3 Recording the Ancient Near Eastern Landscape

Techniques and Analysis

The idea of recording the landscape of the ancient Near East is not new, and during the early decades of this century, rapid strides were made as a result of the development of aerial photography. Consequently, by the time that Bradford's book *Ancient Landscapes* was published in 1957, the field was already some three decades old. We should not therefore pretend that studies of the archaeological landscape are entirely new. Nevertheless, what distinguishes the modern school of Near Eastern landscape archaeology is that there is now much more systematically recorded ground control as a result of surveys and excavations. In addition, more is known about geomorphology and environmental change than formerly, and we also have a broader theoretical base with which to assess the results of aerial reconnaissance.

It is necessary to emphasize that different archaeological methodologies result in different kinds of archaeological data (Barker 1997: 277). In the Levant the original driving force behind many landscape studies was, for example, the study of the Roman frontier, the recording of Byzantine religious buildings, or simply the ability to undertake aerial reconnaissance. Such specialized monothematic approaches have been an important part of landscape studies in the Near East, but they are undertaken at the expense of a wider range of topics that are frequently neglected. Ideally, regional landscape archaeologies should treat the full range of available data (for an example of a good broad spectrum investigation, see the discussion of the Wadi Faynan Project in chapter 8), but unfortunately this is not always possible.

Landscape prospection falls into three basic stages: first is the analysis of maps, aerial photographs, satellite images, and other data sources prior to fieldwork. Second is the recovery of data in the field using various forms of archaeological or geoarchaeological survey; ideally, this part can provide ground control for the first stage. The third stage entails the analysis of samples taken in the field by various techniques such as geochemical analysis, as well as the process of combining data collected in the field with that from the initial reconnaissance stage. Ideally, because Geographic Information Systems (GIS; see below) have become a fundamental tool for manipulating spatial data sets as well as the visualization of ideational landscapes and perception of the terrain, GIS analysis can proceed from the initial stages of a project. In addition, however, it is vital for the landscape archaeologist to understand the processes of landscape formation that may have been in operation in the chosen field area. Such "taphonomic processes" do not necessarily provide the field archaeologist with any dramatic new discoveries, but they do make it possible for the field and remote-sensing records to be interpreted in a more meaningful way.

Data Sources and Techniques

Data Recovered before Fieldwork

Maps provide a fundamental data source for landscape analysis and should not be underestimated because in many parts of the Near East they show numerous features of relevance to landscape archaeology. These include field terraces, *khirbeh* (low ruin mounds of usually post-Hellenistic settlements), ruins (often later in date than *khirbeh*), water reservoirs (*birkeh*), dams (*sedd*), and wells (*bir*) (fig. 3.1). In addition, place names such as Khirbet al-Fulan, Tell Brak, or Bir Halu (sweet water) supply information on earlier phases of settlement and water supply before one even sets foot in the field. The availability of specialized project maps (such as maps for irrigation schemes) can supply detailed topographic information that, in turn, can help define mounded sites. The availability of maps at scales as large as 1:5,000 with contours at 0.5 m intervals, can be invaluable not only for recognizing sites but also for defining quarry pits, ancient routes, and canals (fig. 6.9; Wilkinson and Tucker 1995). Geographically corrected maps or satellite images provide a key base for plotting landscape data and can be used for georectifying less geographically precise aerial photographs or CORONA satellite images. Therefore by the use of image analysis software, aerial photos, or CORONA images, can be warped onto a preexisting map base.

Air photography has long been a tool for archaeological mapping. In the Near East the first steps in landscape archaeology were taken as a result of aerial photography missions flown during and immediately after World War I (Kennedy 2002). Probably the first aerial photograph was taken by Mr. Felix Tounachon over

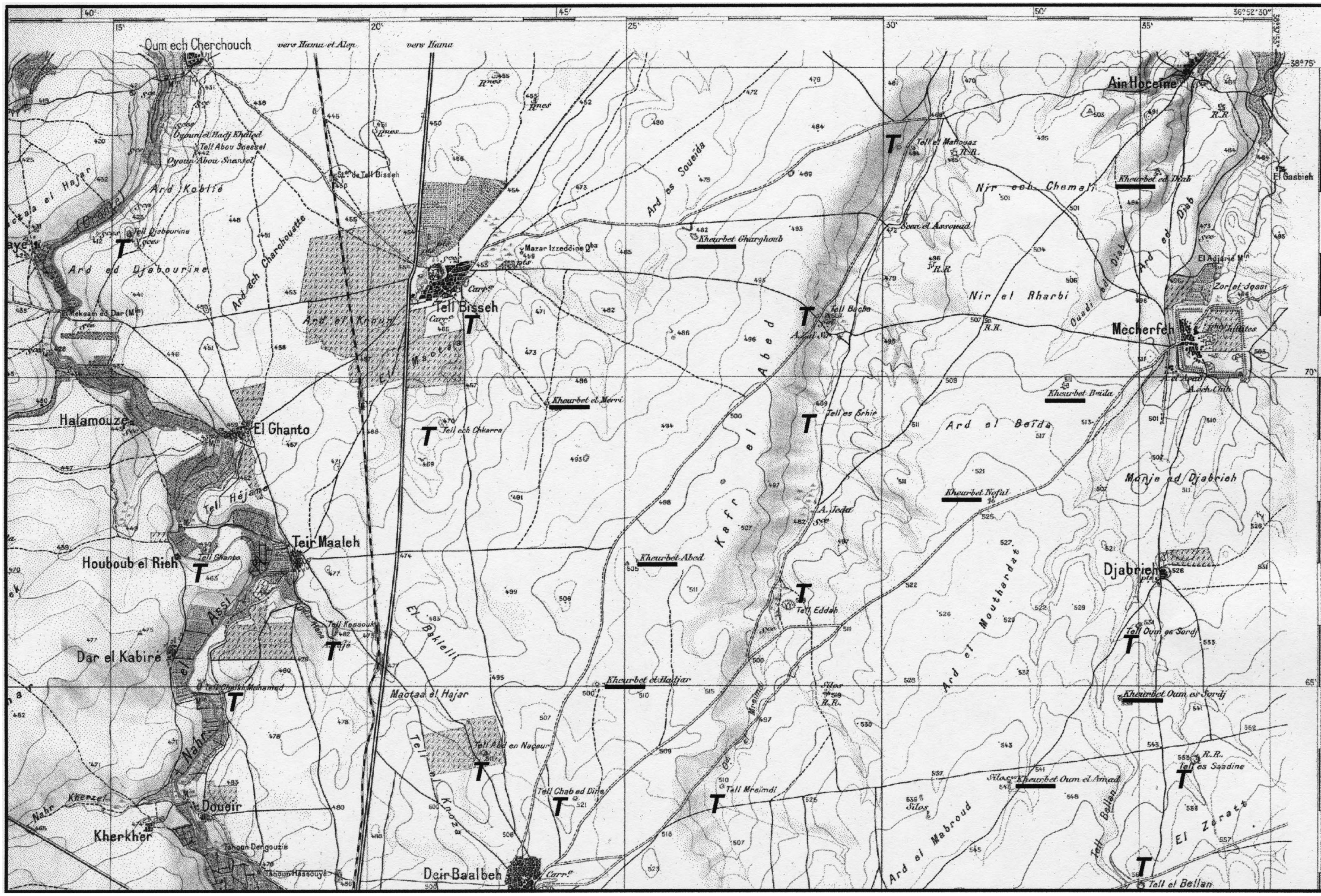

Fig. 3.1 1:50,000 scale map of part of the area of Homs in western Syria showing tells (T), mainly (but not exclusively) along rivers and wadis and in more low-lying areas, and dispersed *khirbet*-type sites (*kheurbet*) mainly occupying the intervening uplands. Note the massive square enclosure of Early/Middle Bronze Age Mecherfeh/Qatna along the eastern margin of the map. Each grid square measures 5 km. (From Service géographique de l'armée 1931 [Paris]).

Paris in 1858 (Verhoeven and Daels 1994: 519), and further progress in the art was made between 1877 and 1887 (for a summary, see Crawford 1923 and 1954). However, it was not until a German aerial photography unit was pioneered by Dr. Theodor Wiegand during World War I that serious advances were made in landscape archaeology. Wiegand's pioneering efforts made noteworthy photographs of Byzantine villages, forts, and monasteries as well as runoff agricultural systems in the Negev Desert of Palestine (Crawford 1954; Kennedy and Riley 1990: 28). These campaigns were published in 1920, at around the same time as a flurry of other publications appeared from Lieut. Col. G. A. Beazeley, Sir Aurel Stein, and others (Beazeley 1919; Stein 1919).

The great potential of aerial photography was also evident to some Near Eastern archaeologists, and James Henry Breasted undertook a number of photographic missions over Egypt, Iran, and the Fertile Crescent between 1919 and 1931 (Breasted 1933: 36, 85, 93). Unlike modern landscape studies that concentrate on ground surveys to provide a detailed record of cultural and physical landscapes, earlier aerial reconnaissances were usually more sparing in the use of ground control. Although ground control was frequently undertaken, often by simply landing the airplane or even by conducting quick trial excavations, these earlier surveys were dominantly aerial photographic reconnaissances (for overviews, see Gregory and Kennedy 1985; Schmidt 1940). Certainly, the massive potential of aerial photography for landscape analysis was rapidly appreciated, and the results of field campaigns during the 1920s, 1930s, 1940s, and 1950s provided a substantial body of data and theoretical insights. This has been well summarized by Bradford (1957), whose book used a wide range of Near Eastern and Mediterranean examples. More recent works on the use of aerial photographs include D. R. Wilson (2000) and Kennedy and Riley (1990), the latter concerning applications of aerial photography to the specialized study of the history of the Roman frontier. To fully appreciate the impact of aerial photography, however, it is necessary to look at the huge increase of known sites in areas where aerial photographs have been used as a means of reconnaissance. This is particularly evident in northern Jordan, where a dense rash of new sites has appeared as a result of the interpretation of 1953 aerial photographs (Kennedy 2001:2).

In theory, the use of satellite remote sensing should have revolutionized landscape mapping in the Near East, especially because it provides terrain data on areas for which aerial photographic coverage is often unavailable for reasons of security. Although these new technologies supply valuable new data on the terrain, they have not entirely supplanted aerial photographs that provide a historical record of the landscape as it was before modern developments erased many earlier features (Kouchoukos 2001: 82). In addition, aerial photographs are capable of recognizing individual archaeological features such as field walls and also are more readily viewed stereoscopically. Thus by using overlapping stereo pairs taken along a single plane run, it is possible to view the landscape in three dimensions (D. R. Wilson 2000: 210–217). This is especially advantageous in the Middle East, where individual sites as well as landscape features such as canals have a topographic component that can be exaggerated on 3-D aerial photographs.

Despite their sluggish adoption by many archaeologists, orbital observation satellites now provide valuable data on the landscape of the Near East (table 3.1). In these systems, satellites rotate around the earth in sun-synchronous orbits at altitudes of around 750 km. They provide views of swathes of terrain that can then be analyzed by means of a range of imaging software (Lillesand and Kiefer 1999; Donoghue 2001). There are two forms of earth observation systems: first are so-called passive systems that monitor electromagnetic radiation reflected back naturally from the earth's surface. This spectrum includes not only visible light but also longer wavelength radiation such as infrared and thermal infrared radiation. Second are "active" systems that send out their own impulse (such as radar) and then receive the reflection back as digital data. Today passive systems find the greatest use in archaeological remote sensing, although in recent years increased use has been made of radar imagery. Frequently used passive systems are the American LANDSAT, the French SPOT, and the recently released American CORONA images, but more recently IKONOS, ASTER, Indian IRS, and Russian Soyuz and KVR-1000 systems have become available (Kouchoukos 2001). The advantage of multispectral image data is that by providing a wide range of the electromagnetic radiation spectrum, these images enable features that are not necessarily visible to the naked eye or regular photographic techniques to be perceived. This is particularly valuable for the recognition of archaeological sites that include in their composition ash and refuse that differ from the surrounding soils and that can provide a distinctive signature on wide spectral range images such as the LANDSAT TM (Thematic Mapper) series. By combining high resolution with a broad spectral range, the new generation of imaging systems should make significant contributions to the recognition and mapping of archaeological features.

On the other hand, there is a distinct advantage for the archaeologist in the earlier CORONA images because these were taken during the 1960s and 1970s, before the appearance of much modern clutter such

Table 3.1 Some Basic Imaging Systems Useful for Landscape Archaeology

Imaging System and series	Pixel Size and/or resolution m	Bands	Frame Size	Comments
Air photographs	< 1 m	Normally visible light only*	Stereo pairs; frequently 23 × 23 cm prints	3-D capability. Shows most sites and landscape features: fields, ancient tracks, canals, etc.
CORONA	ca. 2 m, 3 m	Visible light (photographic)	Long strips (negative or positive)	Main period of data collection 1959 (KH-1) to 1972 (KH-4B). Good for recognition of sites, canals, ancient roads, and field systems. Some 3-D capability. Best missions with KH-4B camera.
LANDSAT MSS 1–5	79 and 82 m	4 bands visible + near infrared	185 × 170 km	Introduced 1972. Useful for general land-use and geomorphological mapping.
LANDSAT TM and LANDSAT 7	28.5 m (15 m for panchromatic)	4 bands visible + near/mid infrared	185 × 170 km	Sites as small as 1 ha or less and some off-site features such as canals are detectable.
SPOT	10 m and 20 m	Panchromatic and near infrared	60 km × 60–80 km	Canals and some landscape features visible as well as many sites. Stereo-mapping capability.
IKONOS	1 m (panchromatic and color) and 4 m (multispectral)	Multispectral and panchromatic	Variable	Introduced 1999. Capable of showing details of archaeological sites down to the scale of individual buildings.
ASTER	15 m, 30 m, 90 m	14 bands multispectral	60 km	Introduced 1999. Shows a wide range of archaeological sites.
Russian KVR 1000	1–3 m	Visible light (black and white)	40 × 40 km	Introduced 1984.
Russian TK 350	10 m	Visible light (black and white)	200 × 300 km	Introduced 1987. Includes stereo-mapping capability.
Indian IRS	5 m (black and white), 23.5 m (multispectral)	Visible (5 m) and multispectral (23.5 m)	70 × 70 km (5 m pixel); 140 × 140 km (23.5 m pixel)	Introduced 1988.

*Because cameras can use infrared as well as conventional films, air photography has a capability extending beyond the range of visible light.

as houses, industrial areas, military bases, reservoirs, and irrigation systems (Kennedy 1998; Philip et al. 2002a). These images, which were taken for the Central Intelligence Agency of areas deemed as potentially a threat to U.S. security, cover a wide area of the globe (McDonald 1995). They were earmarked for general release by President William Clinton in 1995 and are available for viewing over the World Wide Web (http://edcwww.cr.usgs.gov/). Being photographs, these lack the wide spectral range of the more recent satellite images, but they do provide remarkably high-quality views of the Near Eastern landscape. Not only are archaeological sites frequently readily visible, but specific landscape features such as canals, some field systems, and ancient routes can also be recognized (fig. 3.2).

Emerging techniques include radar images that generate a pulse, which is then received by a radar antenna to construct an image. By detecting variations in surface roughness or by penetrating, for

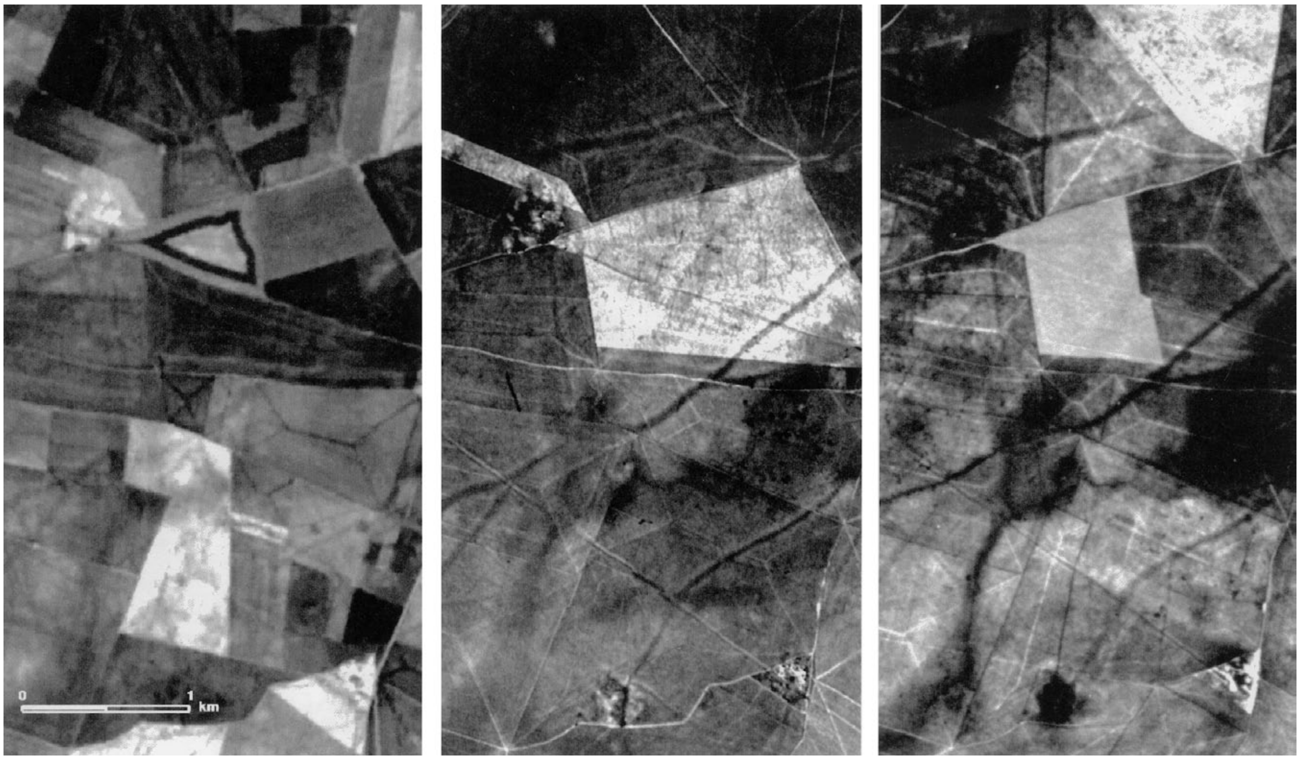

Fig. 3.2 Representative views of part of the landscape to the west of Tell Hamoukar (Syria) showing differing image quality according to imaging system and time of year. Left: SPOT image (taken between 1992 and 1995). Center: CORONA photograph (December 1969). Right: CORONA photograph (May 1972). Note that the strong dark lines running from top right to bottom left are linear hollows (see chapters 4 and 6); the diffuse gray feature trending from the top to the bottom left corner appears to be the course of a relict wadi infilled with plough wash. (By Jason Ur; courtesy of U.S. Geological Survey)

example, dry sand, radar can provide an image of subsurface terrain. This technique has given remarkable views of early drainage channels such as the recent images of relict drainage systems in Saudi Arabia (fig. 2.3; Dabbagh et al. 1998). The wide spectral range of LANDSAT and especially specialized sensors such as ASTER and MODIS are particularly valuable for assessing modern land use and vegetation, which, in turn, can be used as a baseline for estimating past land-use systems (Kouchoukos 2001: 83).

Although remote sensing is proving to be a valuable technique for the recovery of landscape data, the Middle East continues to be rather poorly served by archaeological remote sensing studies. There are few publications that can be compared with satellite and aerial photographic studies undertaken on, for example, Mayan land-use systems (Adams et al. 1981; Pope and Dahlin 1989), pre-Hispanic fields in Peru (Moore 1988), and New World roads (Trombold 1991). Nevertheless, the work of Robert Adams (1981) and Verhoeven and Daels (1994) on Mesopotamian settlement patterns; Brunner (1997) and Gentelle (1998) on South Arabian irrigation; Tate (1992) and Gentelle (1985) on Syrian field systems; van Liere and Lauffray (1954) on north Syrian landscapes (Ur 2002, 2003); Kennedy (1998) and Kennedy and Riley (1990) on the Roman frontier all demonstrate the potential of remote sensing for recording ancient landscapes.

Data Recovery by Field Work

Archaeological Site Survey

Archaeological survey, which aims to locate and analyze the distribution of ancient settlements, usually according to period, supplies the basic data framework for the landscape archaeology of a region. Archaeological survey does not, however, always supply information on the landscape features themselves, unless the survey is of the "siteless" variety that investigates both the sites as well as the land in between. Traditional Near Eastern archaeological surveys frequently record only the mounded sites, whereas smaller unmounded occupations or more dispersed sites of low relief are often underrepresented (chapter 4). This is unfortunate because not only can low sites extend over large areas, but also smaller settlements (say those less than 1 ha in area) frequently form the bulk of settlement for certain periods; therefore, to omit such sites can severely bias the survey.

In recent years the archaeologi-

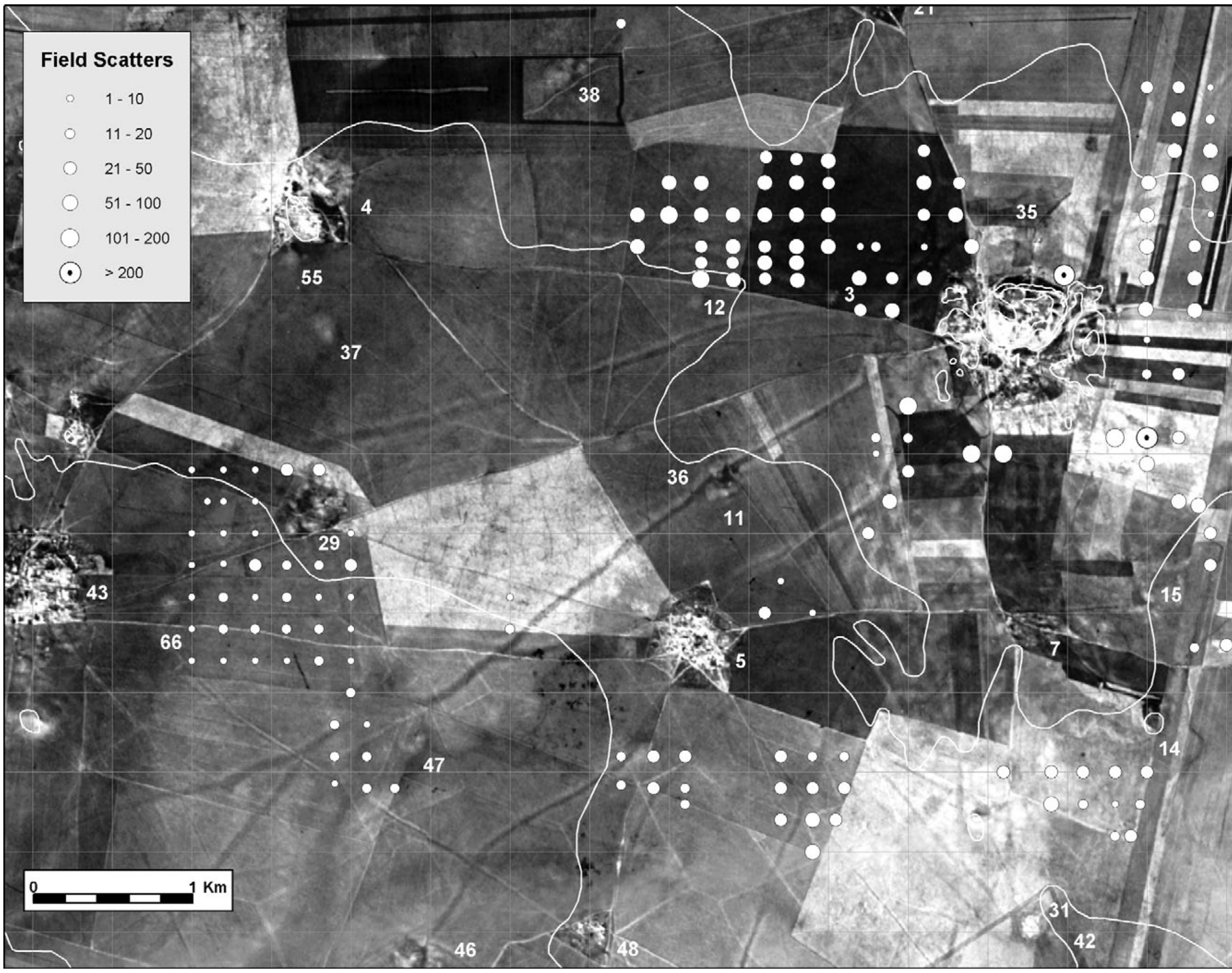

Fig. 3.3 Area of Hamoukar (THS 1) in Syria showing off-site collection areas (field scatters) in relation to archaeological sites and superimposed on a CORONA image. Note the well-developed linear hollow leading southwest from the major Early Bronze Age site of Hamoukar. Contour lines (at 5 m interval) are derived from a 1:50,000 topographic map (photograph courtesy of the U.S. Geological Survey; data compiled by Jason Ur).

cal landscape has been perceived as forming an almost continuous record, with off-site activity being represented by cultural features such as quarries, roads, tracks, artifact scatters, irrigation systems, fields, wine or olive presses, and threshing floors (chapter 4).

A basic tenet of off-site survey is that the notion of a site is a subjective construct and would better be replaced by a more rigorous definition that allows for the sparseness or poor spatial definition of human activities (Dunnell and Dancy 1983; Cherry 1983). Nevertheless, in many parts of the Near East, archaeological sites of sedentary settlement are well defined, and often are mounded, so that a real distinction can be made between "site" and "off-site" areas. On the other hand, the presence of sometimes dense artifact scatters off site can blur the picture. Such scatters can be explained as resulting from a range of agricultural process, as well as locally intermittent settlement or other activity (see below, chapters 4 and 6). To obtain robust off-site data, surveys should be designed to supply a continuous record of the landscape in the form of transects across the terrain, or there should be a sample between sites by means of sample squares (Banning 2002). Before 1990 the positioning of transects was impeded by the limited availability of good maps or the relative inaccuracy of hand-held mapping systems (such as the prismatic or Brunton compass). Now with the widespread availability of hand-held GPS (global positioning systems) units, it is possible to walk to specific sample locations positioned on, for example, a grid of 100 or 200 m to fix points within ± 5 m or even less. At each location a sample square or circle is laid out and all surface artifacts are collected (fig. 3.3; Ur 2002).

Despite the application of off-site techniques to landscape survey since the 1970s, Near Eastern surveys still lag behind those in the Mediterranean in terms of technique and quality of data recovery. The methodological differences are well expressed in recent volumes in the series *Archaeology of the Mediterranean Landscapes* (Barker and Mattingly 2000), which provide numerous insights into how methods of intensive survey and integrated survey practice can be applied to the archaeological landscape to provide enhanced levels of data recovery. With the advent of new GPS technology and geographically corrected satellite images, it is now possible to recognize and target features on images and employ the "go to" capability of the GPS to find precisely and visit key features.

Existing databases for survey in the Near East remain scanty, but some government databases provide information on archaeological site locations and distributions. These include the Atlas of Archaeological Sites in Iraq (Iraq Department of Antiquities 1976), archaeological maps of Jordan, the TAVO (Tübinger Atlas des Vorderen Orients) maps of Tübingen, and the TAY (Türkiye Arkeolojik Yerlşmeleri) series from Turkey. In addition, some of the most intensively surveyed parts of the Near East are found in the southern Levant, where the archaeological survey of Israel has built upon earlier surveys of Palestine undertaken by the British Mandate.[1]

Recent critiques of settlement survey often regard past surveys as being inadequate at representing the dynamics of settlement change because they provide only a staccato development of settlement history, subdivided into arbitrary stages (Brück and Goodman 1999). However, this factor is inherent in the very problem of representing potentially unstable systems such as settlement patterns (Roberts 1996: 120–128), and attempts are being made to take such considerations into account (e.g., Bintliff 2000). The incorporation of a dynamic element into settlement survey using the techniques of Dewar (1991) goes some way towards demonstrating that settlement history does not simply progress in somewhat arbitrary chronological stages. The recognition of persistent features in the landscape that often hark back to earlier time periods, or relict features or sites that continue to have meaning to the local people, can also provide insights into long-term perspectives on settlement change that are not dealt with by earlier surveys.

Preoccupations with capitalist-type economic models are also rightly subject to criticism, although this is less a problem for Near Eastern archaeological surveys because there, the basis for comparing the archaeological record has been a persisting and often vigorous traditional way of life. Ethnographic or ethnoarchaeological studies of the social and economic systems of traditional village or nomadic communities over the past two hundred years has supplied a wealth of data for unraveling past landscapes (Kramer 1979; Sweet 1974). Although it would be naive to regard the modern communities as linear descendents of the ancient communities, they can provide a basis for comparison with the archaeological record that is very different from our own fully capitalist economies. Substantial insights into landscape history can therefore be obtained from ethnoarchaeological studies or simply by discussions with local people, who frequently have an intimate knowledge of the way installations such as threshing floors, terrace walls, or dams actually operated. The uncritical extrapolation of the ways of life of present-day traditional societies into the past can, however, be misleading. This is especially the case if the population has arrived fairly recently and is not well acquainted with the landscape, as is the case for those parts of the Fertile Crescent that have experienced the recent resettlement of population groups.

Geochemical Prospection

Geochemical prospection provides a spatial record of human activity in the form of a fixed anthropogenic signal superimposed over that of the soil chemical environment (Heron 2001: 565). Soil samples are analyzed to provide a spatial patterning of chemical properties that yield a signature of both the original soil record as well as a signal of later human activities. Key indicators include phosphates, lead (Pb), zinc (Zn), copper (Cu), manganese (Mn), and nickel (Ni) (Heron 2001; Taylor 2000; Rimmington 2000). Phosphate analysis has been employed in archaeology for some forty years to record various geochemical forms of phosphate that result from activities such as pasturing or bedding of animals, ancient manuring, modern fertilizer practice, burial of the dead, as well as settlement middens. Most surveys attempt to detect the inorganic phosphate (P_2O_5) component of the soil, which gradually accumulates by means of transformation from an initial input of organic phosphates. In addition, more sophisticated methods such as phosphate fractionation have been used, for example, to demonstrate the accumulation of phosphates in irrigated soils in southern Arabia (Eidt 1977; Brinkmann 1996). Trace metals also accumulate in the soil over the millennia to produce complex patterning around occupation sites (Bintliff et al. 1992). Like phosphates, trace metals can be related to patterns of past activity such as the intensity of land use, disposal of rubbish, and other processes.

Geochemical indicators can then be related to patterns of off-site artifacts to produce a composite interpretation of ancient activities in the region (Wilkinson 1990a; Bintliff et al. 1992). The combination of such signatures in concert with the assay of biomarkers (e.g., lipids) provides a specific impression of activities such as manuring or even the presence of certain animal species (Bull et al. 1999, 2001). Unfortunately, unlike artifact scatters, most geochemical patterns can rarely be dated, with the result that they provide a signature of long-term activity rather being specific to any particular period of occupation.

Geoarchaeology

Geoarchaeological studies form an essential part of landscape archaeology and enable landscape surveys to be placed within a dynamic physical context. Field surveys should therefore endeavor to record as many cuts and sections as possible to obtain sequences through Pleistocene and Holocene sedimentary accumulations. The application of earth science techniques also allows the landscape record to be assessed in terms of natural transformation processes (Schiffer's n-transforms: 1987: 235–262). By undertaking geoarchaeological studies simultaneously with archaeological surveys, it is therefore possible to determine what proportion of sites and landscapes have been lost through erosion, whether features may have been buried by sedimentation, or whether sites lie on relatively stable terrain (Kouchoukos 1998: 100–103). In addition, geoarchaeological studies such as soil micromorphology, particle-size analysis, and soil-profile description provide essential information on the development and dynamics of landscape features such as buried land surfaces, infilled quarry pits, and terraced fields (Groenman-van Waateringe and Robinson 1988; Miller and Gleason 1994).

Geoarchaeological techniques form a key element in the interpretation of many landscape features. For example, if a surface mound contains abundant gravel, it is necessary to determine the source of that gravel, which may indicate whether the mound comprised material cast up from the excavation of a well that penetrated to a specific geological substratum (fig. 4.1). Similarly, geoarchaeological techniques can be used to assess the size, sorting, and depositional environment of sediments transported along the beds of irrigation canals. Where sediments have accumulated behind terrace walls, analysis of soil properties and their inclusions aid in the recognition of episodes of soil stabilization in the form of palaeosols (Waters 1992; Courty et al. 1989; see also chapter 4 and following chapters).

Geophysical Techniques

Geophysical techniques have been applied to the investigation of ancient landscapes in many parts of the New and Old Worlds, but relatively little use has been made of them in the Near East (Sarris and Jones 2000; Bevan 1994). On the other hand, during the last ten years, geophysical prospection has been applied to settlement sites in Turkey with impressive results (Summers and Summers 1998; Matney and Algaze 1995; Becker and Jansen 1994). Proven techniques include resistivity survey, which measures the electrical resistance of the soil; magnetometry survey, which measures variations in the earth's magnetic field or the magnetic susceptibility of the subsurfaces; electromagnetic survey; ground-penetrating radar; and seismic survey. Insightful recent applications of geophysical prospection include resistivity survey for defining site boundaries at Tell al-Amarna, the recognition of tombs or tunnels using resistivity survey (Sarris and Jones 2000: 18–19), and the location of mudbrick structures at Neolithic Çatal Höyük using magnetometry (Shell 1996).

Most of the foregoing have been undertaken as part of settlement-based studies, but both ground-penetrating radar and seismic techniques show considerable potential for the recognition of canals and buried channels (Sarris and Jones 2000: 36–40; Karastathis and Papamarinopoulos 1997). The underutilization of geophysical techniques for landscape analysis will surely change in the near future, however, because ground-penetrating radar and soil-resistivity survey are of considerable value for providing supplementary records of features that appear on satellite images. In the future it should therefore be possible to test whether, for example, a dark mark crossing the landscape represents a canal or a shallow feature worn into the terrain by prolonged use (such as an ancient trackway). Although such questions are only just starting to be resolved by geophysical survey, the combination of excavation with geophysical survey should provide a basic signature for a verified feature, so that in subsequent investigations geophysical surveys will be capable of demonstrating the likely origin of such features.

Other Environmental Data

Ideally, landscape investigations should take place in tandem with excavations, and indeed they should be conceived as part of one overarching investigation. For example, Naomi Miller's investigations of carbonized plant remains show that during the fourth and third millennia B.C., the landscape along the Turkish Euphrates was becoming increasingly degraded. The landscape analysis supports this point, since it demonstrates that as more trees were removed from the region, it was necessary to burn more dung as fuel. The consequent lack of dung meant that fields could not be fertilized with animal dung and that recourse had to be made to the spreading of household ash on the fields. Geoarchaeological surveys also showed that there was parallel evidence for landscape degradation after around 2000 B.C. (Wilkinson 1990a: 26–29). In some cases, rather than conducting surveys in a given area to answer specific cultural or historical questions, it can be advantageous to conduct surveys in areas where good pollen sequences exist to examine how settlement and vegetation change through time in relation to each other.

Data Integration Using GIS

Geographic Information Systems (GIS) have become a buzzword in archaeology, and although not a panacea, they do provide a convenient and powerful way of integrating different data sets from large-scale regional investigations. GIS enable different types of mapped information to be stored as a series of "layers" that can then be analyzed and manipulated together so as to display them in new ways or to provide new data combinations. It is therefore possible to superimpose distributions of archaeological sites on soil maps to determine favored locations for settlement development, calculate the areas of archaeological sites, estimate the amount of cultivated land around sites of a given period, as well as to ask questions about, for example, distance to the nearest water sources or nearest neighbors. When employed in conjunction with data on the physical environment, GIS provide an excellent way of manipulating the large spatial data sets gathered during survey. For this reason alone they will prove to be indispensable in landscape analysis in the future.

Inevitably, because early applications involved the use of data derived from soils, topographic maps, and land use, there has been a tendency for GIS applications to become deterministic so that site locations, for example, can be predicted on the basis of the physical potential of the landscape alone, rather than combining these with a range of social factors. However, recent innovations that treat landscapes as being perceived from the perspective of the viewer provide a novel component to GIS that has considerable potential (see papers in Gillings et al. 1999). By way of illustration, Gaffney and colleagues (1995) argued that the GIS modeling of the topographic area visible from any site provides a measure of the cognitive environment. Michael Given (2001) has successfully applied viewshed analysis in Cyprus to show the landscape that was perceived during the daily round of work by the inhabitants of individual settlements. Related techniques such as those that place Australian rock-art sites within their cognitive environment could readily be used for equivalent problems in Arabia or for the recognition of intervisibility of burial monuments or tombs on ridge tops.

Landscape Taphonomy

Even during the earlier stages of landscape archaeology there was an awareness that the cultural landscape had suffered progressive attrition of features through time, with some elements being added whereas others were lost. During his assessment of centuriated landscapes of the Mediterranean region, John Bradford described the progressive attrition of field boundaries (Bradford 1957: 208). More recently, Schiffer (1987) has formalized landscape transformation processes into those resulting from cultural and those resulting from environmental processes (c- and n-transforms respectively). Christopher Taylor's recognition of landscapes of destruction and survival in Britain (Taylor 1972) was a landmark statement because this conceptual framework enabled archaeologists to take account of the likelihood of feature survival when assessing the landscape record. For example, above the limit of cultivation in the uplands there was an increased likelihood of landscape features or entire landscapes surviving, whereas in the lowlands where processes of settlement and cultivation had endured over millennia, there was a much greater chance of earlier landscapes being lost. This simple conceptual framework received less attention than it deserved, but in a revised and more detailed form, Tom Williamson has applied it for the British Isles. Despite the fact that Taylor's neat conceptual framework oversimplifies what is in reality "a particularly complex kaleidoscope of patterned creation and structure destruction" (Williamson 1998: 6 and fig. 3), it is clear that landscape transformations have played a fundamental role in the preservation or loss of landscape data.

Strictly speaking, the term *taphonomy* applies to the processes that act upon biological materials after death and before they become fossils, but I have adapted the term to landscape studies because similar principles apply. This is illustrated by the progressive removal of, for example, stones from a wall to build a new one or the wholesale removal of some features when they become redundant. Similarly, geomorphological processes either can erode parts of the landscape away or can entomb landscape features beneath an obscuring blanket of sediment.

Suitably amended, the Taylor model can be effectively applied to the ancient Near Eastern landscape. Landscapes with the greatest probability of feature survival occur in deserts and high mountains, whereas progressive loss of features is at its maximum in areas of long-term cultivation and rather less so in marginal zones of settlement. The coastal zone experiences a patterned loss and survival depending upon coastal sedimentation and currents. Major taphonomic zones in the Near East can be suggested as follows, although it requires emphasis that the patterning of landscapes of destruction and survival can be extremely complicated.

Zone 1: Zone of Preservation in Deserts

Because most deserts lack the potential for cultivation, they are not normally occupied by long-term sedentary settlement. Nevertheless, if settlement did take place, there is little likelihood that their remains would be erased by subsequent settlement. Consequently, archaeological remains can be remarkably well preserved in deserts. Indeed some of the first steps in landscape archaeology were conducted in the hyperarid regions of the Gobi and Takla Makan deserts, where relict canals, off-site sherd scatters, and fossilized orchards, dating from the first millennium A.D., were all recorded in fine detail (Stein 1921).

Probably the best examples of zones of preservation occur where economic, environmental, or political factors have encouraged the extension of settlement into otherwise marginal areas. For example, a remarkable pattern of prehistoric fields near Tepe Yahya in southeast Iran remained for some seven thousand years because of the lack of subsequent settlement, but they were then lost from view by the extension of cultivation during the late twentieth century A.D. (Prickett 1986; Lamberg-Karlovsky personal communication; chapter 5). Similarly, the deserts of Jordan, Saudi Arabia, and southern Israel, with rainfall of less than 200 mm per annum, provide numerous examples of landscapes of preservation. Despite the high quality of preservation of surface features, establishing a date for them is frequently difficult because of the lack of associated dating evidence. Hence, in Jordan various field systems near Nabatean, Roman, or Byzantine settlements remain difficult to date with confidence (Kennedy and Freeman 1995: 39; Barker et al. 1997).

Zone 2: Zone of Preservation in Mountainous Areas

At the other extreme, mountains provide conditions that are unsuitable for sustained human activity, with the result that permanent settlement rarely occurs above a certain limit. When it does occur, for example, if the area suddenly becomes important for mining or as a source for stones such as obsidian, or highland pastures are adopted for upland camps (equivalent to the Turkish *yayla*), then archaeological remains may be preserved with remarkable clarity. Such preservation can occur as long as the characteristic geomorphological processes of mountain areas (mass wasting, talus development, and so on) have not destroyed them. By way of example, forming an island within an otherwise well-watered part of northwest Syria near Aleppo, the limestone uplands of the "Massif Calcaire" present an almost complete relict landscape of Late Roman/Byzantine date. Settlements, oil presses, trackways, and fields are all preserved with remarkable clarity because there has been little subsequent settlement since the ninth century A.D. to remove their remains (chapter 7). The record from this small area therefore forms a remarkable island of archaeological preservation that stands in stark contrast to the nearby lowlands, where the remains of the same period usually take the form of rather anonymous tells or low mounds. Off-site features in such landscapes of destruction are usually lacking unless they are particularly robust.

Zone 3: Intermediate Zone (Marginal Rain-Fed Steppe, with Fluctuation Settlement Levels)

The Jazira region of northern Syria and Iraq is dominated by tells that attained their maximum size often during the middle part of the third millennium B.C. For landscape archaeologists, this marginal zone of rain-fed cultivation in Upper Mesopotamia holds special significance because it houses an unusual combination of important sites together with related landscape features that provide valuable insights into Bronze Age economic activities (Wilkinson 1994; Kouchoukos 1998).

With a mean annual rainfall ranging from ca. 200 to 500 mm, Zone 3 can register well-preserved, off-site features such as linear hollows (of ancient tracks), off-site sherd scatters, and relict canals (chapter 6). Other landscape features such as ancient relict fields are usually absent, except where "windows" of the landscape of preservation may be visible on localized uplands (fig. 3.4). In the Jazira the retreat of settlement from around the fifteenth century A.D. until the nineteenth and twentieth centuries resulted in a large area of tells and their associated landscapes remaining beyond the limits of the settled areas. As a result, archaeological landscape features appear to have survived particularly well (fig. 6.6). Overall, optimum landscape preservation may occur in the intermediate zone. This is because in wetter areas, sustained human settlement has increased the loss of early features or sites by attrition or by burial below later sites. In drier areas to the south, however, even though landscape transformation processes are less marked, long-term settlement has not been sufficiently heavy in its imprint to cause features to be embedded into the landscape.

Through the millennia this area has experienced several cycles of settlement rise and decline. The cause of this pattern of rise and decline continues to be debated, but it appears to result from a combination of climatic, social, economic, and political changes (see papers in Dalfes, Kukla, and Weiss, 1997). In such areas the retreat in the margin of settlement has allowed the early phases of settlement and landscape to be visible. Feature survival in the intermediate zone has also been encouraged by the nature of the subsequent settlement pattern (roughly post Late Bronze Age), which was dispersed and consequently left a lighter print on the landscape than the nucleated pattern of the Bronze Age. As a result, occasional hiatuses or declines in settlement have resulted in diminished attrition of landscape features.

Fig. 3.4 Small "taphonomic window" on edge of basalt plateau near Tell Beydar, Syria. Preserved features include lynchetlike terraced fields on scarp slope of basalt in center, and circular stone settings of nomadic huts (mid–late first millennium A.D.) left of center; the ploughed land forming the landscape of attrition is along the right-hand margin of the photograph.

Zone 4: Zone of Attrition

Whereas Zone 3 exhibits a partial landscape record in which occasional earlier features remain, in the "zone of attrition" there is decreased chance of feature survival because long-term settlement has been virtually continuous over some nine thousand years. This vast zone includes the Levantine coastal plain and much of Israel, Lebanon, western Syria, as well as parts of Turkey, Jordan, and Yemen. Although it is impossible to do justice to such a complex zone, the following example illustrates that processes of landscape transformation in Zone 4 have operated to deplete significantly the Roman landscape over the past two thousand years.

In Syria several examples of Roman centuriation have been recognized as relict patterns within the modern field systems (chapter 7). The presence of a few remaining relict field boundaries on an apparent grid within a pattern of recent field systems implies that existing field systems hold traces of earlier systems in them, just as in other parts of the Mediterranean (Wirth 1971: 375, 412; Bradford 1957, Alcock 1993: 139–140 for Roman; Gaffney, Bintliff, and Slapsak 1991 for Hellenistic). If such systems can be dated archaeologically, they can then supply a datum for estimating the ages of yet earlier field systems and landscape features, as has been possible in, for example, East Anglia (Williamson 1987).

Zone 5: The Coastal Zone

The small tidal range of the coastal waters surrounding the Near East restricts the potential for the discovery of sites in intertidal locations. Nevertheless, following from pioneering studies assembled by Masters and Flemming (1983), shallow underwater survey has now yielded impressive amounts of prehistoric occupation (chapter 2). Sites on the coast of Israel (Galili et al. 1993) and Greece (Flemming 1983) indicate that the level of preservation is often considerable, and this zone itself has its own processes of taphonomy that encourage or discourage preservation. Coastal geomorphological processes are obviously of greater importance than cultural transformations. According to Flemming (1998: 134), discovery of a submerged marine site is most likely to occur when a site that has been buried in sediment is slowly re-eroded as a result of a change in sediment supply or related circumstances. When investigated using geoarchaeology, geophysical prospection, and underwater archaeology, such landscapes can provide results that complement the record from adjacent dry lands. As in coastal sites in northwest Europe, feature preservation is often extremely good. In the future, this zone should provide valuable control for the heavily degraded record from adjacent drylands.

Conclusions

The foregoing pages argue that there is no such thing as a complete landscape record. Not only do taphonomic processes operate so that there is a progressive loss of landscape features through time, but also the quality of feature recovery will change through time. Hence, despite the availability of modern satellite sensors of unsurpassed precision (especially because of their wide spectral range), aerial photography taken earlier in the twentieth century can still provide results of remarkable quality, in part because they were taken under better taphonomic circumstances with less landscape disturbance. In reality, there is no single formula for the maximum recovery of early landscape data. Rather, it is necessary to harness a combination of remote-sensing techniques, detailed field survey, and local information, together with a certain amount of luck. Once the landscape record has been recovered, it can then be interpreted in terms of feature elements and systems of features, as will be attempted in the following chapters.