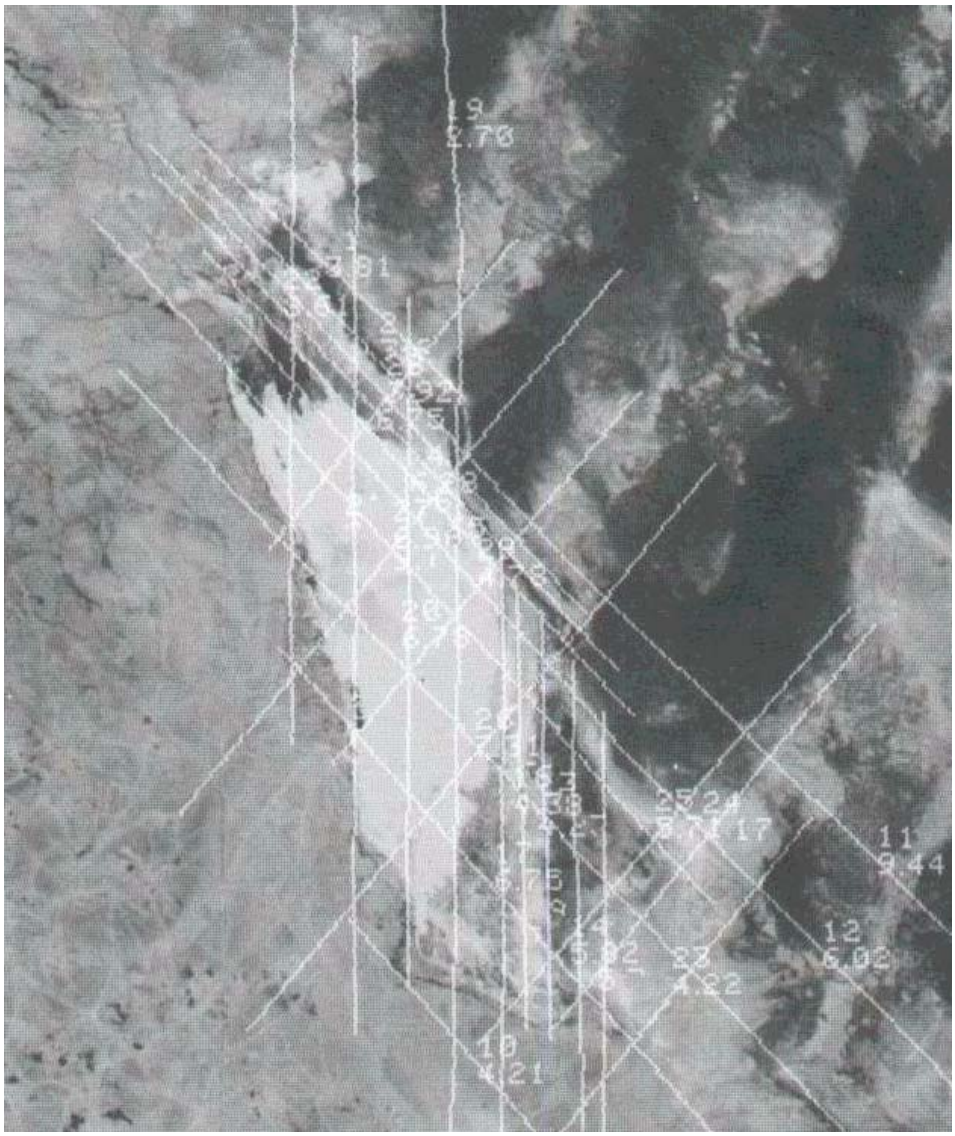

Fig. 4: Lineament analysis of the Shari playa

11 Lineament number 9.44 Lineament length (km)

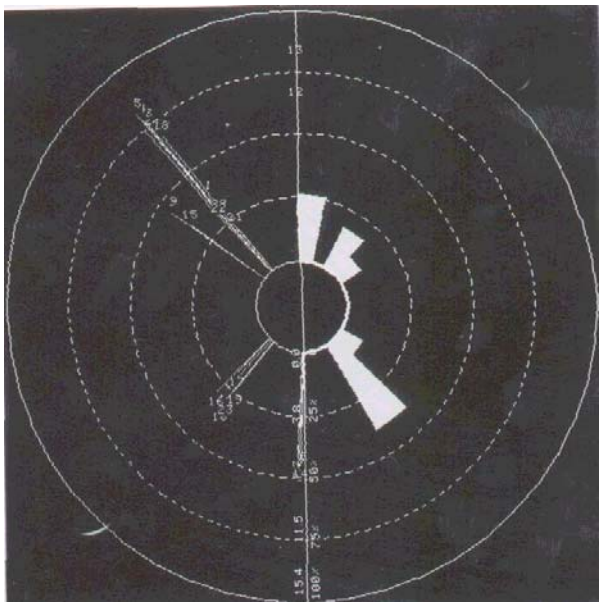

Fig. 5: Rose diagram for the lineaments of the Shari playa marked on Fig. (4)

12 Lineament number 25% Lineaments intensity

SEEPAGES

Shari playa area is characterized by the presence of many water seepages, where ground water flows to the surface of the playa. Due to the relatively low salinity of the water, most of these seepages are marked by the growth of shrubs and reed scattered on the playa surface; birds are also observed to use these seepages for drinking. Enhancement of the Landsat image, bands 2, 3 and 4 for the view of March 1990, also revealed the presence of a large number of seepages in the playa (Fig. 6). Visual inspection of this figure may also reveal the alignment of many of these seepages along lines parallel to the playa trend and the lineament directions. These seepages represent the out flow of ground water along weakness zones, most probably the fault systems expressed by the lineaments, and in particular the intersection of these systems. Thus the water seepages also indicate the structural setting of the playa area and its effect on ground water movement and hence salt formation.

Evidence of palaeoseepages is also found outside the present area of the playa. A cone shaped greenish clay deposit with many gypsum seams were found in a sand layer (Fig.7) located at a distance of about one kilometer to the east of the playa in the sand dune fields. This feature has been dissected by Wadi AbulAsuad. It is interpreted as a palaeoseepage formed in the very early stage of faulting and was abandoned in the later stages where subsidence of the area took

place. The subsidence motivates the ascending brines to shift its course to the topographically lower area represented by the present playa. The presence of gypsum in the palaeoseepage cone reveals that the ascending solutions were Ca^{2+} and $S0_4^{=}$ rich. These ions might be a dissolution product of evaporite beds of Fatha Formation at depth.

Fig. 6: Seepages distribution detected on Landsat image of the Shari playa taken on 28th of March 1990

Fig. 7: Photograph of a palaeoseepage cone shaped sediments in the dune fields east of the Shari playa

ESTIMATED AGE OF THE PLAYA

The age of many salt deposits in the world has been calculated from the rhythms and annual banding of evaporite deposits or evaporitic and non-evaporitic sedimentation. These sedimentation patterns are largely controlled by climate, synsedimentary subsidence of the basin, topographic relief in the catchment's area and nature of the exposed rocks and sediments. Because of the annual banding and sedimentary structures were destroyed and the salt crust is annually dissolved in the Shari playa, a reliable age estimation of the playa is not possible on these basis.

Calculations based on the rate of accumulation in the other saline lakes together with other data about the climate and geological history may provide a rough but reasonable estimate of the age. For example, the accumulation rate of salt and mud in Searls Lake (California, USA) was calculated to be 0.12 cm/year on the basis that the upper 36 m were deposited in the last 30 000 years (Borchert and Muir, 1964). The Shari playa has a total saline sediments thickness of 7.85 m formed mostly of mud with embedded crystals of glauberite and or gypsum. Therefore, using the average depositional rate of 0.12 cm / year will date the onset of salt accumulation in the Shari playa at about 6542 years before present.

Another approach is to compare the rate of the clastic sediments with modern detrital lake sedimentation. The Shari playa sediments consist of 75% mud and thus, the detrital thickness of these sediments is 5.89 m. Thickness of detrital sediments in modern lake basins vary widely. Sediments rate in Lake Kivu (East Africa) ranges from > 30 m / 1000 years in the upper part of the sediment column to 100–500 cm / 1000 years in the lowest part (Stoffers and Hecky, 1978). In Lake Tenganika, sedimentation rates in the basin are on the order of 30 – 50 cm / 1000 years (Stoffers and Hecky, 1978). Detrital sedimentation in the black sea ranges from 6 cm / 1000 year (actual) or 15 cm / 1000 years (calculated) at present to 90 cm / 1000 years during the last glacial period and 22 cm / 1000 years during the early Quaternary (Hsu and Kelts, 1978). A core of 180 cm thickness of carbonate and clastic sediments in Lake Balton (Hungary) was estimated to have been deposited during the last 7000 years (Muller and Wagner, 1978) giving a sedimentation rate of approximately 26 cm / 1000 years.

Therefore, a sedimentation rate of 100 cm / I000 years for the detrital portion of the Shari playa sediments does not seem unreasonable and gives an age of about 5890 years which is close to the aforementioned deduced age. Such an age is also concordant with the palaeoclimatic history deduced from the palynological data, which revealed two wet periods that may be correlated to the Holocene climatic history; i.e. an age of < 10000 years (Jassim, 1997). Thus, it may be concluded that subsidence of the Shari playa area resulted in closing the basin and thus, the formation of a saline lake and evaporite deposition at approximately 6000–6500 years B.P., which is concordant with the second wet period mentioned by Jassim (1997).

CONCLUSIONS

- The lineament sets detected in the area are oriented in NW – SE, NE – SW and N – S directions, which are parallel to the major structures in the region.
- The regional stresses that formed such lineaments in the area probably activated movements along old fault systems resulting in the formation of graben structure.
- The intersection of the different sets of faults in the area resulted in the formation of seepages in the area.
- The estimated age of the playa is about 6000 – 6500 years B. P.

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