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Paleoclimates of the Upper Pleistocene in the Jordan Rift

Abstract
Since its formation, the Jordan Rift has been occupied by water bodies of various sizes and different salinities. The sediments of those bodies are the imprints which throw some light on the paleoclimates of the Upper Pleistocene. During this time, the Jordan Rift was occupied by the fresh water Samra Lake in a humid climate followed by the more saline Lisan Lake which is less humid, but certainly much more humid than present-day climate. On the other hand, all the evidence indicates that during the Upper Pleistocene humidity increased from the Dead Sea area northwards.

Introduction

Quaternary is the latest period of time in the history of the earth: it makes, together with the Tertiary, the Cenozoic era. It is divided into two parts: older or Pleistocene and younger or Holocene (Recent). The lower boundary of Pleistocene with Pliocene is problematic. This is due to the controversy amongst the workers in this field on a correlatable contact or a world-wide event for this boundary. A group of workers accepted the beginning of the cold periods as well as the appearance of man as the start of Pleistocene. For this, they divided the Quaternary into glacial or Pleistocene and postglacial or Holocene (Gignoux, 1955). The Pleistocene was then divided into four glacial periods separated by interglacial periods (the Holocene being the fourth interglacial after the Wurm). Those workers put the boundary of Pleistocene–Pliocene at 1.6–1.8 million years (Ma). Other groups of workers include part of the Pliocene in the Pleistocene and put the boundary at 2.8 Ma. The additional period of time is usually called periglacial Pleistocene (Horowitz 1979). Table 1 shows the Quaternary and Tertiary subdivision, duration and absolute age (Bowen, 1978). The Quaternary climate of the area has been much studied. Amongst the major works in this respect are for example: Butzer (1958), Horowitz (1979) and Al-Sayari and Zotl (1978).

Table 1 Major units of standard global chronostratigraphic (Geochronologic) scale for the Cenozoic Era

			Isotopic dating (Ma.)	
Erathems and Eras	Systems and periods	Series and Epochs	Duration of unit	Age of beginning of unit
	Quaternary	Holocene	0.01 Ma.	0.01 Ma.
		Pleistocene	1.6 Ma.	1.6 Ma.
Cenozoic		Pliocene	5	7
		Miocene	19	26
	Tertiary	Oligocene	12	38
		Eocene	16	54
		Paleocene	11	65

Ma. = Millions of years.

Origin of the Jordan Rift

The Jordan Rift (sometimes called Jordan–Dead Sea Rift or Dead Sea Rift or Jordan–Araba Rift) forms the northernmost part of the East African–Red Sea–Levantnine Rift, which extends about 6,000 km. (FIG. 1). The Red Sea started to form late in the Cretaceous period and continued as a wide shallow trough until the Miocene, when a new phase of opening took place and the central trough of the Red Sea as well as the Jordan Rift started to form. However, there are two theories for the formation and evolution of the Rift (ignoring the details).

The first hypothesis is the vertical tectonics or graben tectonics. In this hypothesis, the vertical downwards movement of the low land took place along a series of step faults. The major North–South faults are supposed to be present bordering the graben. Some of the advocates of this traditional hypothesis are Blankenhorn (1912), Bender (1968, 1974, 1975, 1983), Wetzel and Morton (1959), and Picard up to 1970.

The second hypothesis is the horizontal tectonics or the strike-slip movement (plate tectonics). According to this idea, the Arabian plate (including the Arabian peninsula, Jordan, Syria and Iraq) has moved 107 km. to the NNE relative to the Sinai microplate (including Sinai, Palestine, Lebanon and NW Syria). This movement took place along the Jordan Rift. Lartet (1869) was the first advocate for such horizontal

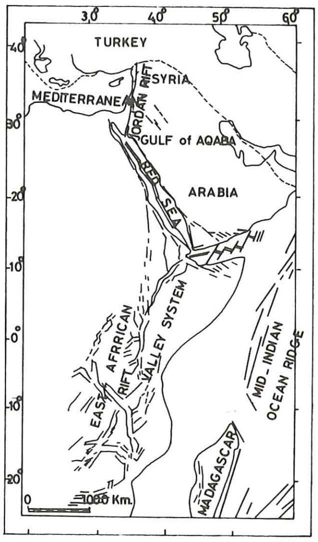


Fig. 1 THE SYRIAN—AFRICAN RIFT SYSTEM

movement. Quennell (1956, 1982) was the first to calculate the movement as 107 km., long before the plate tectonics theory was established late in the sixties. After that many workers followed, calculating various amounts of movement (e.g. Freund *et al.* 1970; Vroman, 1973; Jarrar, 1979; Abed, 1982).

Most of the workers now accept the second hypothesis, especially when taken with the evolution of the Red Sea. The general view is that the Rift started forming at some time in the Miocene period (with a possibility of being older; i.e. Oligiocene) (Bender, 1974, pp. 88–93). The Rift is bordered by much older rocks (pre-rift formations). In the southern Wadi Araba the rocks are igneous and metamorphic Precambrian, rocks and formation becoming younger northwards. This is well explained in the classical geological maps of the area (FIG. 2). The following is a brief discussion on the post-rift formation (i.e. those formations deposited *within* the Rift) so as to assist understanding of the paleoclimates of the Upper Pleistocene times. Figure 3 shows the distribution of the Quaternary formations in the Jordan Rift.

The Neogene

Usdum formation

The formation name is take from Jebel Usdum (Sedom) in the extreme southwest of the Dead Sea (FIG. 4). This formation is made almost totally of rock salt (halite) with rare horizons of carnalite and shale. Its thickness is about 4,000 m. as penetrated in El-Lisan-l wild cat. These salts seem to exist below almost all of the present Dead Sea area (Neev and Emery, 1967; Bloch and Picard, 1970). The age of Usdum formation is Miocene ?-Pliocene (Bender, 1974, 1975). It seems that the Usdum Lake was still connected to the Mediterranean Sea in Neogene times. Salt water was recharging this lake continuously through a channel or channels connecting the Dead Sea with the Mediterranean. Rock salt (halite) was deposited from the hypersaline water of the lake and the bitter waters were sent back to the Mediterranean (Bentor, 1961). A continuous subsidence of the then shallow Rift is necessary to explain this thickness of sediments. The climate of this period must have been rather dry so as to evaporate and produce these salts. Recalling that the Dead Sea is now precipitating gypsum and aragonite with minor amounts of halite, then the climate must have been much drier than at present. It is important to mention that this is not the only interpretation in this respect. Rock salt can be precipitated in a more humid climate, depending on the surface area of the lake and the amount of recharge. Thus, halite can be produced in a lake with a large surface and small amount of recharge in a relatively humid climate. Compare that with the Dead Sea before and after the diversion of the River Jordan by Israel (Abed, 1983).

Shagur formation

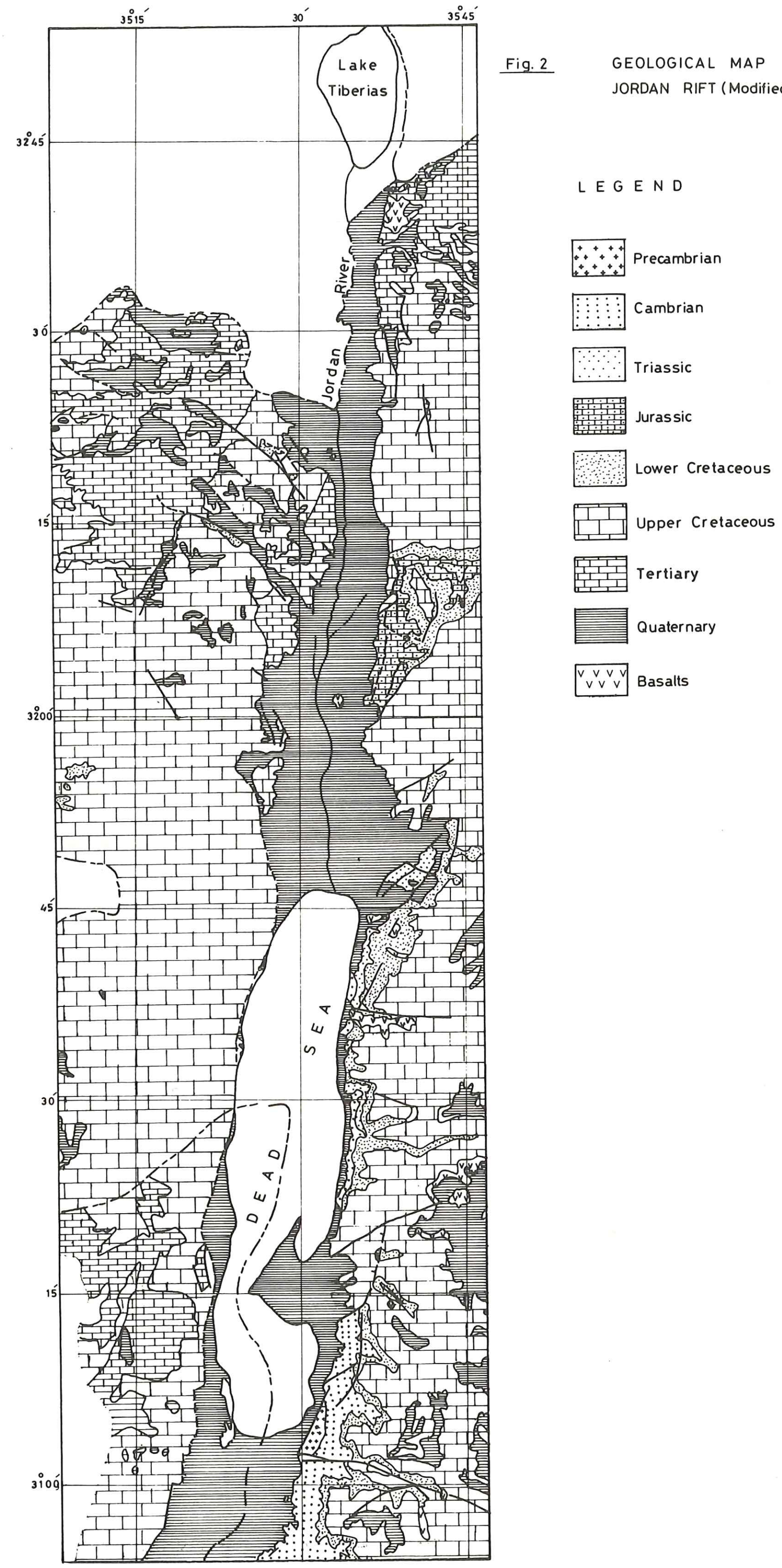
This is a 100 m. thick coarse-grained conglomerate, situated in Wadi Abu Qaraf, 3 km. SE of El-Kufrein. It is a rather massive, hard calcareous conglomerate containing boulders up to 1 m. thick. Sometimes it grades into hard travertimes and sometimes into pebbly sandstones. It also changes thickness according to relief cut in older Mesozoic and Cenozoic rocks. The formation is highly deformed (Bender, 1974) (FIG. 5). Huckreide (1966) identified the following fossils: *Melanopsis praemorsa* Lennel, *Trichia*, *Poiretia*, ostracods and plant remnants (Palms). According to its fossil content and texture a fluvia-lacustrine origin is assigned. The age is accepted by Bender *op. cit.* as Late Pliocene to Early Pleistocene. The former age is more appropriate (see Horowitz, 1979) and TABLE 2.

Early Pleistocene

Ghor El-Katar formation

This formation outcrops some 27 km. north of the Dead Sea, west of Ghor Kibid (several km. NW of Karameh) on the River Jordan. It is made up of 350 m. highly deformed conglomerates, conglomeratic sandstones, cross-bedded sandstones and green and red clays. All these sediments are overlain by an olivine basalt flow (Ghor El-Katar basalt). This

Fig. 2 GEOLOGICAL MAP OF THE JORDAN RIFT (Modified BENDER 1975)



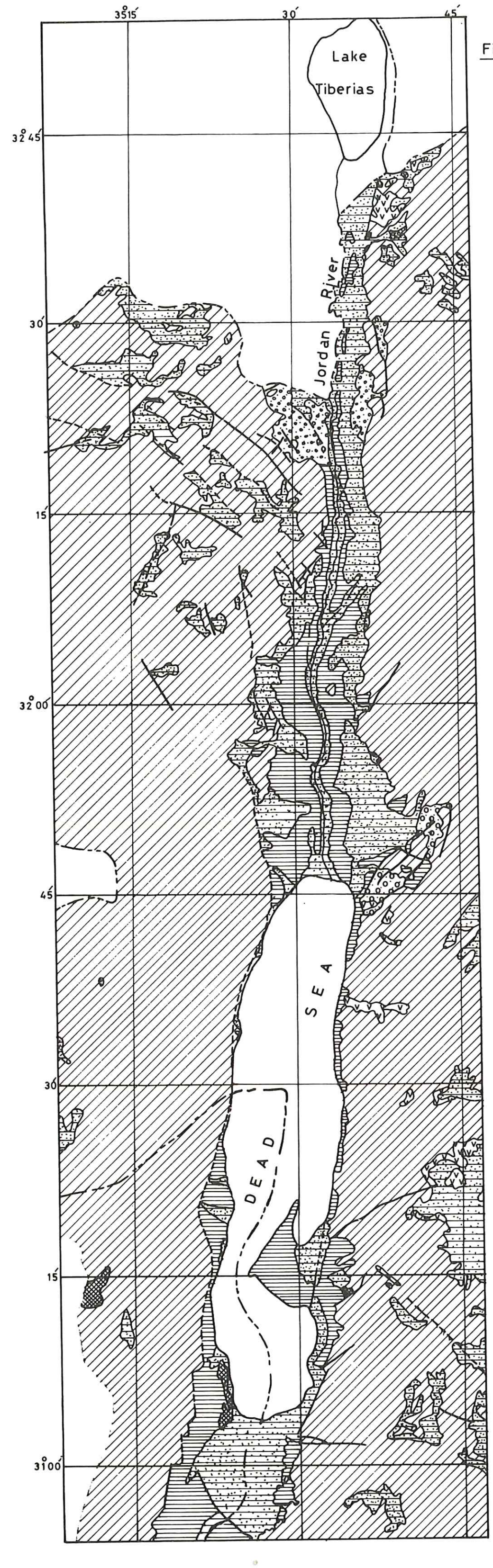


Fig. 3 GEOLOGICAL MAP OF THE QUATERNARY IN THE JORDAN RIFT (MODIFIED AFTER BENDER 1975)

LEGEND

- Recent Unconsolidate Sediments (River Jordan Deposits, Eolian Sands..)
- Upper Pleistocene Lisan and Samra Formations
- Plio-Pleistocene Conglomerates (Shagur & Ghor el Katar..)
- Pliocene (Usdom Formation - Rock Salt)
- Quaternary Basalt
- Pre-Rift Formations

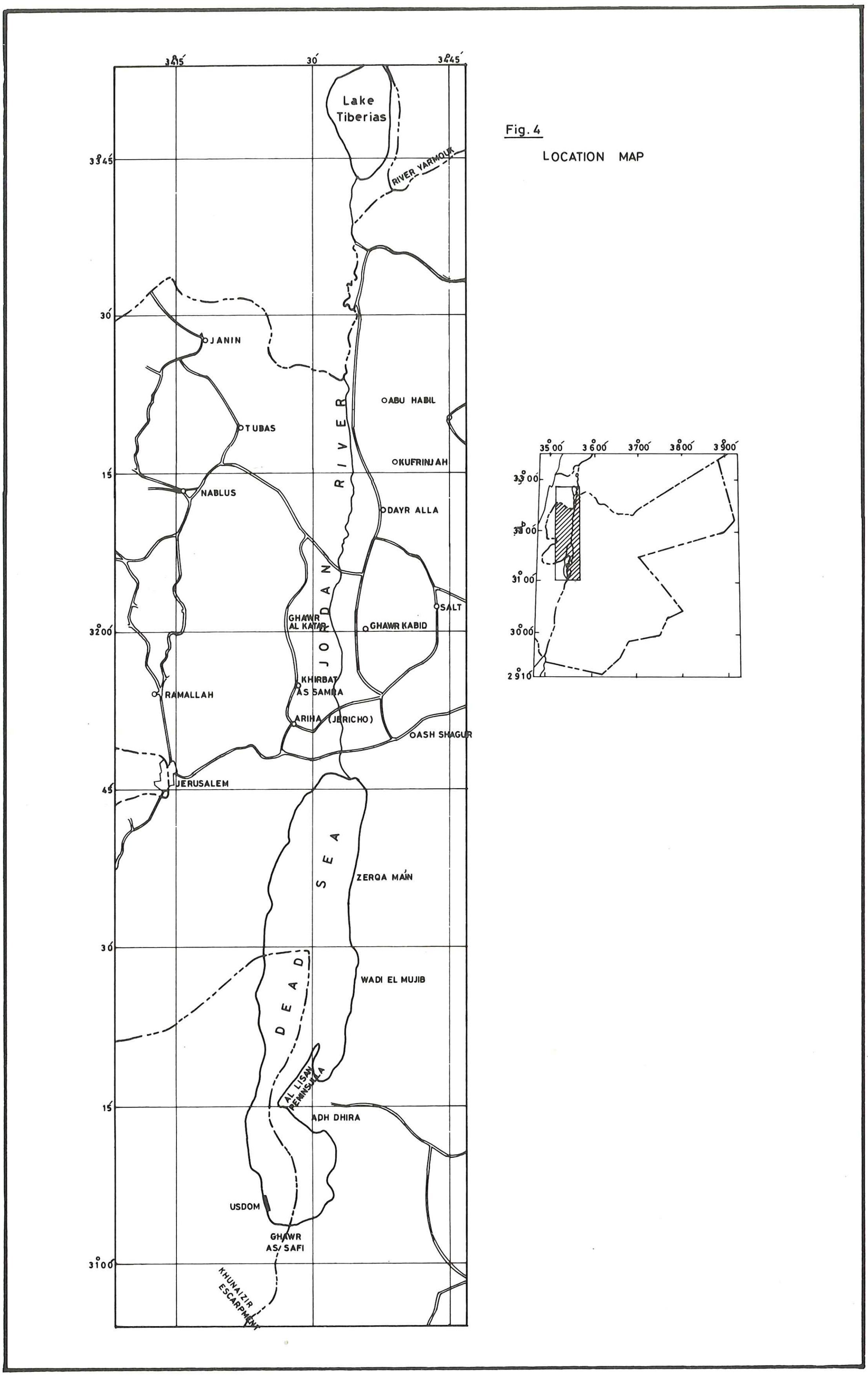


Fig. 4

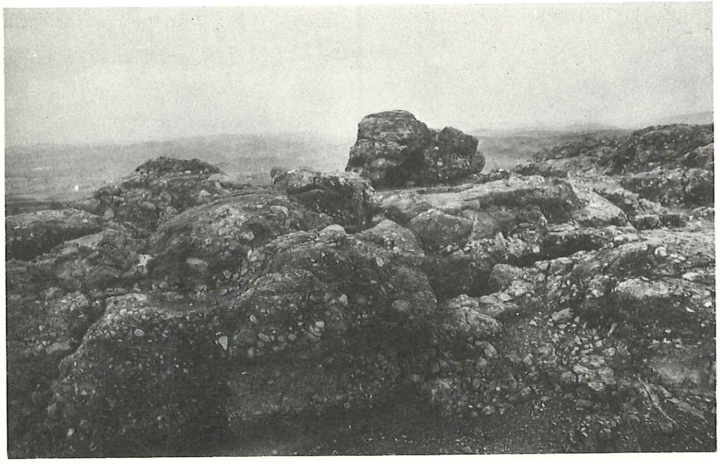
LOCATION MAP

Table 2 Age and stratigraphic correlation of the various post-Rift formations

ERA	System	Series	Continental glacial stages	Absolute age	Formation (in Jordan)	Thickness (meters)	Formation (in Palestine)	Remarks
Cenozoic	Quaternary	Holocene	Recent	11–11.5 Ca.				Dead Sea sediments, Zor (River Jordan) deposits, Wadi deposits and Fanglomerates
		Pleistocene	Wurm	60–70 Ca	Damya Fm. Lisan Fm.	10 40	Clastic Unit Lisan Fm.	Red mudstones and sandstones (soil-like) Laminated lacustrine evaporites with various amounts of mudstones and sandstones
				0.12–0.13 Ma.	Samra Fm.	35	Samra Fm.	Fresh water lacustrine mudstones and sandstones
			Riss	0.3–0.35 Ma.	Kufringa gravels	100	Naharayim Fm.	Fluviatile conglomerates
				0.6–0.65 Ma.	Abu Habil series	100	Ubeidiya Fm. Erk El-Ahmar Fm.	Fluviatile conglomerates
			Mindel	1.0–1.2 Ma.				
				1.4–1.5 Ma.				
			Gunz	1.7–1.8 Ma.				
	Tertiary	Miocene?–Pliocene		2.7–2.9 Ma.	Ghor El-Katar series and Shagur Conglomerates	350 100	Ghor El-Katar series	Fluviatile, lacustrine mudstones, sandstones and conglomerates
					Usdum Fm.	4,000	Usdum Fm.	Rock salt

basalt itself is overlain by more recent conglomerates (see Bender *op. cit.*) and they are all overlain by the horizontal Lisan formation. These same rocks occur also 2 km. SSE of Kureimeh (thickness 75 m.). Huckreide (1966) identified *Melanopsis praemorsa* and ostracods, and assigned an Early Pleistocene age for it. More recently Horowitz (1979) gave an age up to 2.8 Ma., which according to him is still Early Pleistocene, but if the Pleistocene ends at 1.8 Ma, then this formation is also a Late Pliocene–Early Pleistocene. This formation must have deposited in a lacustrine-fluvial environment. The existence of thick clay beds with the absence of evaporites would indicate that the center of the Rift was occupied by a calm, relatively deep, fresh water lake. The association with cross-bedded sandstones and gravels is an indicator (especially the latter) that shallower water (or possibly wadis or rivers) were dropping their sediments in the center of the Jordan Rift.

5. Coarse grain conglomerates and limestones of the Shagur formation outcropping right on the Amman–Jerusalem highway about 2 km. west of wadi Hisban bridge.



Middle Pleistocene

Abu Habil conglomerates

This conglomeritic formation outcrops in the area of Abu Habil, in the north central Jordan Valley (see FIG. 4). The formation overlies an unconfirmed Ghor el-Katar formation, but older than Ghor el-Katar basalt. It contains pebble tools. Huckreide (1966) placed it in the Middle Pleistocene, and Horowitz (1979) made it equivalent to his Middle Pleistocene with an age of about 1.8–0.60 Ma. This formation is made equal to the Erk El Ahmar and Ubeidiya formations in the Tiberias area (TABLE 2).

Kufringa gravels

These are poorly consolidated gravels with red argillaceous matrix and with early Paleolithic artifacts. They are correlated with the Naharayim formation in the Lake Tiberias area (Bender, 1974; Horowitz, 1979). They are also correlated with Ghor el-Katar basalt which seems to have erupted at the time of formation of these gravels. The age of this formation and basalt is accepted as Middle Pleistocene (see TABLE 2).

Late Pleistocene

Samra formation

The name is taken from a quarry in Khirbet Samra, 6 km. NE of Jericho, west of the River Jordan (Picard, 1943). The same sediments were also called Hamarmar formation. Begin *et al.* (1974) rejected the name Hamarmar in favour of Samra, while Horowitz (1979) accepted the reverse and considered the Hamarmar as Lower Lisan formation, rather than an independent formation. Bender (1974) considered the detrital clayey-sandy section near the Damya bridge as an equivalent to Samra. Abed and Helmdach (1981) while studying the Lisan formation south of the Damya bridge, considered the detrital clayey-sandy sediments as the lower part of the Lisan formation. This is due to the fact that the same sediments are interbedded upwards with the typical Lisan formation.

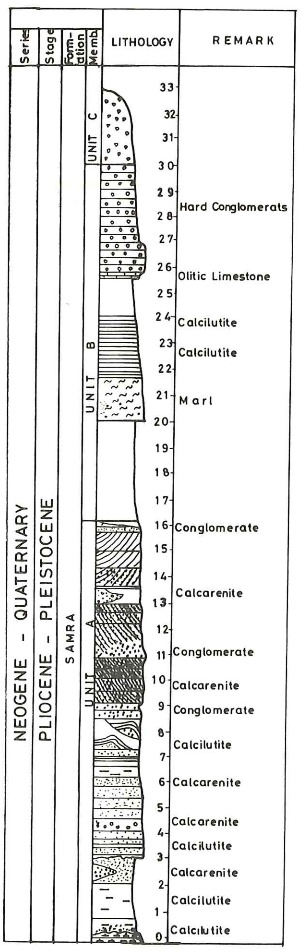


Fig.6 Acolumnar Section of the Samra Formation near Jericho
Modified from Begin 1974

Despite all this controversy amongst the workers in this field, all are agreed that these sediments were deposited in a fresh water lake or lakes extending about 190 km., from Lake Tiberias in the north to the Dead Sea in the south. Typical sediments in Khirbet Samra itself (Picard, 1943) are made up of about 10 m. of calcareous sandstones with intercalation of marls, flint and pebbly conglomerates overlain by the Lisan. Picard (1943) correlated these sediments with his earlier 'Oolitic formation' near the southwest corner of the Dead Sea. He also correlated them with the violet-coloured conglomerates in the Biesan area (called later Naharayim Conglomerates). Begin (1974) studied this formation in detail in the Jericho area and gave it a thickness of 35 m. (FIG. 6 is a reproduction of his FIG. 2). The gravels below Samra are accepted by him as part of it: however, the section is made of calcilutite, calcarenite, oolitic limestones and conglomerates. Figure 7 is a photograph of this formation south of Damya Bridge.

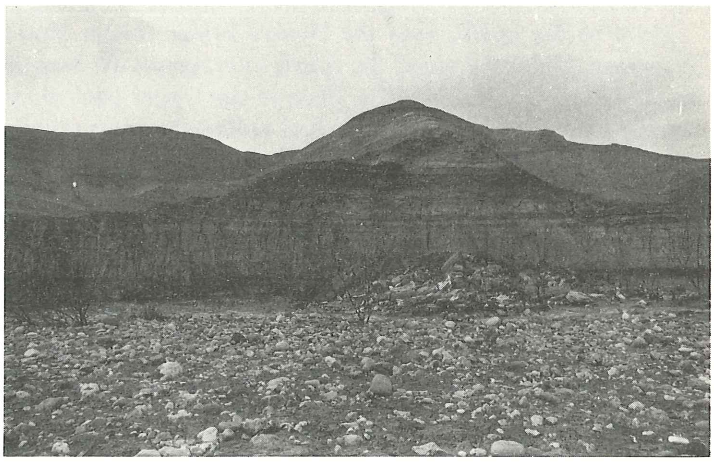
The age of this formation is put by Picard (1943) as Early Pleistocene. Begin (1974) accepted even an earlier Plio-Pleistocene. Bender (1974) assigned it to the Upper Pleistocene which is also the age accepted by Horowitz (1979) and Abed and Helmdach (1981). It seems that its age is just older than 70,000 years.

Lisan formation

The name is taken from the Lisan Peninsula separating the north and south basins of the Dead Sea (FIG. 4). Lartet (1869) was the first to call them Lisan deposits (Dépôts de la Lican). Later, they were called Lisan marl and Lisan formations (Picard, 1943; Bender, 1974). The age of this formation is uppermost Pleistocene. The absolute age was determined by radiocarbon methods. It extends from 60–70,000 years for its base to 16–14,000 years to its top (Neev and Emery, 1967; Kaufman, 1971; Vogel and Waterbolt, 1972). See also TABLE 2.

The typical Lisan sediments in the Lisan itself are made of

7. The Samra formation in Um-el Awtad area south of Damya bridge.



8. Typical laminated sediment in the Lisan formation. Notice the white and grey laminae.

(0.2–2 mm.) alternating grey (green) and white laminae (0.2–2 mm. thick) all the way through (FIG. 8). Relatively thick (up to 15 cm.) gypsum beds are encountered. The section is 24 m. thick and shown in FIG. 9. The white laminae is dominated by aragonite with smaller amounts of gypsum and rare traces of quartz and calcite. The grey laminae is dominated by calcite with gypsum and quartz playing a more important role than in the white laminx. No variation in mineralogy is noticed vertically except for the gypsum beds which are placed at almost equal distance in the measured section, thus it is not possible to subdivide the section into members. Table 3 shows relative mineral abundance in this formation measured as peak height in the X-ray diffraction charts.

To the north, and in the area of Abdullah (Swaiymeh) bridge and Hussein (Allenby) bridge, the typical Lisan facies are present only in the Upper part of the section (Cliff Member of Begin *et al.*, 1974). In the Lower part, thick clastic intercalations are becoming rather important (Laminated Member of Begin *et al.*, 1974). However, little gypsum can still be seen within the aragonitic white laminae (FIG. 10).

More to the north, near the Damya bridge (Umm Shurt, Sha'shaah, Umm el Awtad) the clastic interactions are becoming more important (FIG. 11). Even in the Upper part, these detrital beds exist, but the chemical sediments (gypsum and aragonite) are still dominating. In the northernmost part of the Jordan Valley, the sequence is almost all detrital, with rare aragonite laminae. Gypsum is absent; instead a few horizons 10–30 cm. thick, laminated and made of diatomites exist. These are made of diatom shells. Begin *et al.* (1974) studied these diatomite beds in detail. Finally kaolinite and palygorskite clay minerals are decreasing northwards, while smectites and mixed layer smectite/illite are increasing northwards (Wiersma, 1970).

From the above description, it is evident that the Rift was occupied by a huge Lake (Lisan Lake) 220 km. long and about 20 km. wide extending from Lake Tiberias to the extreme south of the Dead Sea basin (Khunaizer escarpment) (FIG. 12). It was at −180 m. below sea level and 220 m. deep. It was possibly hypersaline in the south getting fresher towards the north, until it was fresh near Tiberias.

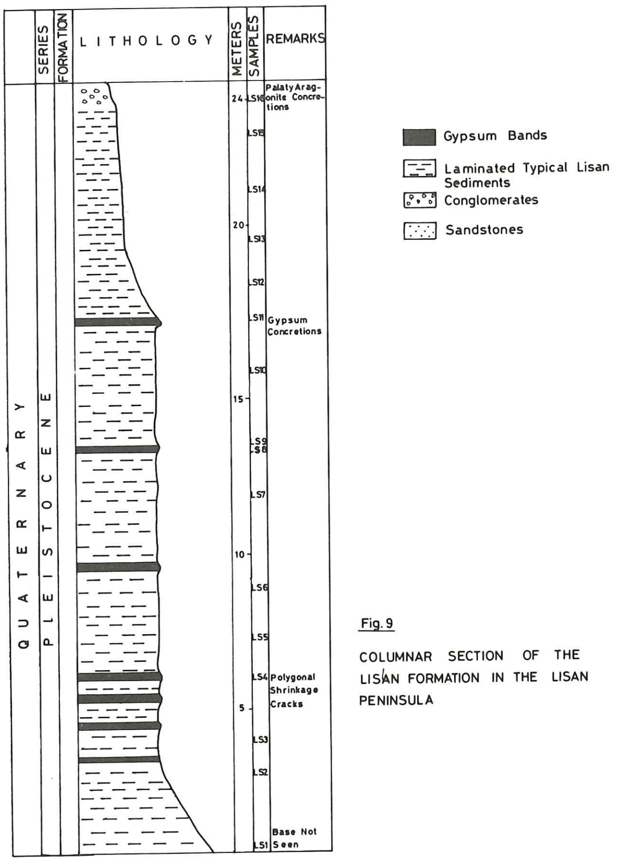


Fig. 9

COLUMNAR SECTION OF THE LISAN FORMATION IN THE LISAN PENINSULA

Paleoclimates

General

Since the opening of the Rift in the Miocene times it has been occupied by water bodies. The deepest area in the Rift was and still is the area of the present Dead Sea. The extent, depth and salinity of those water bodies and thus their sediments are controlled by various factors, including: paleoclimates, tectonics, drainage and recharge and surface area of the water bodies. So, deduction of palaeoclimate from the sediments must be made with care so as to minimize speculations.

Usdum formation, which is possibly the oldest *within* the Rift, is characterized by the huge thickness of rock salt (halite) deposited in the Late Neogene (possibly up to Early Pleistocene). The precipitation of such material would indicate a hypersaline water supersaturated with NaCl. These brines are supposed to be 10 times as much concentrated as the normal

Table 3 Mineralogy of the Lisan formation (see FIG. 9)

Sample no.	Calcite	Aragonite	Gypsum	Anhydrite	Dolomite	Quartz	Kaolinite
LS1W	+	++++				+	t
G	+++						
LS2W		++++	+			+	
G	++	++			t	++	
LS3W			++++				t
G	t		++++			t	
LS4			++++	t			
LS5W		++++					
G			++++				
LS7W	t	++++					
G	+++	+				+++	
LS8W	t	+++	++++		t	+	
G			++++				
LS9W		++++				+	
G		++	++++			+	
LS10W		++++					
G	+++	++	+++		t	++	t
LS11			++++				
LS12W	t	+++					
G	+++	++	++		t	+++	t
LS13W	++	++++				+	
G	+++	+	++			++	t
LS14W		++++					
G	++	+++				++	
LS15W	++	++++	++			+	t
G	+++	+			+	+++	t
LS16		++++	++		+	+++	t

W = White laminae, G = Grey laminae, ++++ = dominant
+++ = abundant, ++ = intermediate, + = minor, t = traces

ocean water. Keeping in mind that the halite is now precipitating from the Dead Sea (after more than 50 per cent of the River Jordan water is pumped out by the Israelis), then, the climate of salt period must have been very hot (hotter than now). It might be said that a smaller recharge and a higher evaporation would produce halite in a relatively cooler and humid climate. The huge thickness of salt associated with the absence of important amounts of gypsum anhydrite or aragonite would prefer a warmer climate than the present one. The non-existence of the salt in the northern Rift can be explained (in this early stage of rifting) by the restriction of the Usdum lake to the south only, since this formation is not yet reported from central or nothern Jordan Valley.

It seems that this highly arid climate became more humid towards the end of the Neogene and the beginning of the Pleistocene. The northern Jordan Valley became also deep enough to collect water bodies. In this period central and north Jordan Valley was occupied by fresh water lakes, along with wadis and rivers dumping the sediments in them. This is documented by the Shagur conglomerates and Ghor el Katar formation. The absence of evaporates in both, and the existence of conglomerates and cross-bedded sandstones with certain fresh water organisms would indicate fresh water bodies occupying parts of the central and north Rift. In Ghor el Katar, the existence of thick clay beds can be interpreted as being deposited in a relatively deep and calm lake.

Pleistocene

The Pleistocene times are known as the 'ice age'. Four glacial periods had affected nearby Europe, with three interglacial periods in between. The glacial periods: Wurm, Riss, Mindel and Gunz. They extend up to 1.8 Ma. Table 2 shows the relation between the local, previously mentioned, formation and the glacial periods. Since the study area was never affected by the glacials, the periods are called pluvial and interpluvial periods. In the pluvial periods, the area was highly humid, with greater amounts of rain. Large fresh water lakes usually cover the Rift, whose sediments are usually detrital deposits with fresh water fossils, while in the interpluvial periods the Rift is rather arid. Sabkha or playa environments prevail and the sediments usually contain evaporates without fossils.

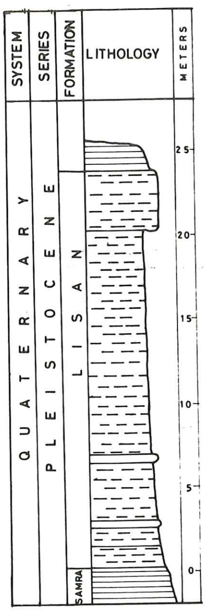


Fig. 10
COLUMNAR SECTION OF THE LISAN FORMATION NEAR HUSSEIN (ALLENBY) BRIDGE

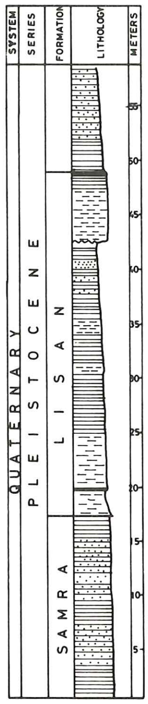


Fig. 11
COLUMNAR SECTION OF THE LISAN FORMATION SOUTH OF DAMYA BRIDGE

Late Pleistocene

As previously discussed, the Late Pleistocene is made up of the Samra and Lisan formations. The Samra formation, whether it includes the gravels below it or not, is almost totally made of clastic material; i.e. conglomerates, sandstones and mud rocks. Chemical sediments and evaporites, such as gypsum, halite and anhydrite, are not present, but fresh water fossils are present (Bender, 1974; Horowitz, 1979). Thus, there is general agreement amongst the workers that the Samra deposits were laid down in a fresh water lake or a series of lakes (Picard, 1943) occupying the Jordan Rift. The climate of the Samra period must have been quite wet, with a considerable amount of rain recharging the Samra Lake (Lakes). Thus, this is a typical pluvial period in the region. No north–south variations are noticed in the sediments, so these pluvial conditions seem to have dominated the whole region.

The Lisan formation is rather different (see TABLE 3). Chemical and clastic sediments are present in varying proportions. The lower part contains more clastic deposits, and near the top sediments are chemical; also, gypsum and evaporites are decreasing northwards and clastics and diatomites are increasing in the same direction. It is clear then that the fresh water Samra Lake must have changed to the brackish-saline Lisan Lake, and the only reason that can be given for this change is dryness. So, the Lisan times were drier than the Samra times, this is in general agreement with the climate of El-Jafr basin in southeast Jordan (Huckriede and Wiesemann, 1968). Two other conclusions can also be reached. The first is that there should have been dry periods, followed by wet periods superimposed on an overall trend of dryness (FIG. 13). The second is that the south was more arid and warm than the north of the Rift. Thus, while the north was more rainy and lower in temperature, the Dead Sea area was more arid (less rain and higher temperatures) (FIG. 14)—a similar trend to the present day climate.

Keeping these variations in mind, it must be mentioned that the Lisan Lake is larger and more extensive than the preceding Samra. Thus, it is hard to believe that an interpluvial period was prevailing for all the Lisan period. On the contrary, absolute age determination puts this formation as coinciding with the Wurm. So it seems that the larger surface area of the Lake (which makes higher evaporites) and the relatively drier times along with a pluvial humidity, determined the type of the sediment, being evaporites or clastics (see also Issar, 1980).

The presence of a clastic post-Lisan formation (Damya

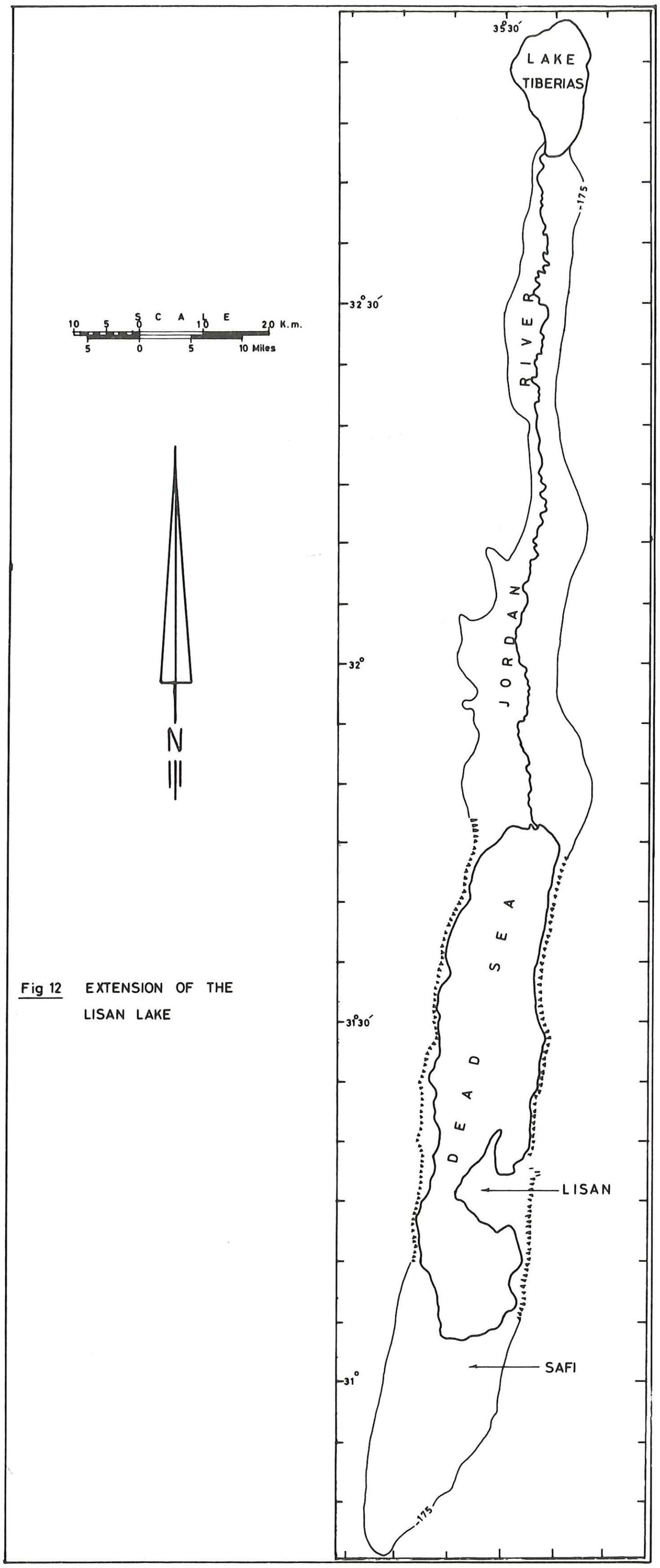


Fig 12 EXTENSION OF THE LISAN LAKE

formation (Abed, 1984, in press)) on top of the Lisan formation reflects more humid and less arid conditions. The non-existence of this formation in the southern Rift also indicates the same trend, that the north was more humid than the southern Ghor. The red colour of the formation is a good indicator of the climate, the more the red the more the humidity. Compare this situation with the present day soil in Jordan. The red colour is decreasing southward and eastwards. Compare it also with the amount of rain in these regions. So, it seems that a peak of pluvial or wet period persisted in the area between 16 and 12,000 years before the present day.

By the end of this period, a new interglacial period (the Holocene) started some 11,000 years ago. All the Lisan Lake had disappeared. Even the deeper position of that Lake which is now under the north Dead Sea basin was devoid of its water, and subareal erosion at the bottom of the Dead Sea north basin is reported (Neev and Emery, 1967). Since then there remain only the Dead Sea and Lake Tiberias as remnants from that past.

Conclusions

From the foregoing the following points are concluded:

1) Since rifting in Miocene times, the Jordan—Dead Sea Rift was occupied by water bodies (lakes) of various sizes and salinities.
2) The glacial and interglacial periods that affected Europe seems to have not affected the area but the area was much more humid and cold in the glacial time (pluvial) than in the interglacial (interpluvial).
3) During the Upper Pleistocene (and possibly older) humidity decreased southwards. Thus, the southern Rift was much drier than the northern Rift, i.e. the Dead Sea area was drier than Lake Tiberias area.
4) Vertically, the Upper Pleistocene was much more humid during the Samra time, then started to become drier until now (with certain fluctuations).
5) Lisan formation is best correlated on a regional scale, thus, the best information to give on points 3 and 4. This is possibly due to the fact that it was the last Lake in the Rift before the present Dead Sea and Lake Tiberias.

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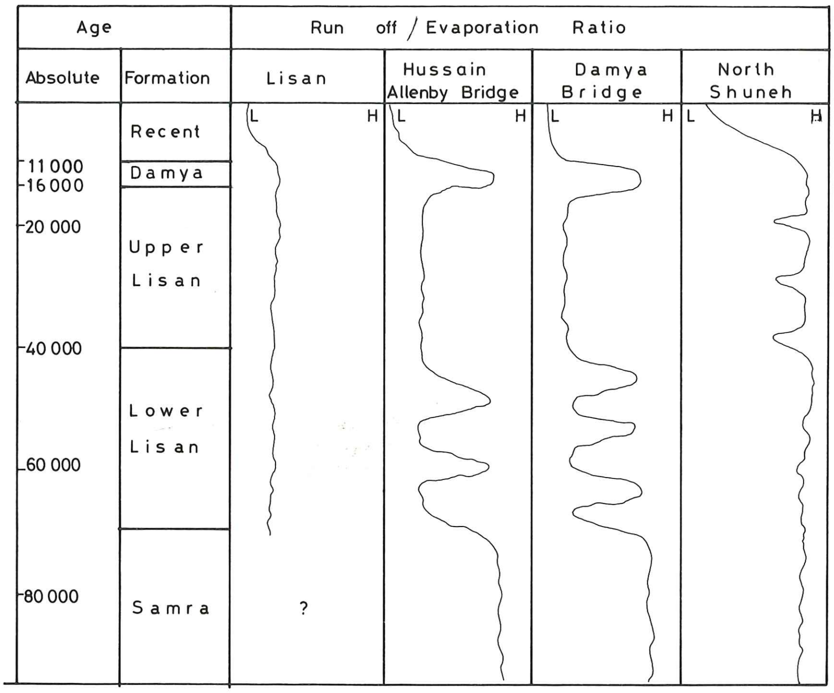

Fig. 13 SHOWS THE VERTICAL CLIMATOLOGICAL CHANGES IN THE LAST 100 000 YEARS IN SEVERAL LOCALITIES IN THE JORDAN RIFT (L = Low, H = High)

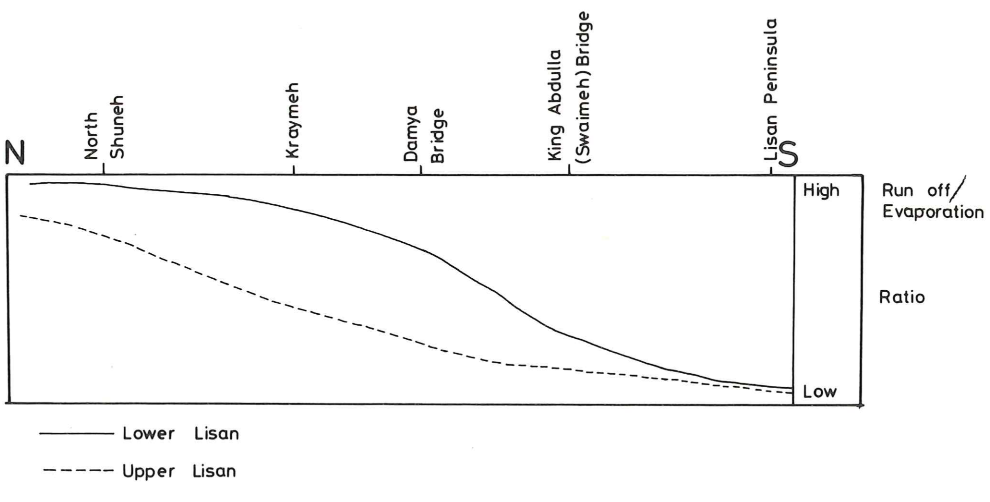

Fig. 14 NORTH - SOUTH GENERALIZED VARIATIONS IN THE JORDAN RIFT DURING THE LISAN TIMES (UPPER PLEISTOCENE)

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