NEW DISCOVERY OF SOME VERTEBRATE FOOT PRINTS IN MUKDADIYA FORMATION FROM CHAMCHEMAL AREA, NE-IRAQ.

BY:

Kamal Haji Karim Khalid Mahmood Ibrahim M. J. Mohyaddin

Abstract

Two types of vertebrate footprints are recorded for the first time in Mukdadiya Formation at Chamchemal area, NE-Iraq. The first one belongs to birds and the second to hoofed sheep-like mammals. Both types are found on the upper surface of thick, massive, occasionally pebbly sandstone beds of Mukdadiya Formation. This formation is composed of alternation of thick beds of light brown claystones and sandstone .The footprints are evidence that the depositional environment of the Formation was continental of fluvial type. The pebbly sandstones were deposited in river channels floor as lag sediments and claystones on flood plain (over bank) while the sandstone beds represented the point bars sediments. The Upper Miocene-Pliocene coastal area of the Zagros Foreland basin was at the position of the footprints .The animal paleocommunity is inferred from footprints that is similar to recent except for large size of the birds as reflected by their footprints. The foot trace fossils were formed during searching for food on bank of the rivers that time.

Introduction

In the studied area, the last Tertiary sequence includes Fatha, Injana, Mukdadiya and Bai Hassan Formations, from older to younger correspondingly. These names are assigned to above Formations recently by Al-Rawi *et. al*, (1992) instead of previous, Lower Fars, Upper Fars, Lower and Upper Bakhtiary, respectively. In according to the basses of sequence stratigraphy, as given by Vincent *et al.* (1998), the Mukdadiya formation deposited during single lowstand system tract (regression). This formation is deposited in late Zagros foreland basin. According to Karim (2004), this basin is developed started from Campanian as an Early Foreland basin. The coastal area, as found by him, during Upper Cretaceous is about 50km far from the location footprint. As foot prints indicate the coastal area in Upper Miocene, the migration of the tectonic front (hinterland of foreland basin) is also 50km to the southwest.

The lower boundary (sequence boundary} of this sequence is represented, at the basin periphery, by a bed of conglomerate at the base of Fatha Formation. While it is gradational at and near the basin center, there equivalent of this conglomerate, at Mishraq area (south of Mosul City) was proved by Karim (1988) to be consisted of sandy limestone.

Injana and Mukdadiya Formations are consisting of alternation of very thick beds of silty brown claystone and thick ones of sandstones (Plate 1.1 and Fig. 2).The sandstones are mostly composed of carbonate rock clasts with some chert and quartz. In some case, they become clayey (graywake). According to Dott (1964), this type of sandstone is called lithicarenite. The only difference between the two formations is that the sandstone beds of Mukdadiya Formation are occasionally pebbly at the base. While Bai Hassan Formation only cropped out on few small hills as thick lensoidal of the Mukdadiya Formation. Buday (1980), considered these two Formations as a one unit. In the studied area the last Tertiary sequence considerably reduced in thickness due to nearness of source areas and topographic higher lands. The Darbandi Bazian Mountain (Fig. 1), being located 10km to the north and northeast, was forming a part of this source area during

deposition of, at least, the last two Formations. During Middle and Upper Miocene till the end of Pliocene, the sediments were mainly clastics

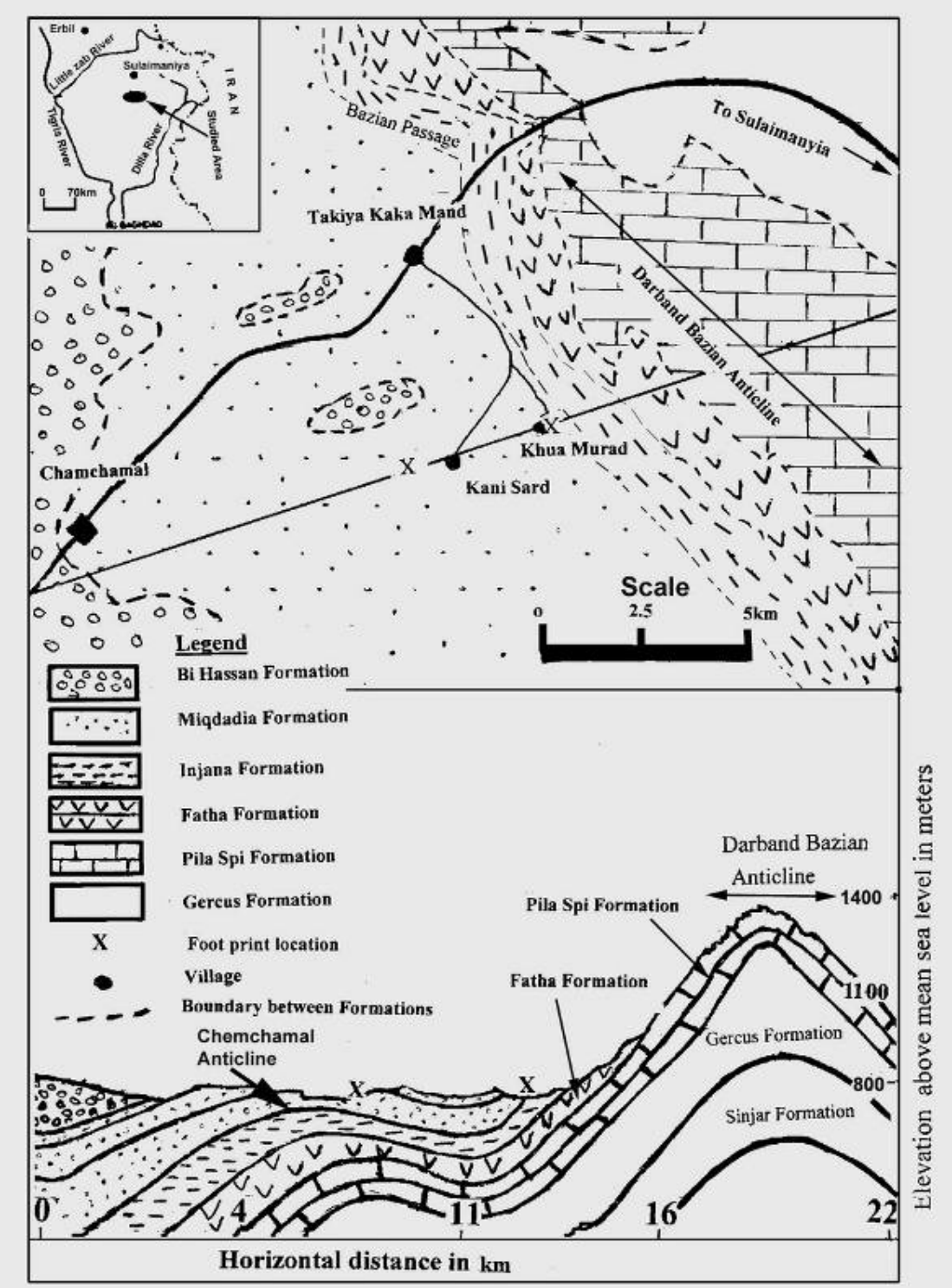


Fig. (1) Geological map and cross section of the studied area.

with the gradual coarsening as a marginal mollase facies.

In the studied area, in contrast to basin center, (central and southern Iraq) Fatha Formation contains only two beds of evaporites (gypsum) and largely composed of sandstone, red claystone, marl, and few beds of fossiliferous limestone. The high thickness (more than 600m) of Mukdadiya Formation was in expense of Injana Formation (less than 150 m). In Hemrin

area, the lower part of Mukdadiya Formation is returned to Upper Miocene and estimated to be aged 9-10 m.y by Thomas, *et. al* (1981). Therefore this Formation, in the studied area, is certainly older than other part of Iraq including Hemrin area. This is because of the following two points: the first one is early tectonic uplifting of the area, accordingly early coarse sediment influx (pebbly sandstone). The second one is early regression of the sea from the area and then deposition of conglomerate of Bai Hassan Formation at the final stage of this cycle.

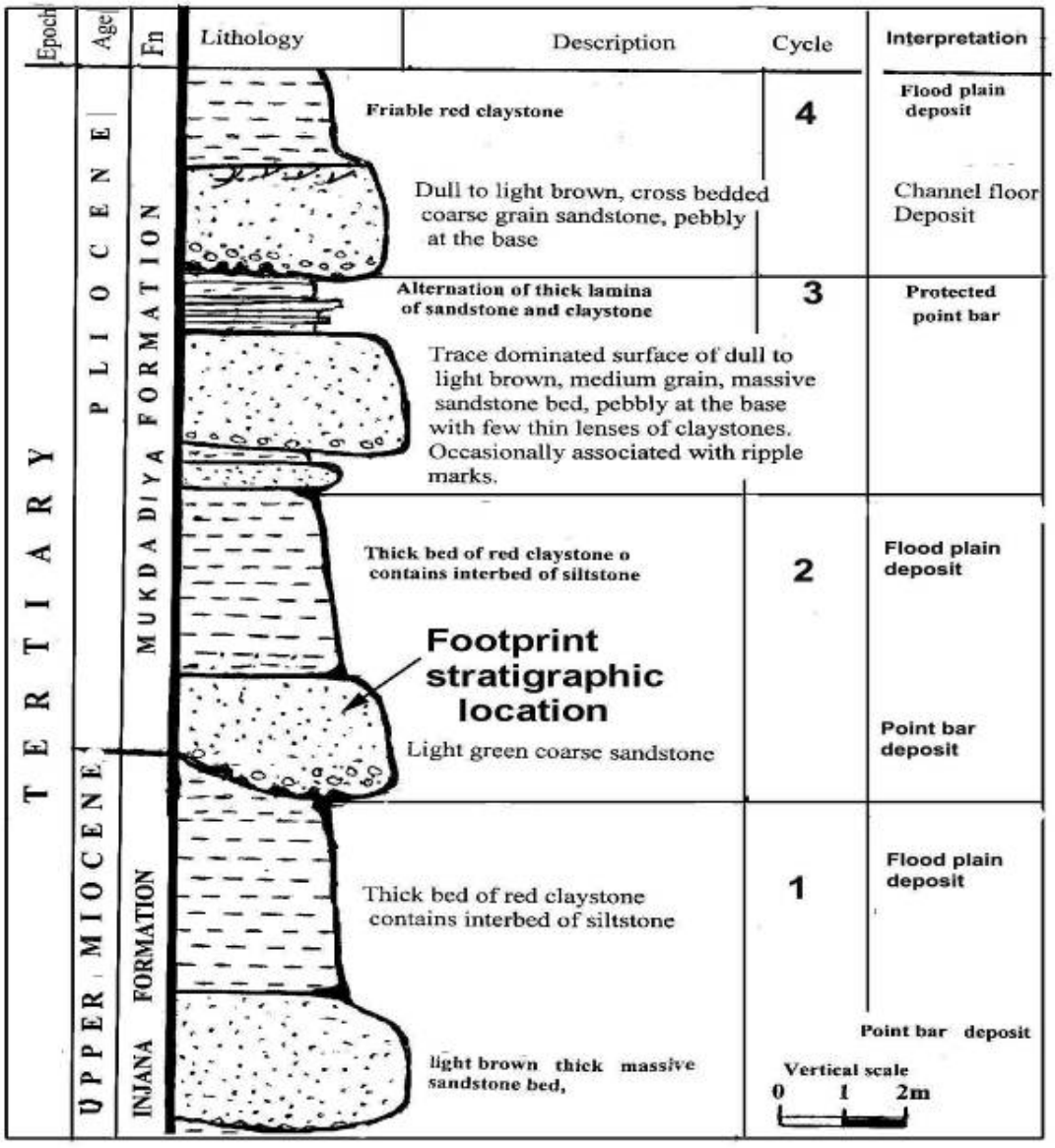


Fig.(2) Stratigraphical column of the boundary between Injana and Mukdadiya Formations in the studied area.

The studied area includes part of southwestern limb of Darbandi Bazian Anti-cline (Fig.1). The toe of this limb forms undulating gentle slope and contains a small syncline running northwest southeast parallel to the main anticline. The bird and mammal foot impressions are found on the both limbs of this syncline, near it's center. Both types are observed on outcrops exposed recently by seasonal small strike streams. According to resident villagers, 20 year before, they had seen similar features on other outcrops, which now

have been removed by weathering. This is due to relative softness of Mukdadiya sandstones, which can be easily broken and disintegrated by hammer. This explains the scarcity of vertebrate tracks in spite of availability and extension of outcrops.

The footprint

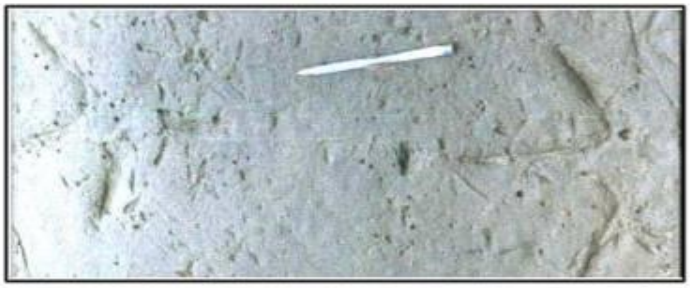
According to Goldring (1999) vertebrate footprints and track ways can provide much information about the ecology of track maker. Also the speed of the travel, represented by tracks can be estimated from the length of stride and foot length

Sarjeant(1975) stated that for studding purposes, paleoichnologists hope to have a series of successive footprints). He added that identification of track ways, at least three sequential sets of impression (molds or casts) must be found . By this the progressive motion (the gait) and the track maker may be determined. He further confirmed that perfect impression of the whole, under surface of the foot, may be formed if the surface is fairly fine grained and cohesive, neither too wet nor too

Plate 1

1. Alternation of thick grey sandstone beds with very thick red claystone beds of lower part of Mukdadiya Formation. The arrow indicates the bed on which all bird foot traces and one type of mammal footprint are found to the southwest of Kani Sard village.

2. Four successive footprint of large bird (ostrich-size), found 1.5km to the southwest of Kani Sard village. That bird has stride length (T) of 47 cm and pace length of 9 cm. The movement was from right to the left. These traces are imprinted on upper surface of a massive thick sandstone bed (pebbly at the base).



3. Close photo of the two footprints shown in the left side of the previous photo (near the hammer head). They are photographed before whitened with chalk.

4. Very close photo of one of the above bird footprints before has been whitened. This impression has length of 25cm and width of 21cm as indicated on the photo.
These traces are imprinted on upper surface of a sandstone bed.

dry and if the animal stepped forward sufficiently slowly.

Seilacher (1967) and Simpson (1975). classified Footprint type trace fossils as Repichna (locomotion trace). This classification is based on manner by which Ichnofossils are formed. Goldring (1999) showed diagrammatically distribution of non-marine trace fossils from shoreline to continental interior.

Bird foot traces

The bird foot traces are found about 1.5km to the southwest of Kani Sard village (plate1.1). They are imprinted on the upper surface of a thick sandstone bed. According to size of footprints three types are identified, small, medium and large ones (Plate 1.2 and 1.3). The largest one is estimated to be in the size of ostrich and the medium in the size of Turkey.

Frey (1975) showed that in bipeds (including birds) left and right feet alternate so the impression are of constant form and are side by side. He gave the definition of stride as the approximate unitary forward movement of the feet on the right or on the left side. It is measured from some fixed points on the impression of one footprint to the same point on the next impression.

In the present study measurements of the largest foot tracks are as the following:

Stride or step length of the track: 47cm.
Pace length of the track impression: 9cm.
Foot track impression breadth: 21cm.
Foot track length: 25cm.

The hoofed mammals footprints

These types of traces are found in two different places, the first one is the same places where the bird traces are found near Kani Sard village. The second place is located directly to the east of Khuwa Murad village (Fig.1). The foot tracks of latter localities are smaller and have sharper boundary (Plate2.3 and 2.4) as compared to the former. They seem that attributed to sheep like small mammals. Those of former localities are returned to larger similar mammals whose footprints (Plate2.1 and 2.2) have the following measurements:

Stride length of the track: 74cm.
Pace length of the track: 12cm.
Width of the hoofs impression: 5cm.
Length of the hoofs impression: 7cm.

The larger foot tracks, near Kani Sard village, have diffused boundary and the two hoofed toes (foot fingers) (plate 2.1and 2.2) are separated. This is returned to soiled hoofs with sticky red soil of that time and the separation of the two toes is due to filling of intertoes space with earth materials.

Stratigraphically both localities belong to the same sandstone bed and position within Mukdadiya Formation. But structurally and geomorphologically they are located in two different positions, whereas those near Kani Sard outcropped on southern limb of the aforementioned small syncline.

Prevailing environment conditions

As mentioned before the footprints are formed on the upper surface of thick sandstone beds which are slightly layered and rippled Their massiveness and lenticular nature indicate sudden deposition by rivers flooding in river channel or point bars. After recession of the flooding, the riverbank exposed to animals' activities, searching for food and water.

Nichols (1999) mentioned that trace fossils in fluvial environment are largely restricted to flood plain. Moreover, the footprints of animals in soft mud have good preservation potentials if the mud dries hard and is covered with sand. He further added that the tracks of many land animals have been preserved in this way, from millipedes to dinosaurs.

The condition of preservation in the studied area is exactly opposite to that of the above because the footprints are imprinted on upper surface of thick sandstone beds. It seems that they are formed as molds on surface of wet sandstone beds. After that filled by clay during sudden return of clay rich stream water in calmer condition. The sandstone surface was then covered by mud; the casts are formed by filling the molds. These relatively sudden processes made good preservation condition for traces before they had been destroyed. Clear evidences, for calmness of condition after imprinting of traces, can be seen in the field, which marked by alternation of several lamina of claystone and sandstone directly above the surface that is contained footprints (Fig.2).

According to Sarjeant (1975), fossil footprints are well preserved in the sediments deposited

Plate 2

1.Four successive hoofed mammal footprints, found with bird footprints on upper surface of sandstone bed, about 1.5 km to the south of Kani Sard village. That animal has stride length (T) of 74 cm and pace length of 12cm. The length of larger hoofs (that of pes) is 7cm and the width is 5cm while those of manus are smaller.

2.Close up photo of the right two prints in the above photo. The boundaries, being not sharp, are indicated by chalk. The smaller one is manus trace and the larger (right) one is representing pes (hand). The prints of hoofs are not sharp because they were, possibly, soiled by sticky red soil of that time. It is clear that the hoofed two toes are separated, possibly by filling of intertoe space with soil (compare this with the photo below).

3. Sharp boundary hoof traces of small mammals (as compared to above ones). They are found directly to the east of Khua Murad village, which they are, possibly belonged to sheep like mammals.

4. Close up photo of the footprint in the center of previous photo. This footprint has sharp boundary because, it is formed by clean foot and imprinted on clayey sandstone bed.

under arid and semiarid continental climate condition, including summer aridity. In these times need for food and water would draw the animals to the drying-out margin of waterways and pools.

The type of paleocommunity of Upper Miocene is can be inferred that was nearly similar to recent one except of large size of animals especially the birds. The evidences for this, in this study, are the recorded footprints. Moreover the figures given by Dunber (1969) for Miocene paleocommunity prove what are mentioned before.

Conclusions

The following conclusions could be derived from this study:

1.Two main types of birds and mammals foot impressions are found in Mukdadiya Formation on recently exposed massive, thick sandstone beds.

2. The depositional environment of the Formation is proved to be fluvial (river) environment in which the sandstones are deposited on point bars and clay stones on flood plains while the pebbly sandstone is returned to river channel floor deposits.

3. The sharp boundary of some foot traces are returned to clean foots while diffused ones are attributed to soil adhering of the animal foots during traveling.

3. The described traces are regarded as new discovery (as the authors aware) in north Iraq.

4. The traces shows that the terrestrial paleocommunity during Upper Miocene and Pliocene is not too much differed from that of the now days. This is inferred from types of studied footprints. The coastal area of the basin was reached the studied area at the end of Miocene. The tectonic migration followed by animal resettlement and those were in competition for home and foods occupied the recently emerged lands, part of which represented by Darband Bazian anticline and it's southwestern limb.

5. Generally, in the studied area, the marine sediments reduced because of closeness of source area. The area is representing coastal area of Zagros foreland basin during Upper Miocene.

References

Al-Rawi, Y. t., Sayyab, A. S. Al-Jassim, J. A., 1992. New names for the Middle Miocene-Pliocene Formations of Iraq(Fatha, Injana, Mukdadiya and Bai Hassan Formations), *Iraqi Geological Journal*, vol. 25, no. 1, pp1-17.

Buday, T., 1980, *Th e Regional Geology of Iraq*, vol.7 Stratigraphy and Paleogeogr-aphy, Kassab, I. I. M. and Jassim, S. Z. (editors), S.O. M, Baghadad, p. 445.

Dunbar C. O.,1969. Historical Geology,3rd ed. John Wiley Inco. 556p.

Dott, R. H., 1964. Wacke, graywacky and matix -what approach to immature sandstone classification? *Jour. Sed. Petrology*, v.34, Pp625-632.

Frey, R.W., 1975. *The Study of Trace Fossils: A Synthesis of Principles, Problems and Procedures in Ichnology,* Springer-Verlag NewYork, p562.

Goldring, R. 1999. *Field Paleontology*, 2nd Edition, Longman Pub. Co., p191.

Karim, K.H. 2004. Basin analysis of Tanjero Formation in Sulaimaniya area, NE-Iraq. Unpublised Ph.D. thesis, University of Sulaimani University, 135p.

Karim, K.H., 1988. Petrology and Sedimento -logy of the Lower Fars Formation in the bore hole (S_1) from Hammam Al- Alil area ,Northern Iraq. Unpublished Maser Thesis, Salahadeen University, p126.

Nichols,G. 1999. *Sedimentology, and Stratig-Raphy*, Blackwell Science Ltd., p355**.**

Sarjeant,W. A. S., 1975. Fossil tracks and impressions of vertebrates, in Frey, R. W.,: The Study of Trace Fossils, Spenger-Verlag, Berlin, p562.

Seilacher, A, 1967, Bathymetry of Trace Fossils; Marine *Geology*, V. 5, Elsevier Pub. Co. Netherland, p. 413-429

Simpson, S. 1975. Classification of trace fossils. In: Frey, R. W. The Study of Trace Fossils, Spenger-Verlag, Berlin, p562.

Vincent, S. J., Macdonald, D. I. M. and Gutterige, P.1998. Sequence Stratigraphy. In: Doyle, P. and Bennett, M. R.(editors). *Unlocking the Stratigraphical Record*, John Wily &Son, New York, p.532.

Thomas, H., Sen, S., Behnam, H.A. and Ligabue, G., 1981. New discoveries of Vertebrate fossils in the Bakhtiary Formation, Injana area, Hemrin South, Iraq. *Jour. Geol. Soc. Iraq*, v.14, no.1, pp43-55.

تسجيل جديد لبعض آثار أقدام الفقريات في تكوين المقدادية من منطقة جمجمال ، شمال شرق العراق

من قبل:
كمال حاجي كريم احمد

خالد محمود إسماعيل شهربازيري
إبراهيم محمد جزا محي الدين

تم أيجاد نوعين من آثار أقدام الفقريات لاول مرة في تكوين المقدادية من منطقة جمجمال (جنوب مدينة السليمانية) ، شمال شرق العراق. النوع الأول يرجع إلى الطيور والثاني إلى الثدييات الظفرية المشابه للخرفان.
كلا النوعين وجدا على السطح العلوي لطبقة سميكة من الحجر الرملي لتكوين المقدادية حيث هذا التكوين يتالف من تتابعات من الطبقات من طبقات السميكة من الحجر الطيني الأحمر والحجر الرملي و هذا الأخير حصوي في الأسفل في بعض الأحيان . استنتج على إن الحجر الرملي الحصوي ترسبت على قعر لقناة نهري والحجر الرملي فأنها تمثل ترسبات الحاجز المجري إما الأخير قد ترسبت على سهل فيضي.
توصل البحث إلى إن تجمعات الحيوانات القديمة في المنطقة الدراسة وفي عصر المايوسين الأعلى-البليوسين كانت مشابه إلى ما موجود في الوقت الحاضر ماعدا ما امتازت به الطيور من الأحجام الكبيرة(ستنتج من آثار الأقدام) نسبة إلى الوقت الحاضر. تدل الدلائل الموجودة في المنطقة على إن آثار الأقدام تكونت في وقت عندما كانت الكائنات تبحث عن الطعام على ضفاف الأنهار.