Methods for identifying, recording and analyzing Palaeolithic surface scatters/sites.

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Abstract

The application of distinct methodologies and techniques, developed by the PADMAC Unit for the investigation of Palaeolithic surface-scatters of lithic artefacts, has the potential to rapidly advance archaeological ability to construct models of hominin dispersal patterns, Palaeolithic habitat preferences (including the provision of resources) and the use of the landscape as a whole. Here, we present evidence that an iterative process of inductive analogous reasoning, utilising a varied and evolving suite of techniques and analytical procedures for the investigation of surface-scatters, can be a powerful tool. This concept is described and applied to the desk-based assessment, field investigations, off-site analyses of field investigation data and techno-typological analyses of artefacts. These evolving analyses produce significant results, including suggestions of inter-site relationships, location criteria and hominin dispersal, especially considering the scarcity of alternative comprehensive approaches.

Keywords**:** Palaeolithic; Surface-scatter; Techno-typology; lithic scatter; Arabia; UAE, site

1. Introduction

Well dated excavated Palaeolithic sites from around the world have produced site-specific data of international importance. However data derived from excavated sites are unlikely to provide information on the Palaeolithic peoples' use of landscape as a whole. Conversely, Palaeolithic surface-scatters (PS-Ss) are often the only evidence of a Palaeolithic presence in a locale. It is important, therefore, to fully utilise all the data that PS-Ss can provide. In principle, the interactive approach described here can be applied to any area irrespective of size, in a variety of environments, to identify a Palaeolithic potential (PP). In the UK, and since 2006 in the Middle East, the PADMAC Unit's on-going research has been aimed at identifying areas with PP, predominately in the United Arab Emirates (UAE) and to a lesser degree in the State of Qatar (Figure 1) (Scott-Jackson et al., 2007, 2008, 2009; Scott-Jackson JE & Scott-Jackson WB, 2010a), with the challenge of rendering repeatable, testable datasets which can provide robust answers relating to questions of habitat preferences (including provision of resources), the use of the landscape as a whole and hominin dispersal patterns.

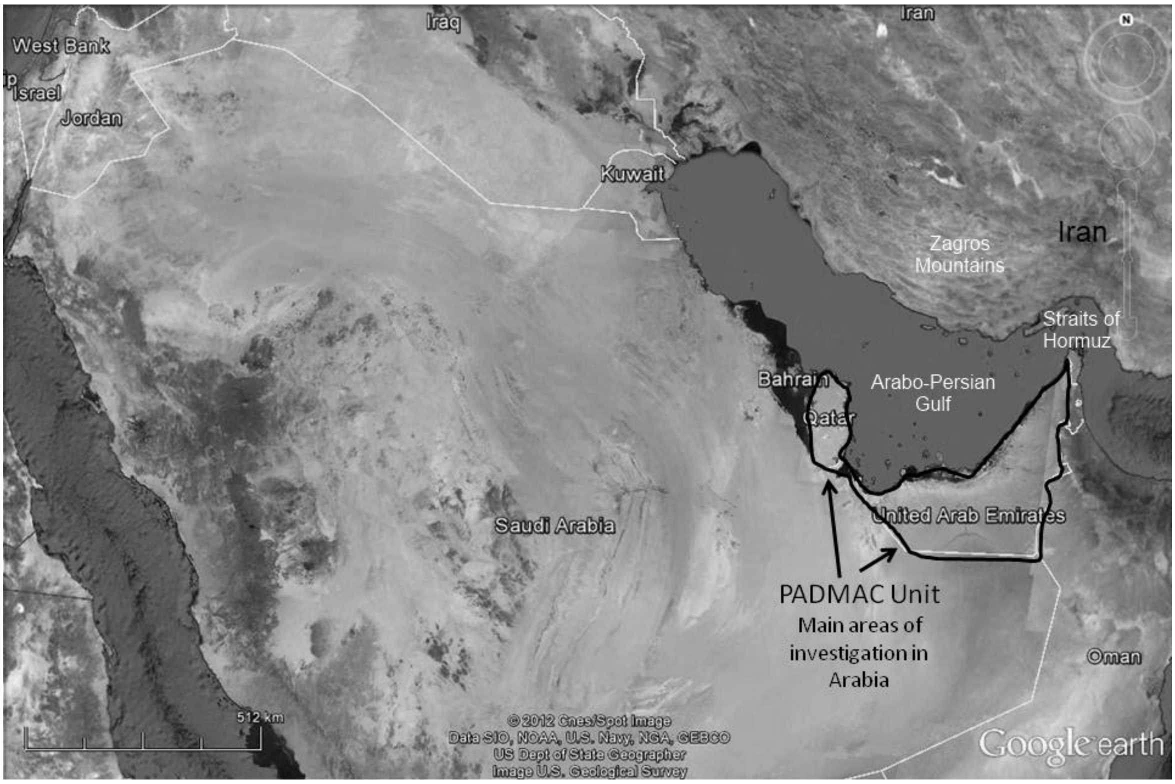

Figure 1: Google map of the Arabian Peninsula showing PADMAC Unit areas of investigation.

We accomplished this goal using the methodologies and techniques specifically adapted for locating, recording and analysing PS-Ss, which are examined here.

Rationale and methods

The presence of multiple components inherent in the preservation or loss of PS-Ss /sites, several which are driven by the mechanisms of reactive chemical and mechanical weathering processes over geological time on both the terrain and Palaeolithic artefacts, results in complex geo-archaeological research. Here we present evidence that an iterative process of inductive analogous reasoning, utilising a varied and evolving suite of techniques and analytical procedures for the investigation of PS-Ss, can be a powerful tool.

The desk-based assessment, prior to fieldwork (Section 3.1.) is considered first, followed by the field-investigation stage (Section 3.2.), the off-site analyses (Section 3.3.) the off-site techno-typological artefact analysis (Section 3.4.).

3.1. The desk-based assessment: the aims, methodologies and techniques for locating PS-Ss, prior to fieldwork.

Understanding Palaeolithic hominin dispersal patterns and hominin behavioural organization, which includes habitat, habitat preferences and provision of resources, across the whole landscape naturally depends on locating PS-Ss. The questions particularly associated with Palaeolithic habitat range and location include, for example: Where did these hunters-gathers go, in a specific area and why did they choose these areas? Other questions relating to the provision of resources across the whole landscape are: What resource (or resources) in any one place, was the focus of their choice? What were their concerns in making those choices? For example, what type of raw material did they generally use, in that area, to make stone-tools?

3.1.1. The Project Database

The particular techniques used to locate PS-Ss (prior to fieldwork) are determined by the geology and topography of the proposed area of research and aims of that specific project. The first stage in any PS-Ss investigation is the creation of the Project Database using a Geographic Information System (GIS), such as Mapinfo (www.mapinfo.co.uk) or Arcview (www.esri.com). This will initially consist of basic geo-referenced digital mapping of the specific area in question and its wider environs. If Palaeolithic evidence exists in the research area, these data are entered into the GIS Project Database to model the known distribution patterns of PS-Ss across the landscape. Other spatial data, such as historical mapping, is also added, as is geological, geomorphological and soil mapping data (Figure 2) which is needed to identify areas with a PP.

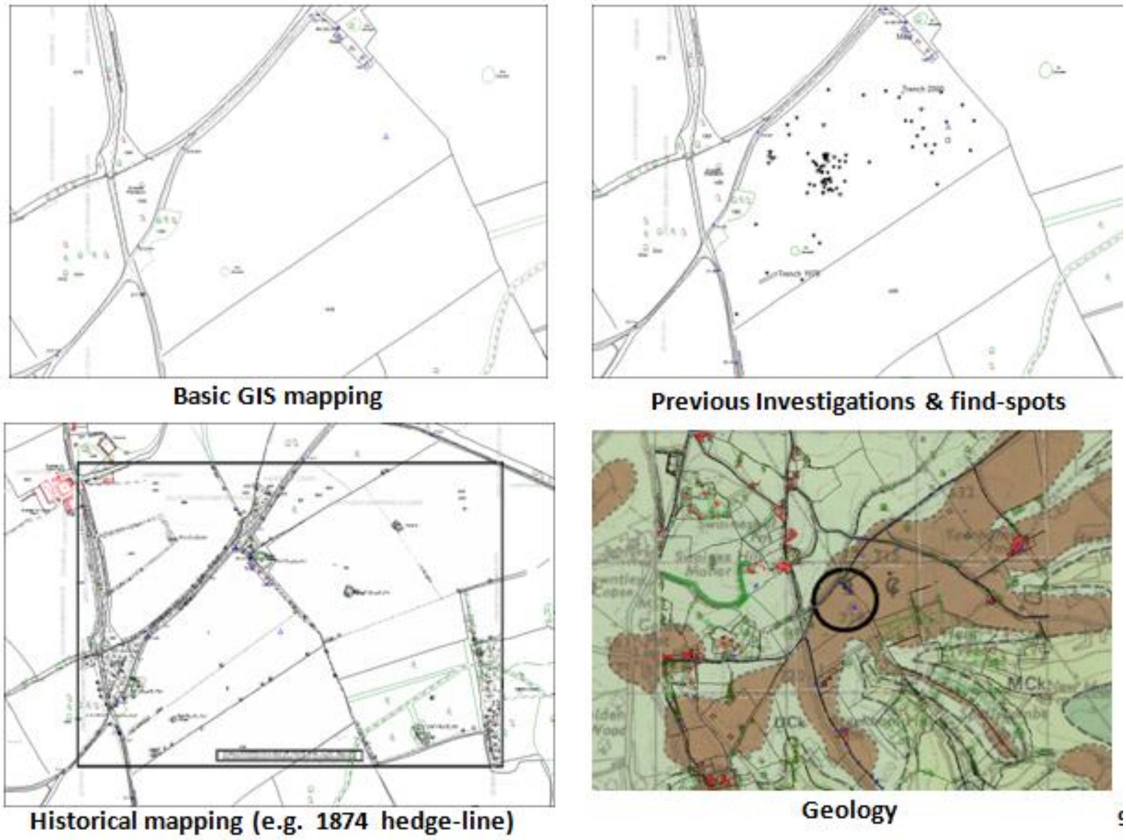

Figure 2: Layers from GIS based Project database for PADMAC Unit site of Dickett's Field, UK.

Data entered into the GIS Project Database can then be exported to a web-based remote sensing satellite mapping system such as Google Earth (Figure 3).


Figure 3: Google mapping (vertical and 3d) of PADMAC Unit site of Dickett's Field, UK showing geo-referenced satellite images and artefact locations

3.1.2. Remote Sensing Techniques

Remote sensing techniques access data from satellites, aircraft or other flight platforms. The analysis of these data is desk-based, as the information is available via computer systems and media, but should also, if at all possible, be confirmed through field investigation (‘ground-truthing’). The techniques cited here are not definitive nor indeed are the uses. Satellite mapping, including 3D visualization (Figure 4), is used for example, to explore both landscape features and surface geology to search for areas of PP, and to study relationships between known PS-Ss, in a variety of contexts, such as plateau edges, interfluves and drainage systems (e.g. river terraces and river valleys).

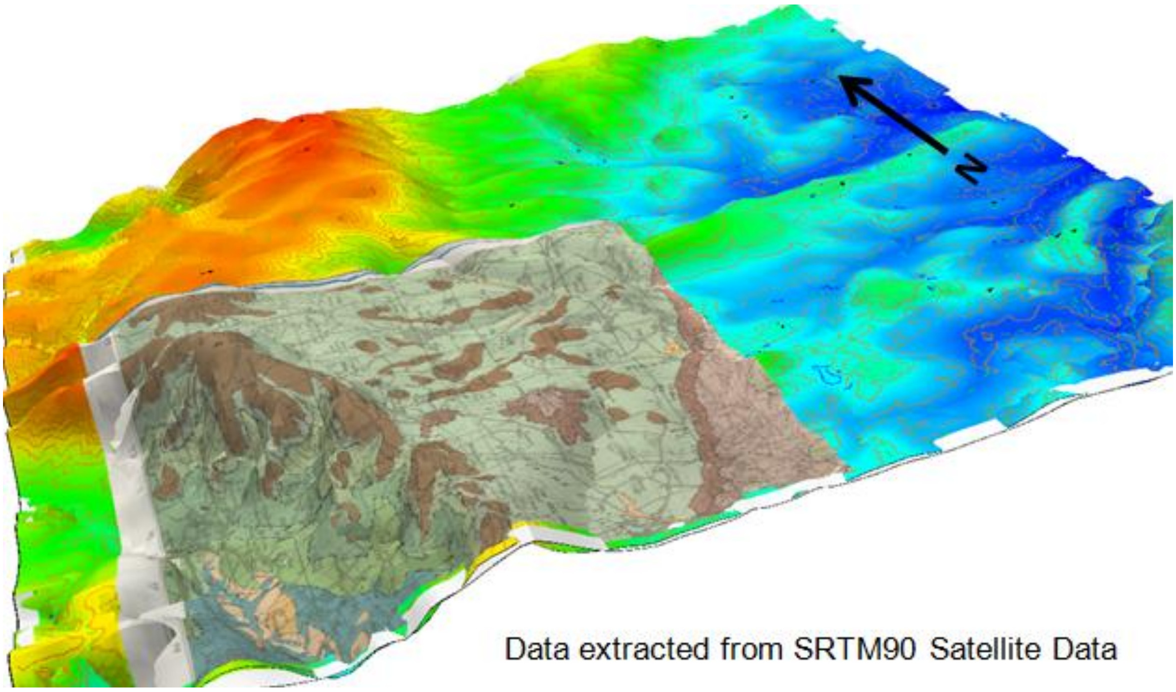

Figure 4: 3d visualization of the region of PADMAC Unit site of Dickett’s Field, UK showing landform and draped geology mapping.

With this remote sensing technique it is also possible to identify evidence of later archaeology, more recent structures and settlements, and routes for field investigations (e.g. Scott-Jackson JE & Scott-Jackson WB, 2010a). Digital Terrain Modeling (DTM), based on calculated heights (from e.g. SRTM90 satellite data) also helps indicate locations with a PP (Figure 5) , when combined with the geological and geomorphological data. For example, mountain ridges, edges of plateaux with views down into valleys overlooking possible animal migration routes, wadis and river systems.

DTM data also enables the modeling of slope profiles, cross-sections and relative distances which can be calculated in relation to provision of resources (e.g. raw materials and/or water).

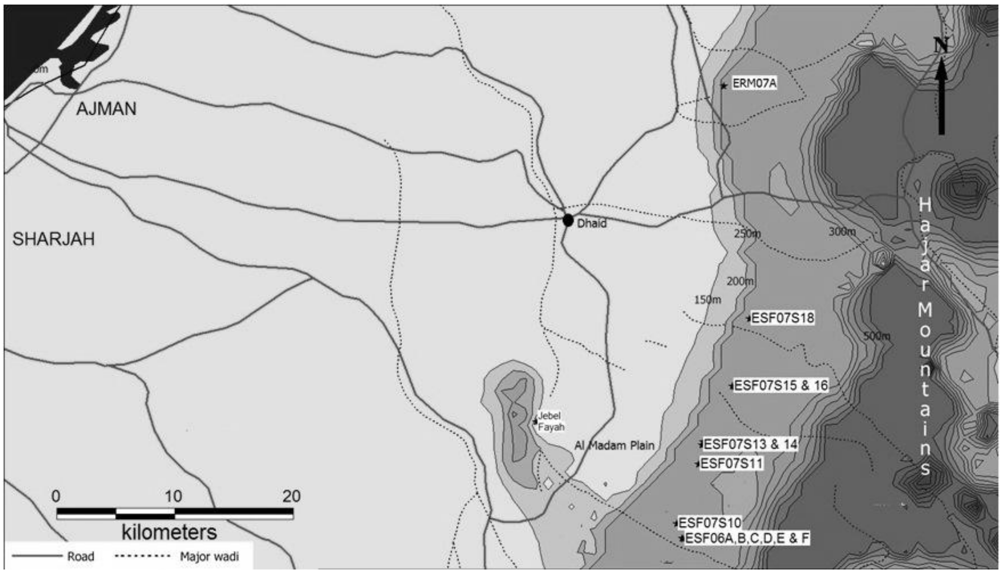

Figure 5: Digital Terrain Map showing PADAMC Unit sites in UAE (up to 2011).

In addition, aerial photography (Figure 6) may show areas of PP and, for example, the proximity to known PS-Ss and/or sites, later archaeology, access to these areas and anthropomorphic modification of landscape. More specialized methods include multi-spectral (e.g. IRS-P4 OCM) satellite imaging, which has a use in PS-Ss prospecting as it can identify, for example, non-visible diagnostic geological/geomorphological features such as palaeochannels beneath dune systems (Rajani and Rajawat, 2011), and remote sensing geophysical aerial techniques (e.g. magnetometry) which are also able to detect sub-surface features over wide areas (Lasaponara et al., 2011).

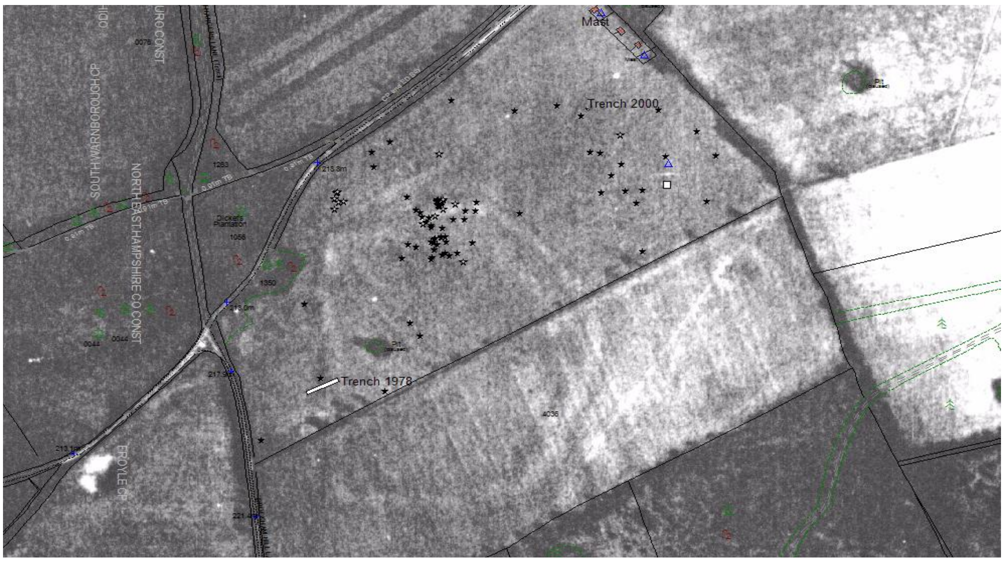

Figure 6: PADMAC Unit site of Dickett's Field, UK. Geo-referenced aerial photograph showing Iron Age Hill-fort in relation to locations of Palaeolithic surface finds.

3.2. Field-investigations: the aims, methodologies and techniques for locating and recording PS-Ss.

PS-Ss should be treated as integral components of the erosional/depositional surface-deposits on which they are found, as an artefact is no more than a natural clast (stone) until recognized as such. Detailed recording of the context in which PS-Ss are recovered, including the topographical, geological, geomorphological and sedimentological processes that have acted upon that specific area, is essential to establish the integrity of this valuable archaeological resource.

3.2.1. Palaeolithic Survey Grid

The desk-based geo-archaeological assessment data previously entered into the Mapinfo GIS Project Database is incorporated into a high-resolution GIS Palaeolithic Survey Grid (PSG) which uses coordinates that comply with (if at all possible) an existing grid system for that region or country. Each specific grid square in the PSG has a unique identifier which allows repeatable, testable fieldwork data sets to be produced. The use of this method facilitates the co-ordination of Palaeolithic field investigations, a comprehensive record of both the presence and absence of Palaeolithic evidence and the retention and access to all the information generated. Ideally, it would also lead to the development of a local and/or regional Palaeolithic Research Agenda to provide a geo-archaeological framework for identifying, recording, preserving and investigating Palaeolithic archaeology, such as the Palaeolithic Research Agenda for Qatar (Scott-Jackson JE & Scott-Jackson WB, 2010a).

3.2.2. On-site methodologies and techniques

Various categories of techniques are employed during fieldwork; those for locating and recording the presence or absence of PS-Ss and geophysical and sedimentological techniques to investigate the context and deposits associated with the scatters. Global Positioning System (GPS) is the essential tool in all field surveys. GPS tracking (Figure 7) and waypoints are used to record the presence and absence of Palaeolithic evidence across the landscape (Scott-Jackson JE & Scott-Jackson WB, 2010a).

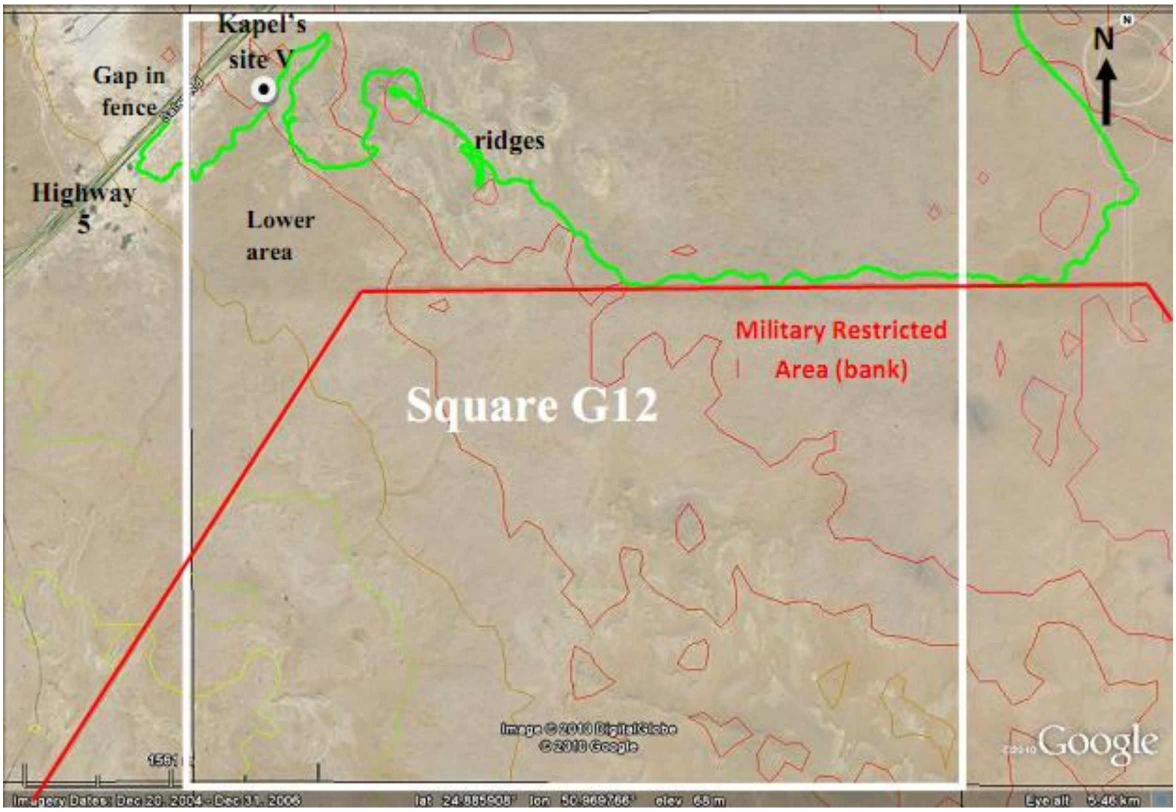

Figure 7: PADMAC Unit Field investigations in Qatar using GPS tracking (MotionX software)

High resolution differential GPS equipment (e.g. http://www.leica-geosystems.co.uk) can also be used within the area of the PS-Ss/site to record the extent of the archaeology and to provide details of the site terrain to produce off-site detailed DTM (Figure 8) to an appropriate level of accuracy for the specific project (Scott-Jackson et al., 2009).

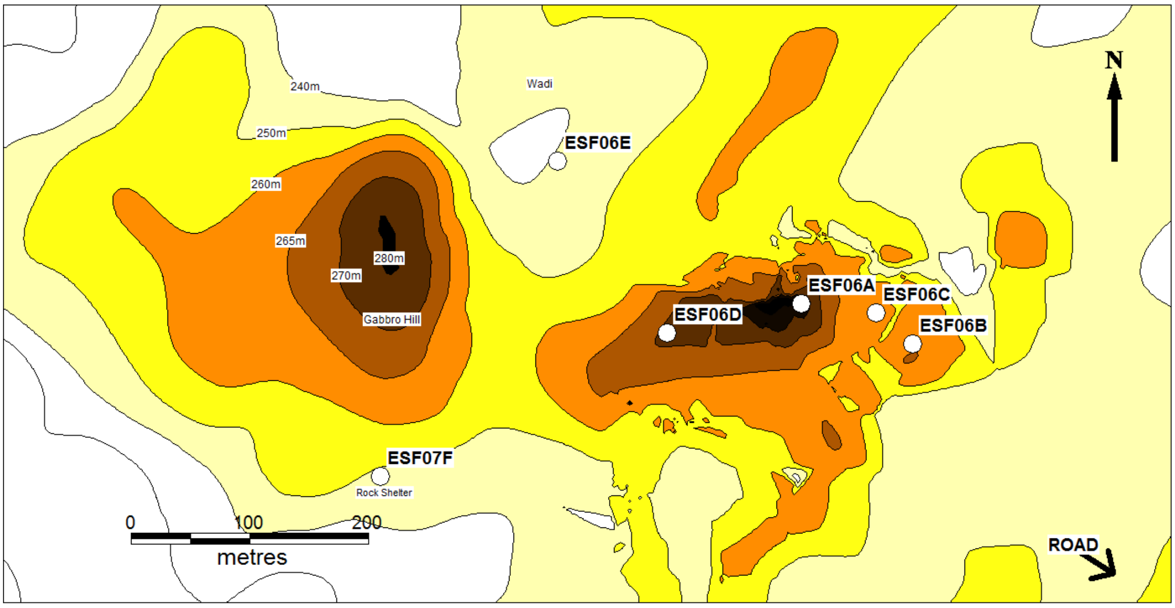

Figure 8; Detailed DTM of PADMAC Unit sites near Fili, Sharjah Emirate , UAE.

Where access to an area is difficult or restricted, the use of close range aerial photography by balloon, kite or powered platform (e.g. AR Drone quadricopter: www.ardrone.parrot.com/) is an option (Verhoeven et al., 2009) (Figure 9).

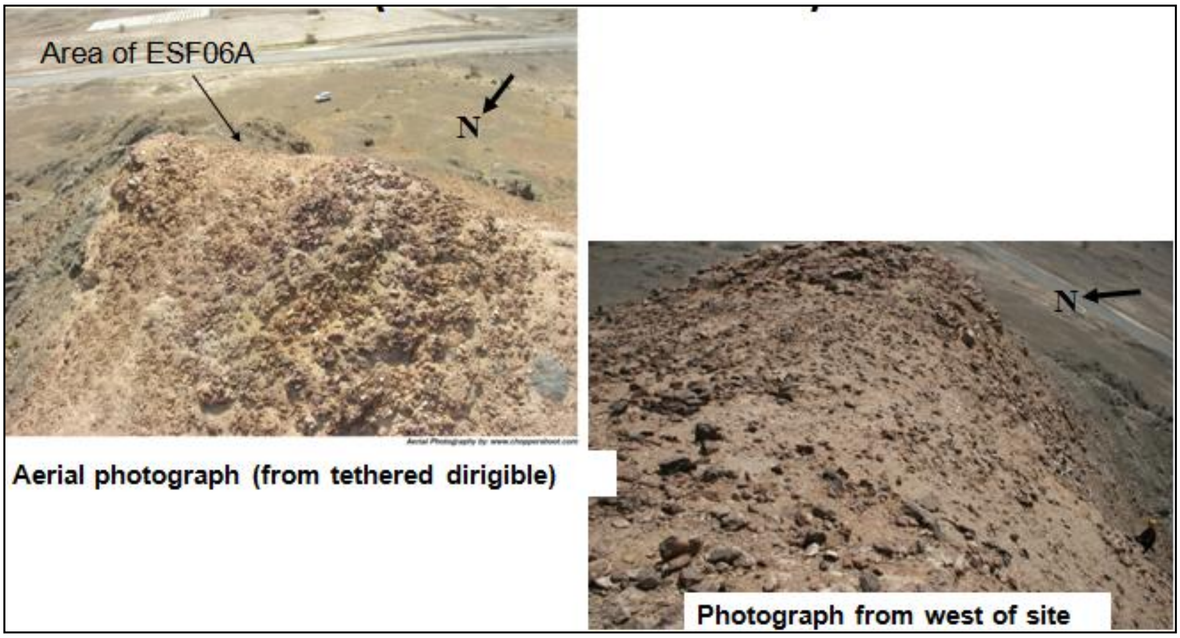

Figure 9: Close Range Aerial Photography using dirigible. PADMAC Unit Palaeolithic surface-scatter ESF06A (United Arab Emirates)

3.2.3. Determining the integrity of PS-Ss

Site-specific investigations are required to understand the particular context in which a PS-S is found. When analyzing desert landforms, for example, it is noteworthy that many features seen today may have been formed in earlier wetter climates. Surface weathering of the bedrock/deposits by fluvial and aeolian processes, which include erosion, transport and deposition of material by the wind, can effectively incorporate a PS-S into the deposits. Later, the same artefacts may be re-exposed by the erosional process of deflation, whereby fine-grained material is removed from an area by wind and water. To understand better the context in which a particular PS-S was found, an analysis of the associated deposits is necessary, as soils and sediments exhibit properties that can be used to understand the site formation processes (Marder et al., 2011).

3.2.4. Photogrammetry

One particular technique which has proved invaluable in determining the in-situ or otherwise status of a PS-S is photogrammetry (using, for example, i-witness (www.iwitnessphoto.com/). This relatively easy method of recording (even in difficult field situations) produces 3D models for orientation /slope process analyses of the PS-Ss (See Figure 10 for photogrammetry of the case study site ESF06A); the only proviso is that the artefacts should be easily visible. Otherwise, a high resolution differential GPS, a laser or total station survey is required (Scott-Jackson JE & Scott-Jackson WB, 2009; Lerma et al., 2010).

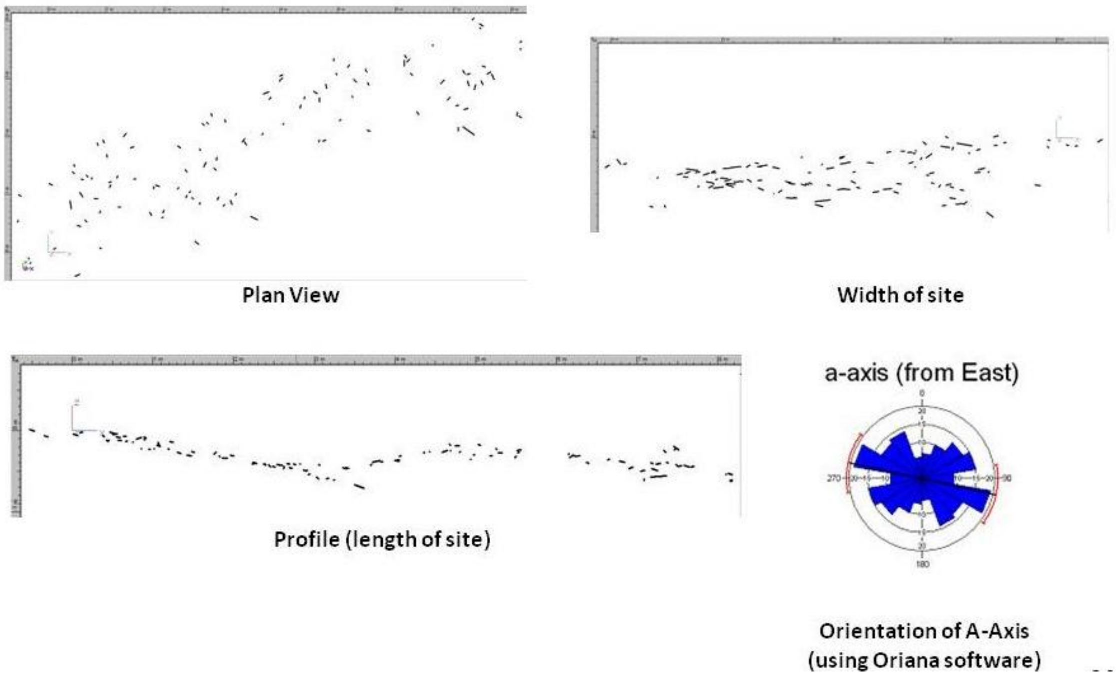

Figure 10: 3d diagram of photogrammetry analysis of artefact distribution at EFS06A, showing angles of dip, orientation and angle of a-axis.

3.2.5. Geophysical survey

The integrity of PS-Ss on high-level ridges and hilltops can be somewhat different to the scatters found at low-levels as in situ high-level scatters/sites are invariably retained in deposits held in depressions and fissures in the underlying rock (the same situation may in certain circumstances apply to low-level scatters). Retaining features such as those described are produced by geomorphological processes, both chemical and mechanical, operating on the sub-surface over geological time. A variety of ground-based non-intrusive geophysical survey techniques are available for the detection of sub-surface features (Gaffney, 2008), but success depends on selecting the appropriate method. Each method has both advantages and disadvantages depending on, for example the geology, geomorphology, topography, soil moisture content of the deposits, and the ultimate aim of the specific project (see Milsom, 2011). A Deep Resistivity Survey (Figure 11) using, for example, a Campus Tigre 128 System (Wenner Array) is the preferred means of geophysical exploration in non-arid karst environments where the need is to identify sub-surface dissolution features such as basin-like hollows, pipes and caves. The caveat to this method is that to be successful it requires a high soil moisture content (Scott-Jackson JE & Scott-Jackson WB, 2010b).

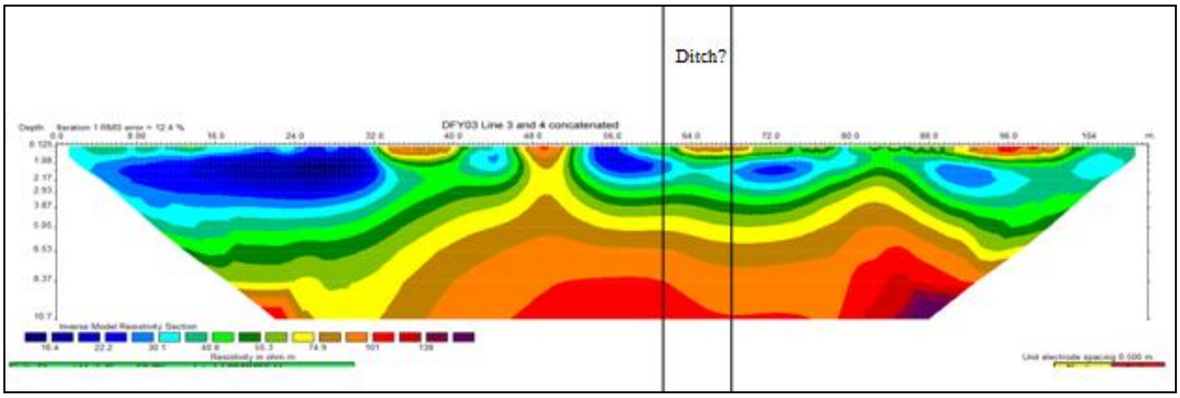

Figure 11: Resistivity Survey diagram of sub-surface. PADMAC Unit site at Dickett's Field, UK.

Ground Penetrating Radar (GPR) can also identify sub-surface voids or differentiated deposits but the effectiveness of this technique is hindered by clay and moist rich soils (Gómez-Ortiz, 2010). Two other geophysical techniques (Figure 12) that have application are: magnetometry to locate sub-surface features such as evidence of previous ditches or banks which during their construction could have been implicated in exposure or movement of PS-Ss/sites (Milsom, 2011) and magnetic susceptibility to reveal areas of differential usage across a landscape and identify land uses that may have disturbed Palaeolithic archaeology (see http://www.archaeotechnics.co.uk/mag.html).

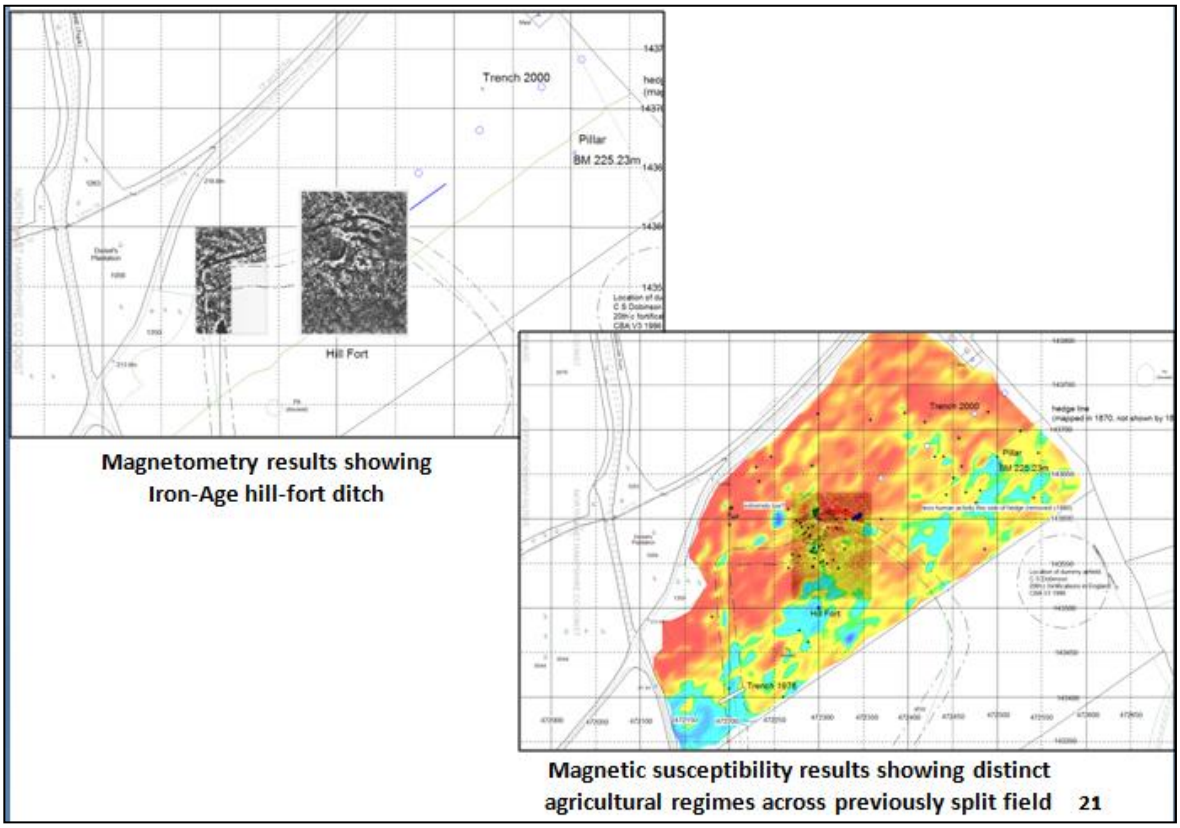

Figure 12: Geophysical Investigations of Palaeolithic Surface-Scatters (DFY03 UK).

3.3. Off-site analyses: the aims, methodologies and techniques for analyzing PS-Ss.

The rapid and on-going development of computer-based techniques and new methodologies is both advancing the research of geo-archaeology in general, and giving a new dimension to the study of PS-Ss in particular. However, inherent in this progress are accelerated opportunities for the misinterpretation of these collected data and of data distortions. The need for careful attention to scale and accuracy is paramount (Goodchild, 2011). For example, DTM data produced to an accuracy of 10 metres cannot be used for analyses requiring an accuracy of 1 metre. Information derived from the desk-based assessment and the field investigations forms the basis for the off-site analyses which is focused on the inter-scatter relationships; the intra-scatter relationships and the techno-typological analysis of the Palaeolithic artefacts. The results of the off-site analyses are subsequently entered into the Project Database.

3.3.1. Inter-scatter Analyses

The off-site analysis begins by accessing the landscape scale DTM from the GIS Project Database. This is used to analyse the inter-scatter relationships (that is relationships between the recorded PS-Ss and/or sites) and to further identify locations with PP; i.e. the integrity of a specific PS-S and the identification of other PS-Ss and areas that have Palaeolithic in-situ potential and may warrant detailed excavation (Figure 13).

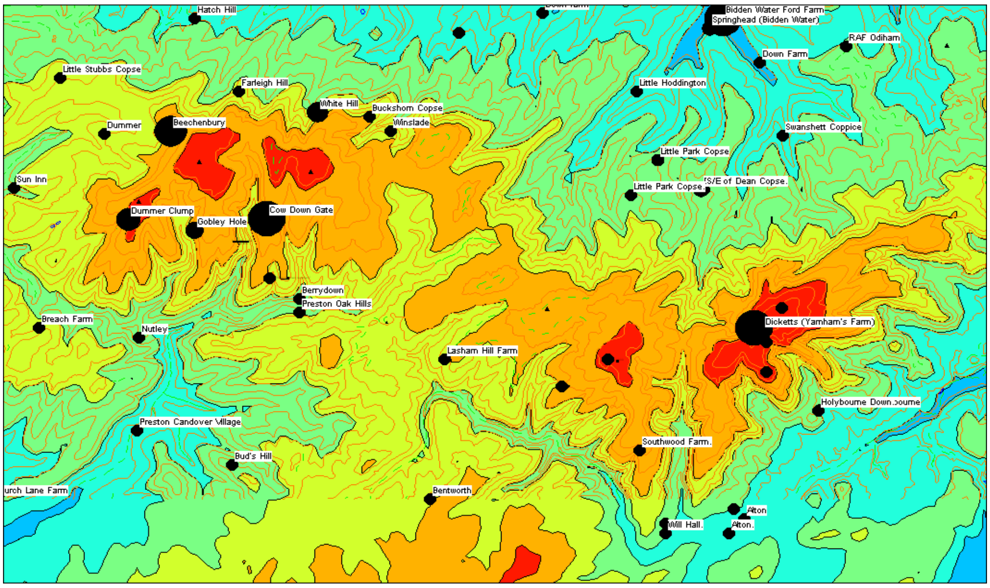

Figure 13: Inter-Scatter analysis of relationships between Palaeolithic surface-scatters in the locality of DFY03 UK

Included in this analysis of inter-scatter relationships is evidence of geomorphological processes of erosion and deposition in the area and the results from detailed analyses of the soil and/or sediment samples. Other applications for the DTM data are the techniques of viewshed and proximity analysis (Alexakis et al., 2011), which from a specified point in the landscape can be used to compare locations and explore location criteria (e.g. the position of knapping scatters relative to views over game routes; views of associated scatter locations; and proximity to raw material and water). The credibility of the resultant data is governed by both the need for a conservative interpretation and the appropriateness of the available data which should take into account changes to the topography over geological time. Other data held within the GIS Project Database, such as historical mapping, is also accessed to identify post-Palaeolithic anthropomorphic modification of the landscape (e.g. later prehistoric structures and changes in agricultural practices in more recent history). For the case study sites, viewshed analysis was utilised, with caution, to explore possible location criteria and historical mapping was used to identify land use changes (in recent history)

3.3.2. Intra-scatter Analyses

For the intra-scatter analyses (i.e. the relationship of the artefacts, one to another, within the PS-S and also that of a scatter within individual spits in an excavated site) a three-dimensional model of the artefacts and clasts, their orientations and patterns of distribution is produced using photogrammetry (employing i-witness software, for example) or data derived from a laser scan or total station survey (Lerma et al., 2010). The resulting orientation of both the natural clasts and the artefacts can now be statistically analysed using software such as Oriana (http://www.kovcomp.co.uk/), which calculates means, variances and other statistical relationships from circular data (Figure 10) such as direction in degrees (where, for example the values of 0 and 360 are identical). These data are then used to identify the geomorphological processes, ranging from soil-creep to mass flow, which have operated in the immediate area of the scatter, in order to determine the integrity of the PS-S (i.e. in situ or dervived). Photogrammetry can also be used to create ortho-rectified composite artefact distribution photographs showing accurate spatial layouts of a complete scatter, the artefacts and other features (Ayoub et al., 2009).

3.4. Off-site techno-typological artefact analysis

The off-site techno-typological analysis of the Palaeolithic artefacts (including debitage) is in two linked parts; the first is the intra-scatter/site analysis and the second, the inter-scatter/site analysis.

3.4.1. Intra-scatter/site: techno-typological analysis of the Palaeolithic artefacts.

The intra-scatter (and/or site) techno-typological analysis begins by compiling a list of attributes (i.e. the observable characteristics) of each artefact (Andrefsky, 2005; Hovers, 2009). For each attribute there are a number of possible variables associated with the observed characteristics. Every artefact is defined by the assigned attributes from the list. Typically, any attribute of an individual artefact is assigned a single attribute status. An individual artefact can then be described by the relationship among its attributes or by technological, typological and stylistic attributes. In addition to the role of determining shared attribution within the assemblage, an intra-site/scatter comparison may isolate any significant techno-typological differences within the assemblage which might suggest that it is a palimpsest. The presence of refitting artefacts in a PS-S assemblage may be indicative of the integrity of that assemblage. Where refits occur it may be possible to construct a reduction sequence.

3.4.2. Inter-scatter/site: techno-typological analysis of the Palaeolithic artefacts.

The inter-site/scatter techno-typological comparison of the PS-S assemblages and (dated sites) is made using data derived from the intra-site/scatter techno-typological analysis. Comparing and contrasting the techno-typology of individual PS-S assemblages (in a specific area) can produce data that has the potential to reveal the location choices of Palaeolithic hunter-gathers across the wider landscape (Figure 14).

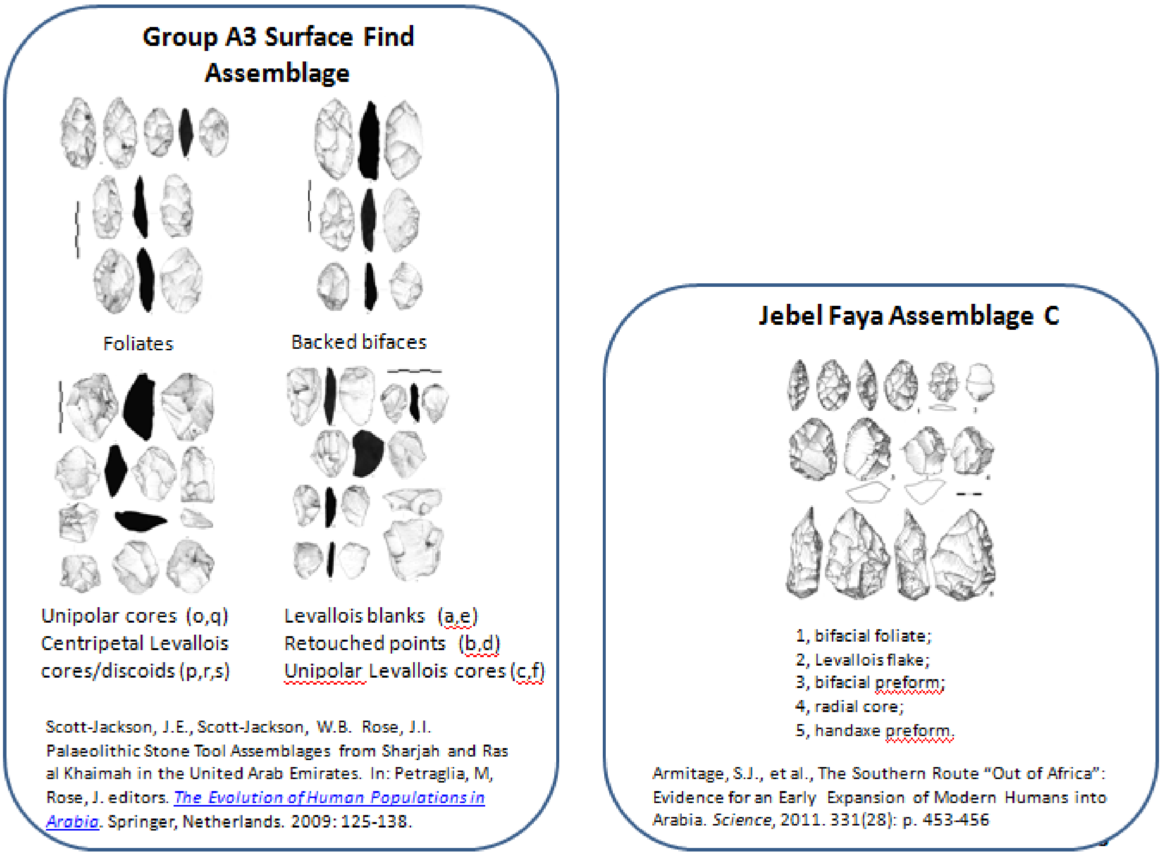

Figure 14: Inter-site techno-typological analysis of Palaeolithic surface-scatters ESF06/7 (United Arab Emirates) (Scott-Jackson, et al., 2009) and the excavated assemblage at Jebel Faya (United Arab Emirates) (Armitage, et al., 2011)

This may be achieved with particular reference to the topography of the studied area; the proximity of the PS-Ss to previously identified sources of knappable raw material (e.g. chert, flint); sources of water (e.g. wadi systems) (Raczek, in press) and, as far as the data allows (see Sections 3.1.2.and 3.3.1.), possible game routes (e.g. where viewshed analysis has allowed a tentative suggestion of migration routes of prey species (Scott-Jackson JE & Scott-Jackson WB, 2008) or more frequent tracks to feeding grounds or water sources). Where high resolution data is generated it may be feasible, with due caution, to extrapolate from these findings suggested hominin dispersal patterns (e.g. distribution patterns of artefact types, which may suggest the types of activities being carried out). For example, a comprehensive study of PS-Ss has added significantly to the general understanding of Palaeolithic hominin dispersal patterns within the Arabian Peninsula.

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FIGURES

Figure 1: Google Map of Arabian Peninsula showing main areas of PADMAC Unit investigations.

Figure 2: Digital Terrain Map showing Palaeolithic surface-scatters/sites investigated by the PADMAC Unit in Sharjah and Ras Al Khaimah Emirates (UAE).

Figure 3: Google map showing Palaeolithic assemblages discussed in the techno-typological case study (Section 4.).

Figure 4: Photogrammetry results from ESF06A showing spatial distribution and orientations of artefacts.

Figure 5: Group A1 representative artefacts.

Figure 6: Group A2 representative artefacts.

Figure 7: Group A3 representative artefacts – large biface and centripetal Levallois core.

Figure 8: Group B1 representative artefacts.

Table 1: Techno-typological Indicators, after Scott-Jackson et al., 2009.