Professor C. Vita-Finzi
Department of Geography
University College London
26 Bedford Way
London WC1H 0AP
England

C. Vita-Finzi

The Prehistory and History of the Jordanian Landscape

Abstract

In the course of its occupation by man the physical landscape of Jordan has undergone profound changes, among them the outpouring of basalts, crustal displacement along faults, fluctuations in the level of the Dead Sea, and the filling and excavation of valley floors. The extent to which man's activities have influenced or been influenced by physiographic history is open to debate; what is certain is that the landscape of today is a poor guide to the conditions that prevailed as little as a century ago.

Introduction

In *The Historical Geography of the Holy Land* (1894), George Adam Smith sought to discover from 'the lie of the land' why history took the course it did and by the same token to isolate the impact of physical nature from the products of moral and spiritual forces. Smith dealt with such complex issues confidently, witness his suggestion that the climate of Palestine lent itself 'to the service of moral ideas' and that its fertility affected immigrants from the desert in two ways: 'an ascent in civilisation and a fall in religion'. In similar vein, Ellsworth Huntington's *Palestine and its Transformation* (1911) set out to investigate the influence of 'geologic structure, topographic form, and the present and past nature of the climate' on man's progress, history and systems of thought. Huntington was able to conclude, among other things, that the physical features of Galilee explained why its history 'was so much less important than that of Judea or even Samaria' and that the timidity of the present Gileadites illustrated 'one effect of the mountainous country'.

According to Smith the topographic variety of Palestine was intensified by differences of soil and climate, and he based his treatment of these differences on present-day conditions. Huntington paid some attention to earthquakes and to the effects of man's 'carelessness and folly' on water supply but otherwise confined his discussion of environmental change to 'pulsatory' climatic variations which, as in the surrounding regions, he considered of importance in determining the course of Palestine's history. Later authors, influenced by the classic studies of W. C. Lowdermilk (1940) and A. Reifenberg (1955), have laid increasing stress on the deleterious effects of soil erosion since antiquity, and in particular during the Middle Ages, generally putting the blame on improvident land use and the neglect of conservation measures (see, for example, Ashtor, 1976). The burial of classical sites by slope wash, the engulfment of ancient bridges by alluvium and even changes in the level of the Dead Sea have come to be regarded as incidental effects of man-made erosion.

Similarly, few prehistorians would still subscribe to the view that, by 'the time Palaeolithic man appeared on the scene, conditions must have been very much as they are now' (Harding, 1959). The environmental record of the Pleistocene, though fragmentary and defective (Butzer, 1975), indicates changes in the morphology and hydrology of Jordan which were sufficiently pronounced to transform the economic potential of the land locally and sometimes on a regional scale. This paper concentrates on the geological features themselves.

Crustal movements

The structural depression occupied by the River Jordan, the Dead Sea and Wadi Araba, known as the Jordan Rift Valley, has long attracted the attention of students of recent crustal deformation, but both the nature and the extent of the movements responsible for its present character remain in dispute. Lartet (1869) was perhaps the first to suggest that Transjordan had shifted northwards with respect to Cisjordan. Quennell (1956) subsequently put the extent of displacement since the Miocene at 107 km.; according to Freund (1965) a post-Cretaceous value of 70–80 km. is more probable. Others find that much of the field evidence can be explained by predominantly vertical movements (Wetzel & Morton, 1959; de Sitter, 1962; Bender, 1968). The amount of movement allocated by geologists to post-Tertiary times is equally variable. Quennell (1956) thought that 42 km. of horizontal displacement had occurred during the late Pleistocene. Zak and Freund (1966) reported that alluvial fans in the Wadi Araba had undergone at least 150 metres of transcurrent faulting in the last 20,000 years. On the other hand Picard (1966) found that strike-slip fractures crossing the southern Jordan Rift obliquely and postdating Pleistocene alluvial fans and Lisan beds (which, as we shall see below, would place the movements within the last 15,000–20,000 years) had very small displacements, and Bender (1968) likewise found strike slips of no more than a few metres at the three locations on the eastern side of the Rift where he observed transcurrent faulting. The normal faulting that he illustrates from Pleistocene gravels and Lisan beds in various parts of the Rift is also of limited extent.

Two sites display the direct effects of such movements. The Ubeidiya Formation in the upper Jordan Valley, which has yielded hominid remains, artefacts resembling the industries in Bed II at Olduvai and a rich mammalian fauna, locally dips as much as 75°. The folds are associated with normal and reverse faults displaced by a maximum of 15 metres (Picard & Baida, 1966). The movements also affected basalts for which a K/Ar age of 640,000 years has been obtained (Siedner & Horowitz, 1974). The second faulted site is Qumran, where a vertical displacement of 30 cm. has affected Essene structures (Zeuner, 1954).

Regional tilting, even if imperceptible, could have proved of greater significance to man through its effects on the character and rate of erosion. Raikes (1967) has suggested that the valley adjacent to the Neolithic site of Beidha was originally filled with deep alluvium, and that removal of this sediment—which would account for what is otherwise an inexplicable site—was prompted by down-faulting or tilting along the lines indicated by Burdon (1959) for earlier periods. Picard (1965) similarly ascribes to the geographical changes produced by 'tectonic catastrophes' the disappearance, if not the total extinction, of some of the Villafranchian (Lower Pleistocene) land mammals of the Ubeidiya formation.

The influence of earthquakes, including those that doubtless accompanied some of the faulting episodes considered above, is also often conjectural. Extensive earthquake catalogues have been compiled (Amiran, 1950–51, 1952) but archaeological evidence of seismicity has to be treated with caution and even when the earthquake is well attested its effects can only be surmised. Thus the fault at Qumran may well relate to the earthquake of 31 BC but the abandonment of the settlement need not (Harding, 1959). Moreover the Dead Sea zone has witnessed few large shocks in historical times and they do not seem to be directly connected with the Rift proper (Ambraseys, 1978). Even so, archaeological sites antedating AD 1000 that show seismic damage are concentrated along the Rift (Karacz *et al.*, 1977), perhaps because the seismic risk is here accentuated by the unconsolidated nature of the terrain (Arieh, 1967). An additional potential source of damage are the sea-waves which, according to Ambraseys (1978), were provoked in the Dead Sea by two historical earthquakes.

Vulcanicity

Northeastern Jordan is dominated by 11,000 km.^{2} of plateau basalts, which form part of the Jebel Druze basaltic province. Minor flows are found east of the Rift and near the N.E. shore of the Dead Sea (Burdon, 1959). The bulk of the northern basalts is made up of the Hauran series, which had accumulated as extensive sheets by about 1.8 million years ago (Siedner & Horowitz, 1974). Following an explosive phase, the more localised Jebel Druze flows were formed. These have been dated to about 660,000 years ago but two flows from the Golan heights have given K/Ar ages of about 72,000 years, and a radiocarbon age of 4075 ± 160 year BP is reported from Jebel Druze (de Vries & Barendsen, 1954). Further evidence for volcanic activity during human occupation of the area is provided by the presence of Acheulean artefacts beneath basalt flows near Suweimeh (Bender, 1968) and north of Lake Tiberias (Siedner & Horowitz, 1974).

Thermal springs are associated with the younger basalts, which occupy some of the river channels eroded below the level of the older basalts. They include the Callirhoe of classical times (frequented among others by Herod the Great) in the Zerqa Ma'in, and those of El Hamme in the lower Yarmuk, near the Graeco-Roman town of Gadara (Bender, 1968; Harding, 1959).

Sea level

The restricted coastline of Jordan makes discussion of Pleistocene eustatic changes appear of little consequence, especially as the steepness of the topography both above and below sea level would render minimal any corresponding advances or retreats of the shoreline. The same applies to the 3 metres or so of uplift that apparently affected the western shores of the Gulf of Aqaba about 5,000 years ago, and the subsidence that followed 3,000 years later (Neev & Friedman, 1978). On the other hand, the fact that the Straits of Bab el Mandeb are at one point less than 120 metres deep means that the marine regressions associated with major glacial advances restricted the inflow of ocean water into the Red Sea, and perhaps stopped it altogether, with a consequent increase in salinity. Four such episodes have been identified in the record of the last 70,000 years (Degens & Ross, 1969).

Lake history

The Jordan Rift was apparently linked to the Mediterranean in Plio-Pleistocene times (Neev & Hall, 1977). Once the connection was severed the basin was occupied by a succession of water bodies whose extent and composition varied in response to climate, tectonic controls and chemical processes. The oldest of these to be well documented is represented by the Ubeidiya deposits, which outcrop on the western side of the Rift from Lake Tiberias to the mouth of the Yarmuk, and whose accumulation began no more than 1.8 million years ago (Siedner & Horowitz, 1974). Four cycles of deposition have been identified. The oldest represents a lake which was at times brackish. The next is dominated by fluvial deposition in a freshwater lake, with the lake margin occupied by the mammals mentioned above. There followed renewed lacustrine deposition under fresh water conditions, and a final episode of fluvial action (Picard & Baida, 1966). How far the sequence simply represents shifts in the position of the shoreline is still uncertain.

Bender (1968) has drawn attention to analogous fossiliferous deposits on the eastern side of the Jordan Valley, namely the Shagur, Ghor el Katar and Abu Habil Formations. The first two of these have been subject to tectonic effects; the last is a conglomerate which contains pebble tools (Huckriede, 1966). A tentative correlation by Bender equates the Ghor el Katar beds with the Lower Ubeidiya and the Abu Halil with the Middle Ubeidiya.

Extensive lake beds make their next appearance during the period roughly between 100,000 and 18,000 years ago, when the Lisan Lake stretched from the northern Wadi Araba to Lake Tiberias (FIG. 1) to cover an area of 2,850 km.^{2} at its maximum. The initial stages were characterised by freshwater conditions which witnessed the deposition of the Samra Beds. There ensued a phase of at least seasonal salinity (Laminated Member) and then of more persistently saline conditions (White Cliff Member) (Begin *et al.*, 1974). The lake then disappeared in steps, as indicated by terraces up to 28 in number (Bender, 1968).

Artefacts of Levallois type have been found in the lower Lisan beds (Picard, 1965) and one artefact dating from 20,000–14,000 years ago has been recovered from the upper part of the sequence in Wadi Jurfa (Vita-Finzi, 1964; Copeland & Vita-Finzi, 1978). Radiometric dating yielded ages for the uppermost deposits of between 20,000 and 15,000 years (Neev & Emery, 1967; Kaufman, 1971; Vogel & Waterbolk, 1972; Huckriede & Wiesemann, 1968).

There are indications that the Lisan Lake dried out about 13,000–11,000 years ago (Neev & Hall, 1977). Both the deep northern basin and the shallow southern basin of the Dead Sea were refilled some 9,500–10,000 years ago. A low level characterised the southern basin (and perhaps also the northern) between 7,000 and 5,000 years ago, to be followed by a renewed rise 600 years later. Between 3,000 and 15,000 years ago the Dead Sea was apparently confined to its northern basin; the rise that filled the southern basin and brought the Dead Sea close to its present level dates from about AD 900. Later fluctuations include a rise of 11 metres in the 19th century and a fall of 6 metres in the first 60 years of the present century (Klein, 1961; Underhill, 1967).

Lake deposits also occur outside the Jordan Rift and its ramifications. At El Jafr an extensive freshwater lake occupying over 1,000 km.^{2} is associated with Lower Palaeolithic and Levalloiso-Mousterian artefacts. The lake became brackish and shallow about 26,400 years ago. Levalloiso-Mousterian occupation coincided with gravel deposition on the lake beds. Solution later removed some of the calcareous lake deposits; Upper Palaeolithic artefacts and material ascribed to a Middle Palaeolithic 'Matakhium' culture are found on the mud-flats and on a delta produced at this time (Huckriede & Wiesemann, 1968).

At Qa' el Jinz there is evidence for a similar lacustrine phase in the form of highly calcareous silts which, like those at El Jafr, contain brackish-water ostracods including *Ilyocypris* and *Candona* (Bender, 1968). Analogous deposits are found in the upper Wadi Hasa, which drains Qa' el Jinz; these yield Middle Palaeolithic and later artefacts and underlie an early Kebaran site, the implication being that deposition had ended by about 18,000–16,000 years ago (Vita-Finzi, 1964; Copeland & Vita-Finzi, 1978). The resemblance to current estimates for the close of the Lisan phase is striking.

Lacustrine deposits at El Azraq indicate a former lake covering about 4,500 km.^{2} but, despite the presence of abundant artefacts (Garrard & Price, 1975–77), including some of Acheulean type (Harding, 1959), its chronology remains obscure. Other basins floored with fluvial and lacustrine material are reported by Bender (1968) 45 km. south of the Dead Sea near Fidan, on the eastern part of the central Wadi Araba near Gharandal, in Wadi Sirhan and at various locations in S.E. Jordan.

Valley evolution

Intercalations of alluvial material are found in the lacustrine beds of the Shagur, Ghor el Katar, Abu Habil, Ubeidiya and Lisan series. The Pleistocene succession in the Jordan Valley also includes a predominantly fluviatile unit—the Naharayim Formation—which is separated by an angular unconformity from the underlying Ubeidiya beds and by a less pronounced break from the overlying Lisan. These gravels are unfossiliferous and devoid of artefacts; according to Picard (1965) they represent a period of strong erosion by the Yarmuk. A further fluvial unit which at present appears to be a localised feature is the gravel deposit yielding Abbevillian-Lower Acheulean artefacts found by Bender (1965) beneath a basalt flow at Jurf ed Darawish, 55 km. north of Ma'an.

The Lisan beds of the Ghor at the margins of the Rift are overlain by the alluvial fans of Picard's (1932) *Oberterrasse*. These can be traced into the tributary valleys as a terraced fill with a maximum thickness of 30 metres, and consist of ill-sorted clastics whose lithology is governed by the country rock. Levalloiso-Mousterian and Upper Palaeolithic artefacts are found within the deposits (Vita-Finzi, 1964). The original view was that the deposits postdate the initial shrinkage of the Lisan Lake, as they apparently overlie the terminal surface of the Lisan unit, but the possibility remains that they are merely part of the marginal deposits found within the Lisan beds proper. This would of course accommodate the 'Upper Palaeolithic' artefact from the Lisan beds at Wadi Jurfa mentioned earlier.

At a few localities the deposit overlies tufa which was laid down by springs to form aprons and terraces. Prominent examples may be seen at 'Ain Duyuk (W. Nu'eima), 'Ain Fasayil (W. Rashshash), 'Ain Auja and near Jerash. Some erosion of the Lisan beds preceded their deposition; the tufa is separated from the overlying alluvium by a weak nonconformity and grades into cemented screes. Renewed tufa deposition occurs at most of these springs; in Wadi Fasayil it was sufficiently pronounced in Roman times to call for the rebuilding of an aqueduct at least twice (Vita-Finzi, 1978).

Throughout Jordan channel incision prevailed until post-Roman times, when aggradation produced a fill with a maximum thickness of 4 metres. This was in turn trenched by the wadis to form a terrace. In the Jordan Valley the Zor is partly composed of this unit (Vita-Finzi, 1964). The deposit is well stratified and contains Roman pottery. In the Kofrein-Rama catchment freshwater snails in the fill indicate the prevalence of standing or perennial water (Sparks, 1964).

In Wadi Hasa, and doubtless elsewhere, there is evidence of additional episodes of valley filling and trenching. Near Qa'lat el Hasa localised aggradation dated by archaeological methods to between 11,200 and 11,600–8,000 years ago was followed by the development of an extensive silt deposit indicative of repeated overbank flow (Vita-Finzi, 1966). This deposit dates from between 8,000 and 4,000–2,000 years ago (Copeland & Vita-Finzi, 1978).

Discussion

If major earthquakes, volcanic eruptions and rapid rises in lake level are set aside, the physiographic matters outlined above may appear of marginal significance to the development of human settlement in Jordan especially once they are compared with the effects of changes in total annual rainfall or in its seasonal distribution. Yet, unlike climatic fluctuations, which all too often have to be inferred from the settlement patterns they might otherwise help to explain (Neev & Emery, 1967; Garrard & Price, 1975–77), landscape evolution can be traced independently and hence contribute to the interpretation of the human record.

The scope for this approach is greatest in the study of land use in prehistory and history (White, 1961). Less than 12 per cent of the area of Jordan consists of arable land. Its soils closely reflect the local geology (see, for example, Willimott *et al.*, 1964). The modern soil map owes a good deal to successive episodes of basalt extrusion and the emergence of the Lisan marls; erosion has doubtless further impoverished the thin volcanic soils, as it has those that occur on the limestone and sandstone uplands. In compensation, however, the fans and valley fills nourished by this erosion in late Palaeolithic times provide extensive, often well-drained tracts of alluvium which—as in the Jericho area—contrast sharply with the barren country rock. Later episodes of valley filling have carried this process of soil concentration further, this time with the added advantage of gentle surface gradients and nearness to potential sources of irrigation. The East Ghor Project (Beaumont *et al.*, 1976) demonstrates that the potential may not be realised until long after deposition has ceased; but there may have been times when the process of deposition itself favoured cultivation by periodically supplying both silt and water to the valley floor (Vita-Finzi, 1966).

Many components of this theme remain poorly documented. Above all, present-day soil erosion awaits a dispassionate analysis which takes into account not only the neglect of Nabatean and Roman terraces and dams but also the circumstances that made these measures necessary. The demand for such studies must come from the archaeologists and historians whose sites and cultures will otherwise remain set in an anachronistic landscape.

References

Ambraseys, N. N. 1978 'Historical seismicity and tectonics'. *In* Brice, W. C. (ed.) *The Environmental History of the Near and Middle East since the Last Ice Age*. Academic, London, 185–210.

Amiran, D. H. K. 1950–51, 1952 'A revised earthquake-catalogue of Palestine'. *Israel Explor. J. 1*, 223–46; 2, 48–65.

Arieh, E. J. 1967 'Seismicity of Israel and adjacent areas'. *Bull. geol. Survey Israel 43*, 1–14.

Ashtor, E. 1976 *A Social and Economic History of the Near East in the Middle Ages*. Collins, London.

Beaumont, P., Blake, G. H. & Wagstaff, J. M. 1976 *The Middle East: a Geographical Study*. Wiley, London.

Begin, Z. B., Ehrlich, A. & Nathan, Y. 1974 'Lake Lisan, the Pleistocene precursor of the Dead Sea'. *Bull. geol Survey Israel 63*, 1–30.

Bender, F., 1968 *Geologie von Jordanien*. Gebrüder Borntraeger, Berlin.

Burdon, D. J. 1959 *Handbook of the Geology of Jordan*. Amman.

Butzer, K. W. 1975 'Patterns of environmental change in the Near East during Late Pleistocene and Early Holocene times'. *In* Wendorf, F. & Marks, A. E. (eds.) *Problems in Prehistory: North Africa and the Levant*, SMU Press, Dallas, 389–410.

Copeland, L. & Vita-Finzi, C. 1978 'Archaeological dating of geological deposits in Jordan'. *Levant X*, 10–25.

Degens, E. T. & Ross, D. A. (eds.) 1969 *Hot Brines and Recent Heavy Metal Deposits in the Red Sea*. New York, Springer-Verlag.

Freund, R. 1965 'A model of the structural development of Israel and adjacent areas since Upper Cretaceous times'. *Geol. Mag. 102*, 189–205.

Garrard, A. N. & Price, N. P. 1975–77 'A survey of prehistoric sites in the Azraq Basin, Eastern Jordan'. *Paléorient 3*, 109–26.

Harding, G. L. 1959 *The Antiquities of Jordan*. Lutterworth, London.

Huckriede, R. 1966 'Tagung der Deutschen Quartärvereinigung vom 8. bis 13. August 1966 in Göttingen. *Eiszeitalter u. Gegenwart 17*, 205–17.

Huckriede, R. & Wiesemann, G. 1968 'Der jungpleistozäne Pluvial-See von El Jafr und weitere Daten zum Quartär Jordaniens'. *Geologica et Palaeontologica 2*, 73–95.

Huntington, E. 1911 *Palestine and its Transformation*. Constable, London.

Karcz, I., Kafri, U. & Meshel, Z. 1977 'Archaeological evidence for Subrecent seismic activity along the Dead Sea–Jordan Rift'. *Nature 269*, 234–5.

Kaufman, A. 1971 'U-Series dating of Dead Sea basin carbonates'. *Geochim. Cosmochim. Acta 3*, 1269–81.

Klein, C. 1961 *On the fluctuations of the level of the Dead Sea since the beginning of the 19th century*. Jerusalem.

Lartet, L. 1869 'La Géologie de la Palestine'. *Ann. Sci. Géol. Paris 1.*

Lowdermilk, C. W. 1940 'The lost agriculture of Trans-Jordan'. *Soil Conservation V*, 228–31.

Neev, D. & Emery, K. O. 1967 'The Dead Sea'. *Bull. geol Survey Israel 41*, 1–147.

Neev, D. & Friedman, G. M. 1978 'Holocene tectonic activity on the margins of the Sinai Subplate'. *Science 202*, 427–9.

Neev, D. & Hall, J. K. 1977 'Climatic fluctuations during the

Holocene as reflected by the Dead Sea levels'. *Int. Conf. Terminal Lakes*, Ogden, Utah.

Picard, L. 1932 'Zur Geologie der mittleren Jordantales'. *Z. Deutsch. Paläst. Ver. 55*, 169.

Picard, L. 1965 'The geological evolution of the Quaternary in the Central-Northern Jordan Graben, Israel'. *Geol. Soc. Am. Spec Pap. 84*, 337–66.

Picard, L. 1966 'Thoughts on the graben system in the Levant'. *In* Irvine, T. N. (ed.), *The World Rift System*, Ottawa, 22–32.

Picard, L. & Baida, V. 1966 *Geological report on the Lower Pleistocene deposits of the 'Ubeidiya Excavations*, Jerusalem.

Quennell, A. M. 1956 'The structural and geomorphic evolution of the Dead Sea Rift'. *Quart J. Geol. Soc. Lond. 114*, 1–24.

Raikes, R. L. 1967 *Water, weather and prehistory*. Baker, London.

Siedner, G. & Horowitz, A. 1974 'Radiometric ages of late Cainozoic basalts from northern Israel: chronostratigraphic implications'. *Nature 250*, 23–6.

Sitter, L. V. de 1962 'Structural development of the Arabian Shield in Palestine'. *Geol. en Mijnb. 41*, 116–24.

Smith, G. A. 1894 *The Historical Geography of the Holy Land*. Hodder & Stoughton, London.

Sparks, B. W. 1964 'Non-marine mollusca'. *In* Vita-Finzi 1964, 32–3.

Underhill, H. W. 1967 'Dead Sea levels and the P.E.F. mark'. *Palest. Explor. Quart. 98*, 45–53.

Vita-Finzi, C. 1964 'Observations on the late Quaternary of Jordan'. *Palest. Explor Quart. 95*, 19–31.

Vita-Finzi, C. 1966 'The Hasa Formation'. *Man 1*, 386–90.

Vita-Finzi, C. 1978 *Archaeological Sites in their Setting*. Thames & Hudson, London.

Vogel, J. G. & Waterbolk, H. T. 1972 Groningen radiocarbon dates. *Radiocarbon 14*, 46–7.

Vries, H. L. de & Barendsen, G. W. 1954 'Measurements of age by the Carbon-14 technique'. *Nature 174*, 1138–41.

Wetzel, R. & Morton, D. M. 1959 'Contribution à la géologie de la Transjordanie'. *Notes. Mém. Moyen-Orient VII*, 95–191.

White, R. O. 1961 'Evolution of land use in south-western Asia'. *In* Stamp, L. D. (ed.) *A History of Land Use in Arid Regions*, UNESCO, Paris, 57–118.

Willimott, S. G., Birch, B. P., McKee, R. F., Atkinson, K. & Nimry, B. S. 1964 *Conservation Survey of the Southern Highlands of Jordan*. Durham.

Zak, I. & Freund, R. 1966 'Recent strike slip movements along the Dead Sea Rift'. *Israel J. Earth-Sci. 15*, 33–7.

Zeuner, F. E. 1954 'Recent movement on the western fault of the Dead Sea rift'. *Geol. Rdsch.* 43.