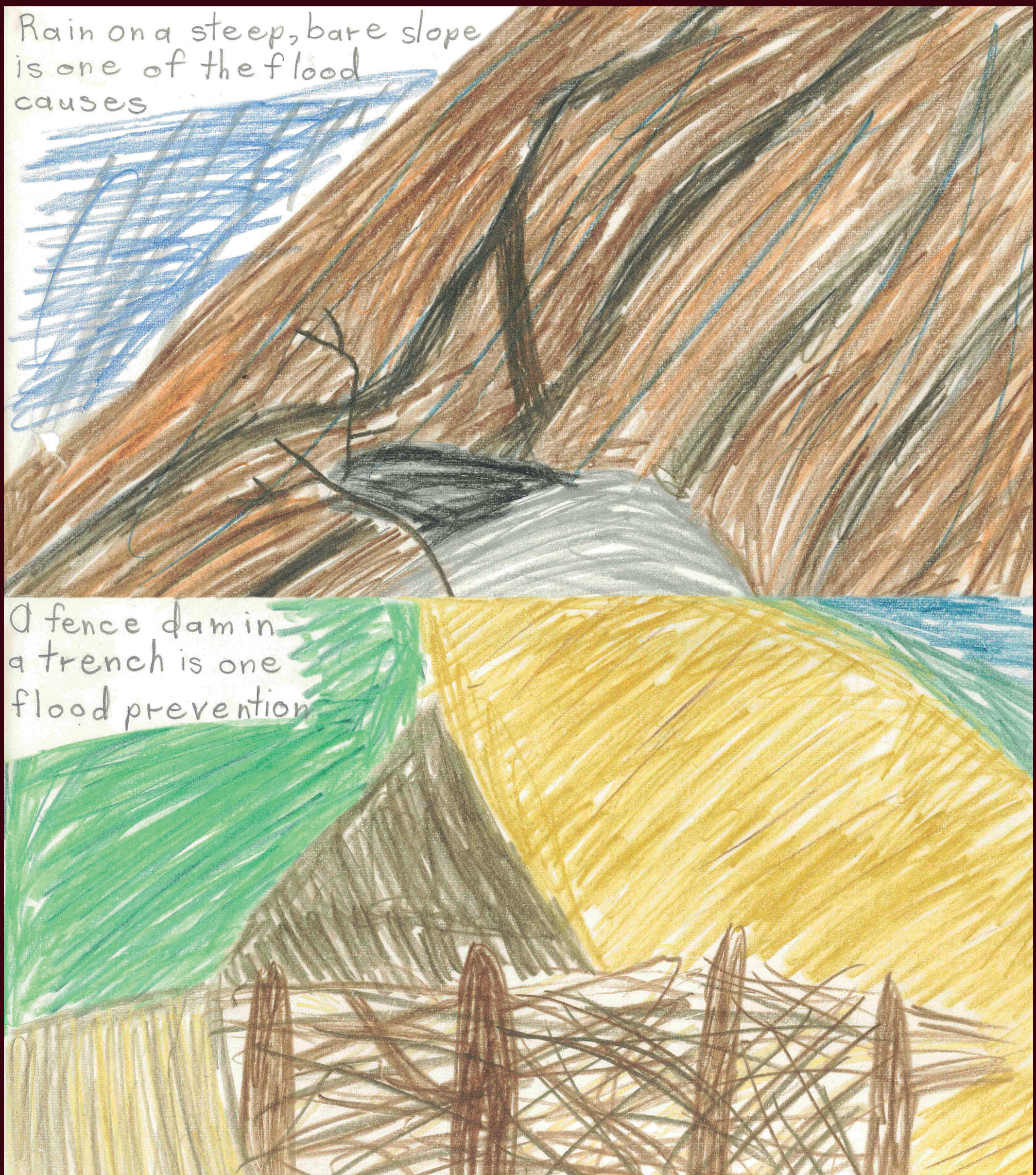
McDONALD INSTITUTE CONVERSATIONS

Inspired geoarchaeologies: past landscapes and social change

Essays in honour of Professor Charles A. I. French

Edited by Federica Sulas, Helen Lewis & Manuel Arroyo-Kalin



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with contributions from
Michael J. Allen, Andrea L. Balbo, Martin Bell, Nicole Boivin, Christopher Evans, David Friesem, Kasia Gdaniec, Lars Erik Gjerpe, Michael Gill, Martin Green, Ann-Maria Hart, Robyn Inglis, Martin Jones, Gabriella Kovács, Helen Lewis, Johan Linderholm, Roy Loveday, Richard I. Macphail, Caroline Malone, Wendy Matthews, Cristiano Nicosia, Bongumenzi Nxumalo, Innocent Pikirayi, Tonko Rajkovaca, Rob Scaife, Simon Stoddart, Fraser Stuart, Federica Sulas & Magdolna Vicze

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On the cover: *Hand drawn illustration by Charly French, aged around 10 years old. Courtesy of Kasia Gdaniec.*

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Mike's (BSc, PhD, MCIfA, FLS, FSA) research and geoarchaeological interest was originally based around the analysis of colluvium and land snails, including in the South Downs, Dorchester, Cranborne Chase, Stonehenge and Avebury in particular; these were the subject of both his undergraduate and PhD research. He has combined a career dominated by commercial archaeology with involvement in university research projects and as a staff lecturer at Sussex, Bournemouth and Oxford Universities. He was Environmental Manager at Wessex Archaeology for twenty years and for fifteen years has run his own geoarchaeological consultancy from a purpose-built bespoke lab, where he is involved in research designs and coordination of environmental archaeology from fieldwork to publication. Projects have been as diverse as intertidal zone research and Maltese prehistoric temples. His interests now lie principally in landscape archaeology and the development and creation of landscapes through prehistoric human intervention. He has worked with – and still is working with – Charly French in Cranborne Chase, the Stonehenge Riverside Project, and both recent Avebury landscape projects. He is vice-president of the Conchological Society, and as founding editor of the Prehistoric Society Research Papers has seen ten peer-reviewed volumes through to publication.

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Christopher was the executive director/director of research of the Cambridge Archaeological Unit (CAU), University of Cambridge until 2021. Having worked in British archaeology for over forty years – with his initiation to Fenland archaeology coming at Fengate – following on from the Haddenham Project, he co-founded the CAU with Ian Hodder in 1990. He has directed a wide variety of major fieldwork projects, both abroad – Nepal, China and Cape Verde (the latter sometimes involving Charly) – and in the United Kingdom. A fellow of the Society of Antiquaries of London, in 2018 he was elected a fellow of the British Academy. He has published widely, including monographs arising from both his own landscape projects and those of earlier-era practitioners in the CAU's 'Historiography and Fieldwork' series (e.g. Mucking in 2016). Together with Tim Murray, he edited Oxford University's *Histories of Archaeology: A Reader in the History of Archaeology* (2008).

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Martin began a fieldwalking survey as a lad on Cranborne Chase in the latter 1960s. Following experience gained on a number of field projects, he began excavating independently in the region in 1976. He joined Richard Bradley's and John Barrett's Cranborne Chase Project the following year, contributing four site excavations to *Landscape, Monuments and Society* in 1991. He continued independent fieldwork in the early 1990s in collaboration with Mike Allen, in particular on the Fir Tree Field shaft which revealed a remarkable sequence of deposits dating from the late Mesolithic to the Beaker period, and worked with Charly French on the Upper Allen Valley Project 1998–2003, contributing four further site excavations to *Prehistoric Landscape Development and Human Impact in the Upper Allen Valley, Cranborne Chase, Dorset* (2007). Since that time, he has continued independent research, also in collaboration with Josh Pollard and Southampton University, on the Dorset Cursus, on Down Farm and in the Knowlton environs whilst continuing to increase the biodiversity on his small farm. He was made an FSA (Fellow of the Society of Antiquaries) in 2004 and received an honorary Doctor of Science degree from Reading University in 2006.

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Richard trained in geology and geography, specializing in soil science (BSc Swansea University). An MSc in pedology and soil survey (Reading University) prepared him for a soil science PhD on podzol development on heathlands (Kingston Polytechnic). An English Heritage-funded archaeological soil contract at the Institute of Archaeology (University College London) provided further training and international research opportunities were developed, including working with the Soil Survey of England and Wales and Macaulay Institute, UK, the CNRS, France, and the Soprintendenza, Italy. This led to the publication of *Soils and Micromorphology in Archaeology* (with Courty and Goldberg; Cambridge University Press 1989), the founding of the International Archaeological Soil Micromorphology Working Group, and training weeks at UCL. As a result, *Practical and Theoretical Geoarchaeology* (Blackwell 2006; Wiley 2022) and *Applied Soils and Micromorphology in Archaeology* (Cambridge University Press 2018), both with Goldberg, were written. Macphail is a recipient of the Geological Society of America's Rip Rapp Award for Archaeological Geology (2009), and is a fellow of the Geological Society of America. He is also the 2021 co-awardee (with P. Goldberg) of the International Union of Soil Sciences Tenth Kubiëna Medal for Soil Micromorphology. The paper included here also reflects more than two decades of research across Scandinavia.

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Francis has studied the archaeology of the Fens since 1971. His major excavations in the region took place near Peterborough at Fengate, Maxey and Etton. In 1982 his team's survey of fenland drainage dykes revealed the timbers of a waterlogged Bronze Age timber platform and causeway at Flag Fen, which was opened to the public in 1989. He was a member of Channel 4's long-running series *Time Team*. He has written many popular books including *Seahenge* (2001), *Britain BC* (2003), *Britain AD* (2004), *The Making of the British Landscape* (2010), *Home* (2014), *Stonehenge* (2016) and *The Fens* (2019). His most recent book is *Scenes from Prehistoric Life* (Head of Zeus 2021).

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Simon and Caroline have been engaged in the research of ancient landscapes for nearly forty years, with a

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Figures

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Chapter 2

Why do we see what we see where we see it? Geomorphological controls on archaeological narratives across space and time

Robyn H. Inglis

Geoarchaeology is fundamental to the creation of the past as the archaeological record that we observe, and by extension our interpretations based upon it, are shaped by geomorphological processes. The impact of these processes on the record is not a filter that can be easily removed before the record can be interpreted; temporal and spatial variability in sedimentation and erosion must be built into the way we excavate and record the record and form the questions we ask of it. These issues are, in common with the archaeological record, inherently multi-scale, and must be central to any archaeological investigation. This paper explores these issues through two case studies that examine the Palaeolithic of the Saharo-Arabian belt from different perspectives. The first is in the examination of the surface Palaeolithic record of the eastern Red Sea, where survey for new Palaeolithic material has grappled with issues of locating and interpreting artefact distributions in a dynamic landscape. The second is from the Haua Fteah cave, Libya, where changing modes of sedimentation and hiatuses have been identified in one of the key chronological sequences for North African prehistory. Whilst operating at different scales, these case studies underline the need for embedding geoarchaeological approaches within methodology as well as interpretation and highlight potential issues with the ways in which we build broad-scale narratives of human dispersals.

As part of the second-year undergraduate archaeology syllabus at Cambridge in the early 2000s, students were asked to 'design a programme of archaeological survey for a Mediterranean valley.' Coming as it did in the first year of specialism for archaeologists on the Archaeology and Anthropology Tripos, the task seemed somewhat overwhelming – where would you even begin to look for new sites in a whole valley? Yet the essay served as a doorway to understanding the fundamental role of geomorphology and geoarchaeology in the formation of the archaeological record, and, when accompanied by Charly French's lectures on landscape archaeology and a copy of *Geoarchaeology in Action* (French 2003), relatively straightforward to answer. To understand where archaeology was preserved in the landscape, one would start by understanding and mapping the geomorphological processes operating within it, combining Dalrymple's classic nine-unit land surface model (Dalrymple *et al.* 1968) with other sources of geomorphological information, such as remote sensing, aerial photography, and systematic augering to build up a framework of depositional units within the valley and assess their ability to preserve archaeology, both buried and exposed on the surface (French 2003, 30–2). This framework would then be used to target archaeological investigations through test pitting and wider excavation in areas where archaeology (and/or palaeoenvironmental archives and dateable material) was most likely preserved. It was a simple but effective way of demonstrating the fundamental role of geomorphology in the preservation of the archaeological record, and the ways in which, by understanding geomorphological processes, archaeologists could more effectively target their efforts in locating preserved archaeology.

Understanding the geomorphological controls on the archaeological record, however, goes beyond guiding survey strategy. At its most fundamental, the essay question asked, 'where do we see archaeology, and why?' and with it the counter query 'where do we not see archaeology, and why not?'. These questions underpin the interpretation of past human activity and intent based on the observed archaeological record. Geomorphological processes act as a powerful driver of artefact preservation, exposure, and visibility in landscapes and within sites, acting at the continental or sub-metre scale, and in so doing they shaped and continue to shape the archaeological records that we see, observe and interpret today (Butzer 1971; Ebert 1992; Fanning & Holdaway 2004). To understand why artefacts are and are not seen within a landscape or site, we must understand the geoarchaeological framework within which we observe them, and incorporate this into our interpretations, or else we risk building grand behavioural narratives ultimately based on geomorphological, rather than human action (Schiffer 1987).

The Saharo-Arabian desert belt that stretches from western Africa to southern Asia is a crucial region in human dispersals, lying as it does between Africa, Europe and Asia (Foley & Lahr 1997; Garcea 2012; 2016; Groucutt & Petraglia 2012). Now predominantly arid, this vast area has undergone massive changes in environment driven by glacial cycles, changes that would have created greater opportunities for human expansion inland during humid periods, particularly during the first expansions of *Homo sapiens* carrying Middle Palaeolithic (MP)/Middle Stone Age (MSA) technology during MIS5 (130–75,000 kya). These changes would have also restricted and isolated populations with the onset of arid conditions across large swathes of the belt (Drake *et al*. 2011; 2013; Jennings *et al*. 2015; Groucutt *et al*. 2015a). The desert belt contains an extensive surface artefact record accessible to survey which, although it may lack chronological resolution, offers the potential to understand the use of and dispersal through the region's landscapes. Stratified sites, though comparatively rare, can act as temporal cornerstones to this spatial record, affording chronological control to changes in lithic technology, as well as direct links with palaeoenvironmental data contained within their sediments. Information from both of these types of record can therefore be combined to build an understanding of the timing and conditions of modern human dispersals in the region.

The temporal and spatial records on which these narratives are built are not direct facsimiles of human activity, however, but the product of intersecting factors that control the preservation, exposure and visibility of artefacts to observation and recording, of which a primary factor is geomorphology (Fanning & Holdaway 2004; Fanning *et al*. 2007). Geomorphological frameworks must not only be used to locate archaeological material, but also to test the patterning in the archaeological record against the null hypothesis that the variability we see is the product of these processes rather than human activity. This paper explores the role of geomorphological processes in archaeological interpretation at two very different scales and settings in the Saharo-Arabian belt: the Palaeolithic surface record of coastal southwestern Saudi Arabia, and the sedimentation processes observed within the Haua Fteah cave, Libya, during the Middle to Later Stone Ages. Investigation and interpretation of these two very different records, one primarily spatial and focussed on artefacts, and the other temporal and focussed on the sedimentary signatures of environmental change, must engage with the same fundamental questions tackled by that undergraduate essay – why do we see what we see where we see it, and why do we not where we don't?

Shaping the surface record

Surface artefact records, whilst broadly lacking chronological resolution, provide the opportunity to examine spatial patterning of artefact deposition from the metre to global scale, something impossible through excavation. By mapping the distribution of artefacts within a landscape, and what landscape features and environments they are associated with, the surface record has been used to interpret whether particular landscapes or environments were attractive or not to past populations, interpretations that underpin narratives of human dispersals and occupations within a region (e.g. Boivin *et al*. 2013; Drake *et al*. 2013; Breeze *et al*. 2016). The observed distribution of artefacts across a landscape at any scale, however, is not an anthropogenic snapshot of past activity; the patterning of surface artefacts we observe and record today is the result of a dynamic evolution of this record, from artefact manufacture to the present day, an evolution in which geomorphological processes play a pivotal role (Holdaway & Fanning 2008; Knight & Zerboni 2018). Understanding the geomorphological framework within which artefacts are (and are not) preserved, visible and exposed to archaeological survey, recording, and interpretation at multiple scales from the site to the continental scale, is therefore central to understanding human dispersals.

The Arabian Peninsula lies at the crossroads of human dispersals from Africa to Asia and Europe, and research over the past decade has furthered our understanding of the chronology and character of its rich archaeological record (e.g. Petraglia 2003; Petraglia & Alsharekh 2003; Armitage *et al*. 2011; Rose *et al*. 2011; Delagnes *et al*. 2012; Groucutt *et al*. 2015b; 2018). The now-desert interior of the peninsula preserves an abundance of lithic artefacts associated with MIS5 palaeolake deposits, as well as a *Homo sapiens* finger bone (Groucutt *et al*. 2018) and footprints (Stewart *et al*. 2020), further underlining the role of 'greened' deserts in facilitating human dispersals carrying MP/MSA technologies during humid interglacials. Yet whilst the interior of the peninsula was de- and repopulated with these climatic shifts, capture of rainfall by the escarpment mountains along the western and southern edges may have allowed the region to act as a refuge during arid periods (Jennings *et al*. 2015),

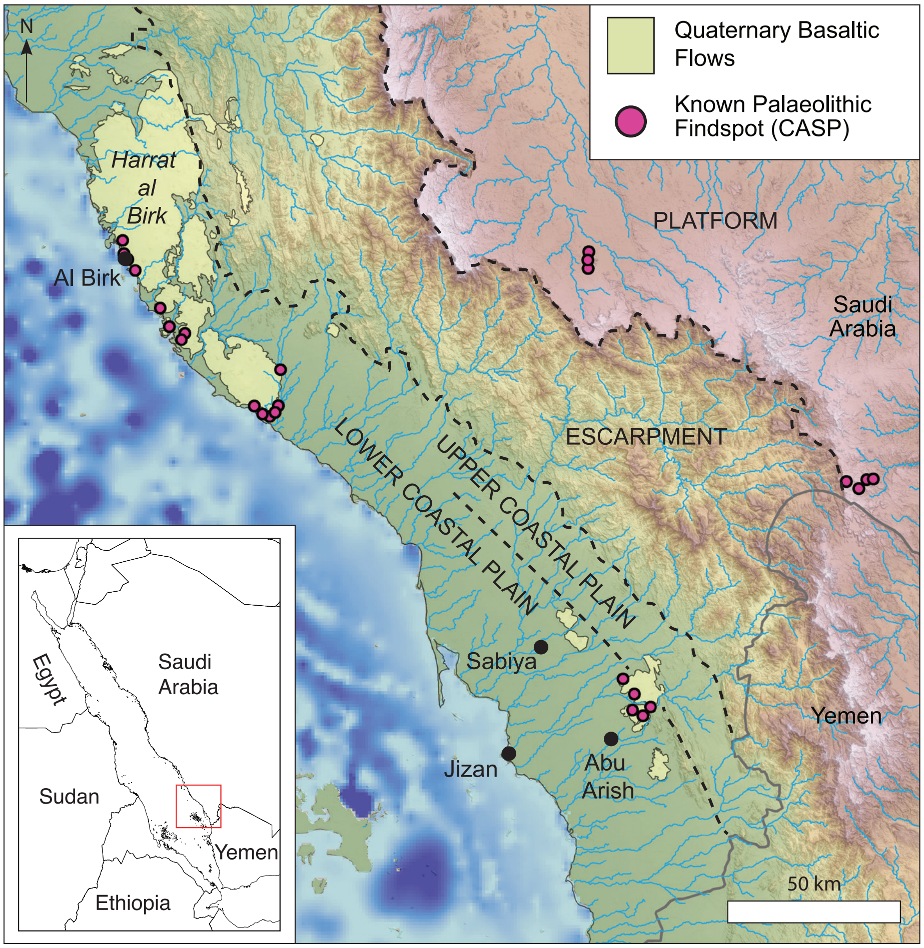

Figure 2.1. *Map of the DISPERSE study area in Jizan and Asir Provinces, southwestern Saudi Arabia. Major landscape zones defined following Devès* et al. *(2013), and previously known findspots of Palaeolithic artefacts from the CASP survey of the southwestern province (Zarins* et al. *1981). Elevation data © CGIAR-CSI SRTM 90 m v4.1 database (Jarvis* et al. *2008); bathymetric data from GEBCO_08 One Minute Grid (Jakobsson* et al. *2008). Image: Robyn Inglis.*

a hypothesis supported by the dating of an MP site in Yemen to 55 kya BP (Delagnes *et al*. 2012). Added to this, these regions would have afforded access to coastal resources and environments, thus providing in periods of regional aridity a further environmental buffer, and in periods of humidity another attractive resource base for exploitation (Bailey *et al*. 2007; Erlandson & Braje 2015).

The DISPERSE and later SURFACE projects (2011–18) set out to examine landscape use by dispersing *Homo sapiens* populations in the Red Sea coastal region of southwestern Saudi Arabia, by locating new Palaeolithic artefacts in the region and analysing them in their landscape context. Were particular combinations of landscape features, e.g. access to raw material, water and coastal resources, attractive to human populations and what role did this play (Bailey *et al*. 2012; 2015)? With only a handful of known findspots with Palaeolithic artefacts within the region at the start of the project (Fig. 2.1; Zarins *et al*. 1980; 1981), locating this new material within time-limited field seasons necessitated an explicitly geoarchaeological approach to survey in order to focus energies on the geomorphological settings that were more likely to yield MSA artefacts. The critical question was where would MSA artefacts be preserved, exposed and visible to archaeological survey in the region, and where would they not?

By combining remote-sensing data and satellite imagery, a high-level geomorphological model of the study region was developed that classified the landscape into broad zones whose characteristics could be assessed for the presence of surfaces of Palaeolithic age (Devès *et al*. 2013; Inglis *et al*. 2014; Sinclair *et al*. 2018). The escarpment mountains were heavily incised by the wadis that drained them, leaving little prospect for the preservation of such surfaces within this landscape zone. The material eroded from these mountains throughout the Quaternary and Holocene had been deposited on the flat, largely featureless lower coastal plain as alluvial fans and floodplain deposits mixed with aeolian sediments, likely preserving surfaces of Palaeolithic age by burying them under metres of sedimentation, but in doing so making them all but inaccessible to survey – this was confirmed by the observation of rare, isolated MSA flakes in quarry cuts

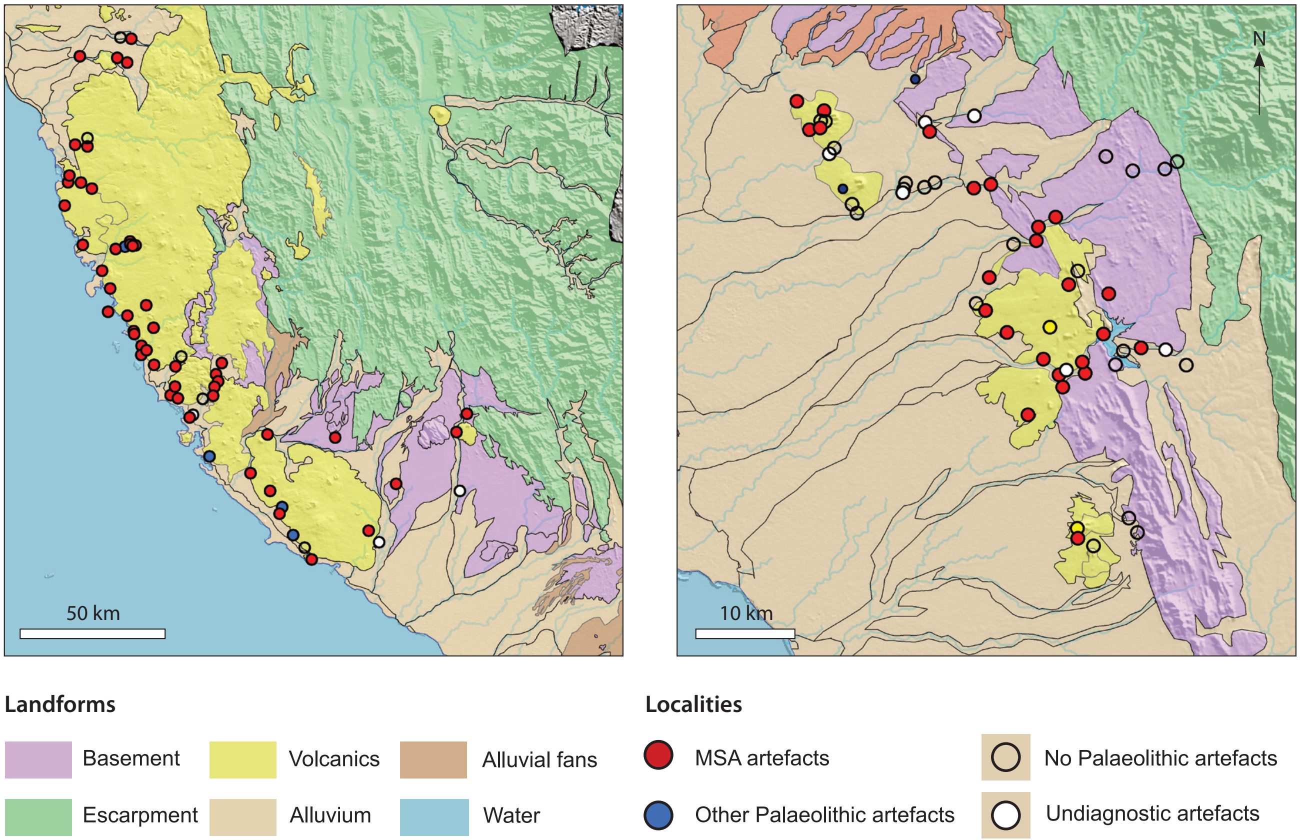

Figure 2.2. *Localities surveyed and artefacts observed between 2012 and 2017. Elevation data © CGIAR-CSI SRTM 90 m v4.1 database (Jarvis* et al. *2008). Image: Robyn Inglis.*

that provided glimpses into these buried landscapes (Bailey *et al*. 2015). Areas of basement rock in the upper coastal plain area (at the foot of the escarpment mountains) that were not covered by alluvial fans potentially represented surfaces of MSA age, but also encompassed a wide range of rock types with varying susceptibility to erosion, e.g. easily weathered schist versus more resistant granites, limiting the settings where MSA artefacts may be preserved (Inglis *et al*. 2014). Aside from changes in what is currently terrestrial landscape, sea-level change had also impacted the broader landscape massively; between the MIS5 high sea stand and the LGM, when sea levels were lowest, the coastline shifted 100 km east, a shift almost completely reversed with the subsequent Holocene sea-level rise, which rendered large areas of landscape that would have been accessible to Palaeolithic populations inaccessible to terrestrial survey.

The one geomorphological setting in the study region that held high potential for observing MSA artefacts was the surfaces of Quaternary volcanics, which in the north of the region formed the ~1,800 km^2 Harrat Al Birk, and in the south the isolated cinder cones. Dates for these eruptions were poorly constrained, ranging from 0.2–2.6 Ma (Coleman *et al.* 1983; Dabbagh *et al*. 1984), but the landforms were thus likely emplaced before or during the period in question. The lava flows formed plateaus above the coastal plain of slow-weathering basalt, thus protecting material on these flows from burial by alluvium or erosion by wadis. During four month-long field seasons, MSA artefacts were observed at nearly all of the localities visited on these volcanics, allowing the development of a fuller understanding of the technological characteristics of the region's MSA record (Sinclair *et al*. 2018).

Interpretation of human landscape use at the regional scale from these data is, however, problematic – the geomorphological controls on artefact visibility that had shaped the survey strategy also shaped the boundaries of interpretation of the data collected. Whilst it is possible there may have been isolated locations preserving Palaeolithic surface artefacts within those landscape zones that were not surveyed, the landscape history of these areas (e.g. extensive Quaternary sedimentation; continuous erosion from steep slopes) and ground-truthing observations were consistent with the interpretation that large areas of the study region were not geomorphologically conducive to the preservation, exposure and visibility of Palaeolithic material. Interpretation of the archaeological record with regard to the regional landscape is therefore impossible, as large areas of the Palaeolithic landscapes and artefacts deposited within them are missing from this analysis. An absence of evidence of human activity based on an absence of artefacts from these areas cannot be assumed to entail an absence of past activity. Therefore, whilst the vast majority of artefacts recorded in the survey were associated with the volcanic landforms, it cannot be interpreted that artefacts were seen on them because humans were attracted to these locations (e.g. for access to raw material, views over the surrounding landscape, etc.) over, say, the lower coastal plain area, but that these were the locations in which stone tools were best preserved and accessible to survey. Our interpretation of this record must be developed within these limits.

The impact of geomorphological processes on the surface artefact record must also be examined at the local and site scale. Survey of a one km^2 tufa-filled basin formed by successive lava flows in Wadi Dabsa in the Harrat Al Birk yielded 2,970 artefacts with ESA and MSA technologies within a 60 × 100 m grid (L0106/0130) on a slight rise in the centre of the basin (Fig. 2.3; Inglis *et al*. 2019). This represented the richest Palaeolithic assemblage observed so far in the study region, and a programme of geoarchaeological investigation combining remote sensing, satellite imagery, field observations, excavation and chronometric sampling of the tufa and surrounding basalt was developed to understand the assemblage in its landscape context. Fundamental to this programme was the question, once more, of why the assemblage was seen where it was seen within the basin, and what were the drivers of the patterning of artefacts across the area covered by the lithic assemblage. Were these patterns driven by geomorphology, or could the

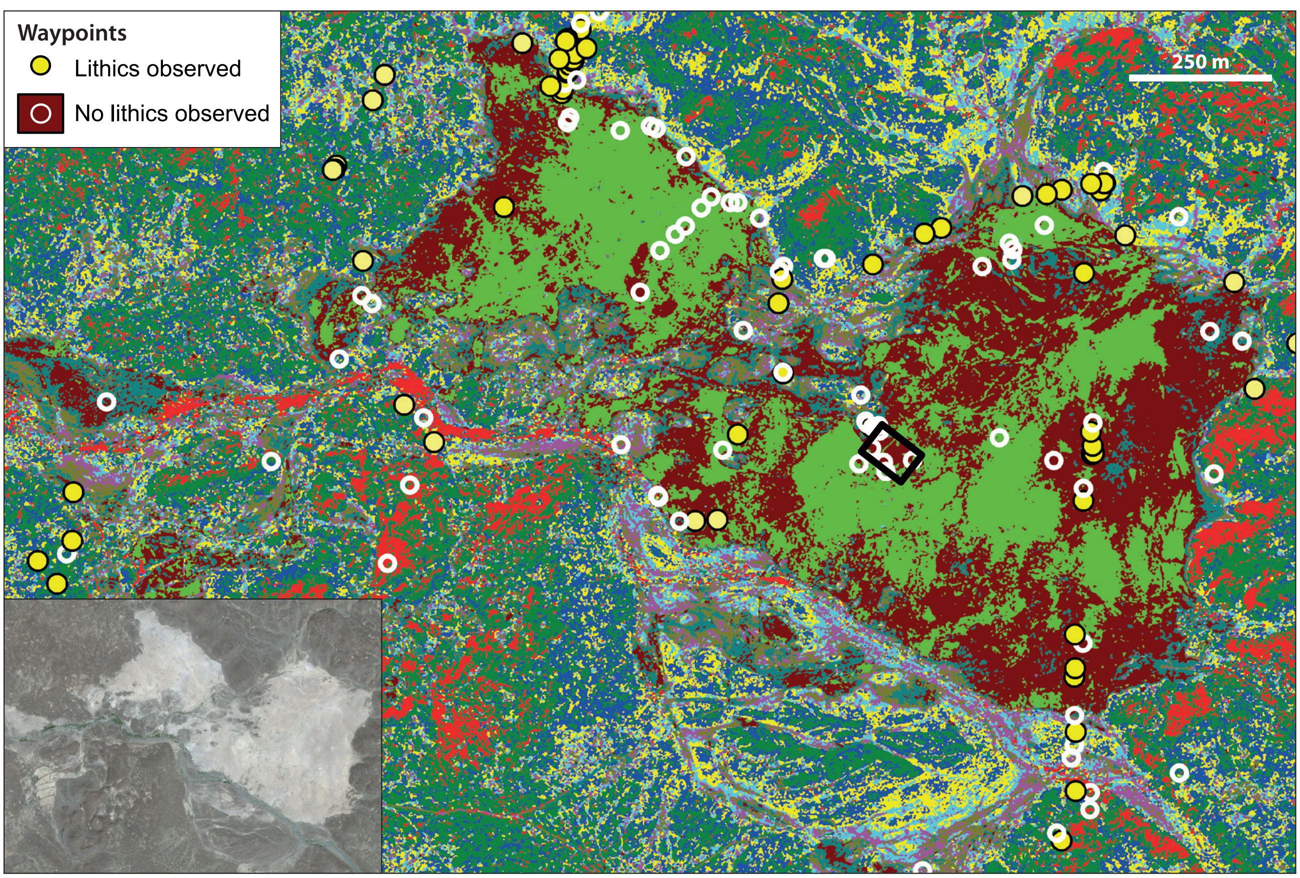

Figure 2.3. *Location of observed lithic artefacts and unsupervised surface sediment classification of Google Earth imagery in the Wadi Dabsa basin. Dark red areas denote bare tufa, bright green areas denote sediment cover over tufa. Black rectangle denotes location of L0106/0130 artefact collection grid. Satellite imagery: © CNES/Airbus, imagery date 19 January 2014 (accessed through Google Earth; Google Earth v7.2). Image: Robyn Inglis.*

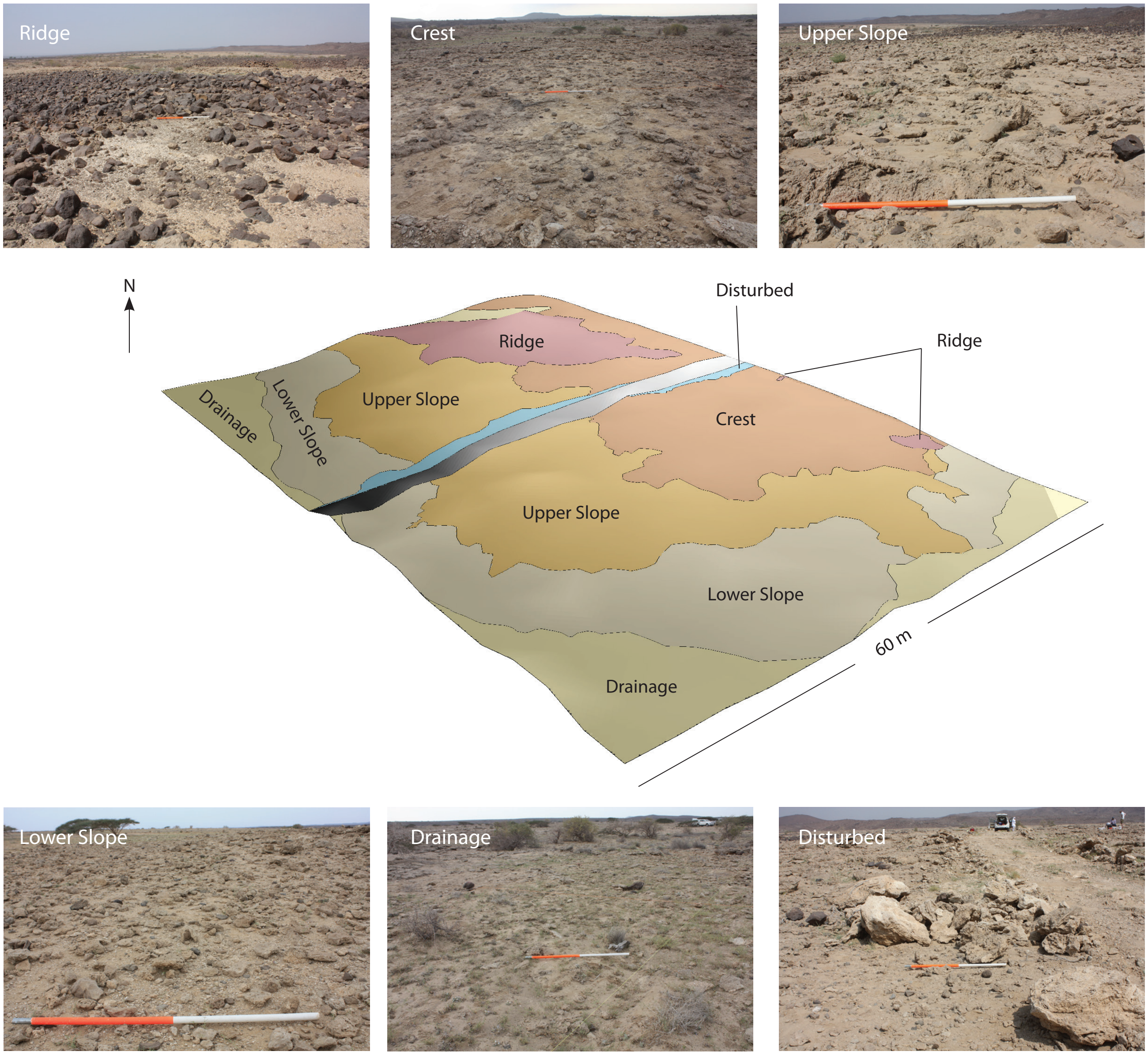

Figure 2.4. *Landform map of the L0106/0130 recording grid, and photos showing surface conditions within these landforms. Adapted from Inglis* et al. *2019, fig. 7. Image: Robyn Inglis.*

basin's record begin to tell us more about the timing and conditions of human activity in the basin?

Artefact patterning at the assemblage scale was examined through geomorphological mapping of units within the recording grid that mirrored Dalrymple's nine-unit landscape surface model (Fig. 2.4); the grid sloped gently (approximately two metres) from a relatively flat 'crest' landform unit, comprising tufa outcrops and sandy silt sediments, into a series of steeper tufa steps capturing rare pockets of sediments ('upper slope'), and from there to a footslope covered by fine sediments and broken tufa clasts ('lower slope'). The 'drainage' unit was a shallow channel filled with mobile sediments that swept around the base of the rise. Distribution of artefacts across these landforms varied with the highest densities on the crest and then upper slope units, decreasing into the lower slope and then drainage units. Excavations of the sediments within the crest units confirmed that artefacts were being exposed and deflated from a sediment unit that overlay the tufa (Inglis *et al*. 2019).

The correlation between artefact density and landforms was consistent with what would be expected in the classic model of downslope erosion: flat topography on the crest meant material was exposed through the winnowing of fine material in a way that left artefacts largely *in situ*. Over time though, artefacts would be washed, through rainfall-driven surface wash, downslope onto the relatively bare upper slope, where they were still visible to survey, before being washed further downslope into the lower slope and drainage landforms, where they would be buried and rendered inaccessible to surface survey. Patterning within the grid, therefore, was mainly controlled by geomorphological processes acting on the deflating artefact-bearing unit rather than spatial organization of past activity within the site. The observation in 2017 of artefacts on parts of the grid from which all surface artefacts had been collected in 2015 highlighted the ongoing dynamism of these geomorphological processes – severe rainstorms in 2016, possibly coupled with surface trampling of the site during the 2015 survey, potentially accelerated this deflation (Fanning *et al.* 2007; 2009). L0106/0130 is therefore a key example of the potential for archaeological records to continue to be shaped by geomorphological processes even as they are observed, further blurring their potential to provide interpretations of the spatial patterning of human activity.

Yet, as well as constraining the research questions that could be answered by the assemblage, understanding the geomorphological formation of the surface assemblage at L0106/0130 allowed the assemblage to be integrated into its landscape context. Using ENVI to carry out unsupervised classification of satellite images of the surface of the tufa, and groundtruthing of this classification with field observations, the grid area was identified as being located in a surface setting that was conducive to the exposure and visibility of artefacts, i.e. with a significant proportion of bare tufa, as opposed to areas of the tufa surface that were covered by mobile sediments that would have obscured artefacts (Fig. 2.3; Inglis *et al.* 2019). Transects and ground-truthing visits to similar 'high visibility' settings elsewhere on

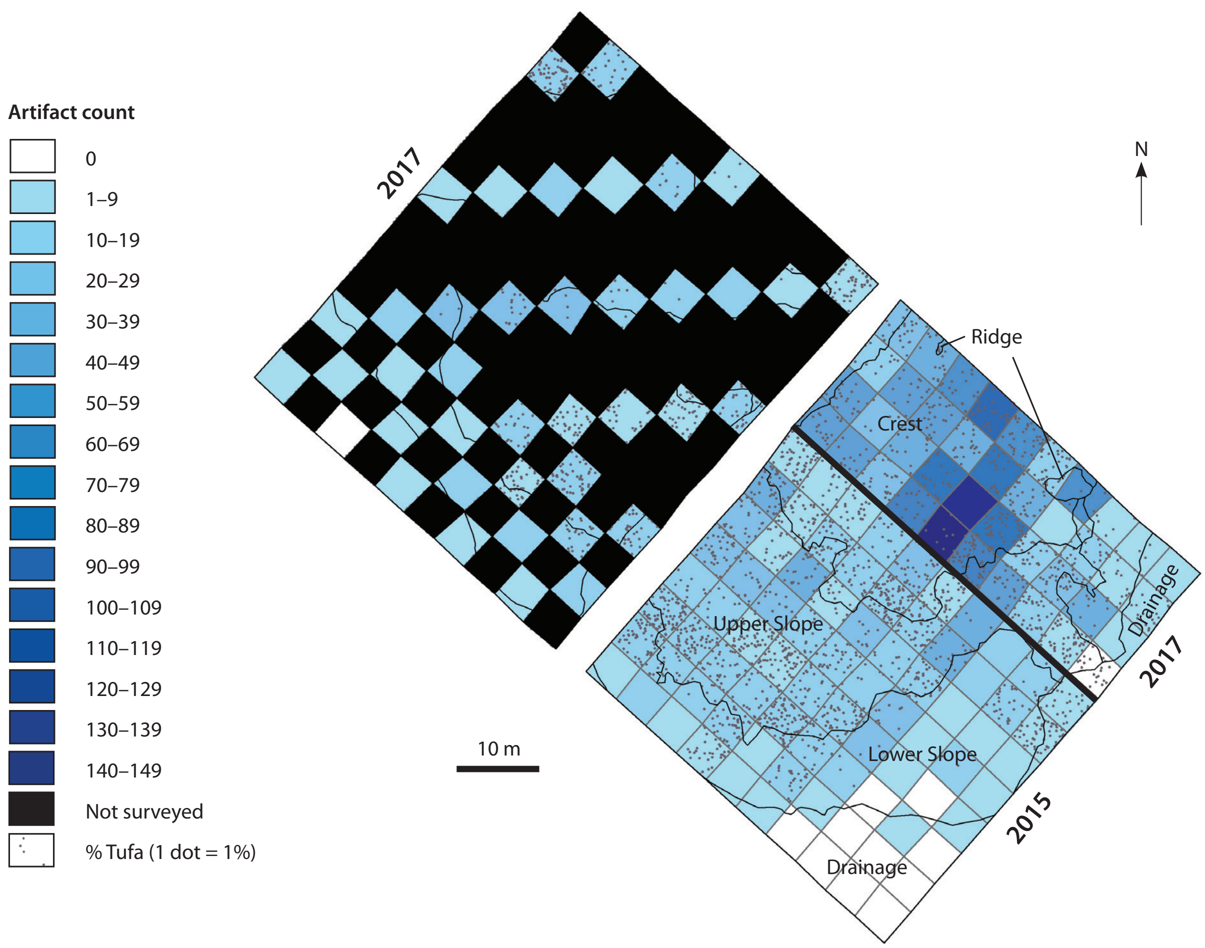

Figure 2.5. *Recorded artefact counts per 5 × 5 m square and landforms across the recording grid at L0106, Wadi Dabsa. Adapted from Inglis* et al. *2019, fig. 13. Image: Robyn Inglis.*

the tufa surface did not identify similarly rich deposits, indicating that whilst the artefacts at L0106/0130 may well represent only a remnant of a much larger assemblage that is undergoing active deflation and erosion, it still may represent a focus of activity not observed elsewhere in the basin in comparative geomorphological settings. The only other location with a notable number of artefacts was L0107 on the foot of the lava fields on the north side of the basin, where twenty ESA and MSA artefacts were observed (Foulds *et al*. 2017). Furthermore, although a key source of the artefacts is the remnant unit that overlies and thus post-dates tufa deposition at this particular location, the observation of an ESA handaxe coated in tufa lying in the northwestern part of the grid indicates that some proportion of this assemblage pre-dated tufa formation, adding to the technological evidence that the assemblage was a palimpsest of activity over an extended period of time, again highlighting the persistent attractiveness of the basin to populations.

Whilst operating at two very different scales of analysis, the investigations in southwestern Saudi Arabia illustrate the key role geomorphology plays in shaping where artefacts are preserved, exposed and visible to survey, and the very real and ongoing ways in which they therefore impact the research questions that can be asked of them. These examples highlight the vital need to critically engage with the geomorphological processes operating within the spatial area and scale that is under study, whether through primary field survey or desktop mapping of sites across whole continents, in order to avoid building behavioural interpretations of spatial data on what is the product of geomorphology.

Shaping deep sequences

The necessity of critical engagement with the geomorphological controls on the archaeological record when building activity and dispersal narratives is not limited to the location and interpretation of the surface record. Cave sites, with their artefact sequences contained in deep stratigraphies, are often used as regional keystones for the surface record, with their sediments acting as, and containing, palaeoenvironmental proxies that can be used to trace past human-environment interactions. Yet the geomorphological processes that transport sediment into a cave to form these sequences, whilst driven by external environmental changes, are mediated by the landscape setting and by the connectivity and morphology of the cave, which dictate its ability to capture and preserve these sediments for future interpretation (Frumkin *et al*. 2016). As the surface artefact record is not a direct facsimile of past human activity, so the sedimentation sequence within a cave is not a complete and continuous, clear record of environmental change that can be linked directly to the artefacts it contains. In reconstructing past environments through cave sediments, and utilizing this reconstruction to build narratives regarding past human-environment interactions we must both ask, 'What sediments do we see and why?' as well as 'What sediments do we not see, and why not?'

The Haua Fteah, Libya, on the Mediterranean coast of the Gebel Akhdar massif, contains >14 m of sediments spanning the last 150 ka to the present day, and is one of the key cultural sequences in North Africa (Fig. 2.6; Douka *et al*. 2014; Jacobs *et al*., 2017).

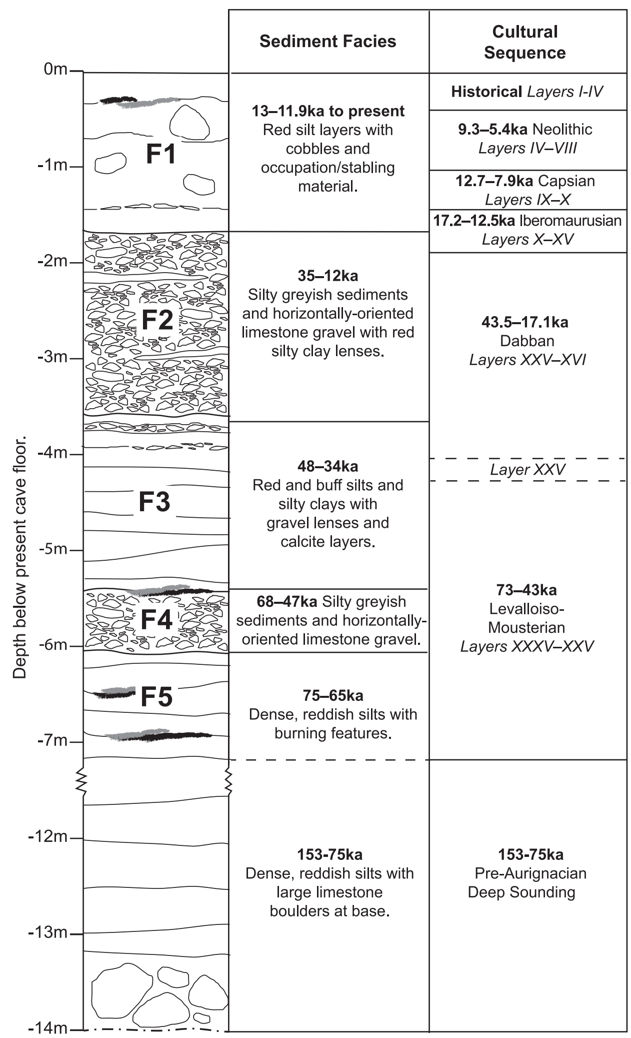

Figure 2.6. *Summary of the Haua Fteah's sedimentological facies and cultural sequence from McBurney (1967), with dates from Douka* et al. *(2014) and Jacobs* et al. *(2017). Adapted from Inglis* et al. *2018, fig. 3. Image: Robyn Inglis.*

Excavation in the 1950s (McBurney 1967) and recent re-excavation coupled with palaeoenvironmental analyses and chronometric dating have built up an archive of data unrivalled in this part of North Africa, and key to understanding the occupation history of the region (Barker *et al*. 2007; 2008; 2009; 2010; 2012; Rabett *et al*. 2013; Farr *et al.* 2014). A key cultural shift recorded in the sequence is the replacement of Middle Stone Age lithic technologies by those of the Later Stone Age ~40 kya (Douka *et al*. 2014).

Whilst there is ongoing debate as to what this technological shift represents in terms of population migrations or cultural innovation, and this is still under examination (Tryon & Faith 2016), the Haua Fteah sediments offered the potential to examine the conditions and timing of this transition, data that could inform these debates. Geoarchaeological analysis of the Haua Fteah sediments, combining field observations and basic sedimentological analyses with sediment micromorphology, identified that the primary sediment types were limestone clasts (interpreted as weathering from the cave walls), and fine reddish to orange silts and clayey silts consistent with the *terra rossa* soils present in the local landscape, and split the sequence into five major facies (Fig. 2.6; Inglis 2012; Inglis *et al*. 2018). Variation in the arrangement and relative proportions of fine and coarse material was accompanied by more subtle variations in the compaction and microstratigraphic features within the fine material (Fig. 2.7). Dark red, compact and relatively limestone-free layers with mosaic b-fabrics and associated with 'dusty' clay void linings directly beneath them were interpreted as inwash events from the mouth of the cave.

In other layers, the fine material was lighter in colour and less compact in the field, with micromorphological observations of stipple-speckled b-fabrics and the presence of 'stringers' of material, with varying amounts of horizontally oriented limestone clasts. These layers were interpreted as deriving from the existence within the cave of conditions close to the present-day dusty conditions, with sporadic wetting from drips within the cave, which persisted even during periods of heavy rain, albeit with some rare small surface washes of material (Inglis *et al*. 2018). Further variations within the sequence included anthropogenic features in the form of burnt layers, as well as cementation of layers by calcite formation, linked to dripping from the roof.

Linking of the sediment changes within the sequence to external environmental conditions was, in some instances, straightforward. Repeated inwash events were linked to marked periods of intense rainfall and transport of soil material driven by landscape destabilization, as could occur during climatic downturns when rainfall became more sporadic but also more intense (Woodward & Goldberg 2001; Hunt *et al*. 2010), and were particularly prominent during the sediments dated to the later part of MIS3 and into MIS2. Limestone spalling from the cave roof and walls was a likely indicator of freeze-thaw processes during cooler periods (Collcutt 1979; Laville *et al.* 1980), and this increased in sediments dated to MIS2 and MIS4. Both conditions left positive indicators of the environmental conditions that produced them – they could be 'seen' in the archaeological sequence because they produced sediments that could be captured by the cave. Yet other sediments characterized within the sequence did not provide a clear link to an external environment – the 'dusty' layers of fine silt that contained multiple ephemeral surfaces had not been laid down by mass movement of material, but by very gradual accumulation. This absence of large amounts of material being added to the sediments could have marked periods of landscape stability or complete landscape denudation – both would have resulted in a lack of mobile sediment that could have been transported into the cave to be deposited as a marker of a particular environment, as well as potentially the high-intensity rainfall required to transport it. Interpretation of the 'dusty' layers therefore hinged on the other climatic 'signals' within the cave sediments, primarily the deposition, or lack thereof, of limestone spalling, to identify whether they were deposited during warmer, more humid periods, or drier, cooler periods. Palaeoenvironmental interpretation of cave sediment sequences must therefore consider why certain environmental indicators are not present, drawing on other proxies within the sequence to develop interpretations where possible, as well as building narratives around the human-environment relationships in the environmental conditions that are in evidence.

The role of geomorphology in cave sediment sequences is also central to how the archaeological sequence is created and preserved – where, in what densities, and in relation to which environmental proxies we can see archaeological material within the sequence is shaped by sedimentation processes as much as by human activity, and therefore so are the interpretations built on them. Excavation systems rely on lithological changes in sediment to distinguish excavation units, and thus sedimentation literally defines the primary unit of technological analysis. Added to this, changing rates of sedimentation will alter the time periods of two layers of identical depth, inviting the question of how to compare units of analysis encompassing differing periods of time within a sequence in terms of artefact counts and density (Bailey & Galanidou 2009). Truncation of sediments during high energy

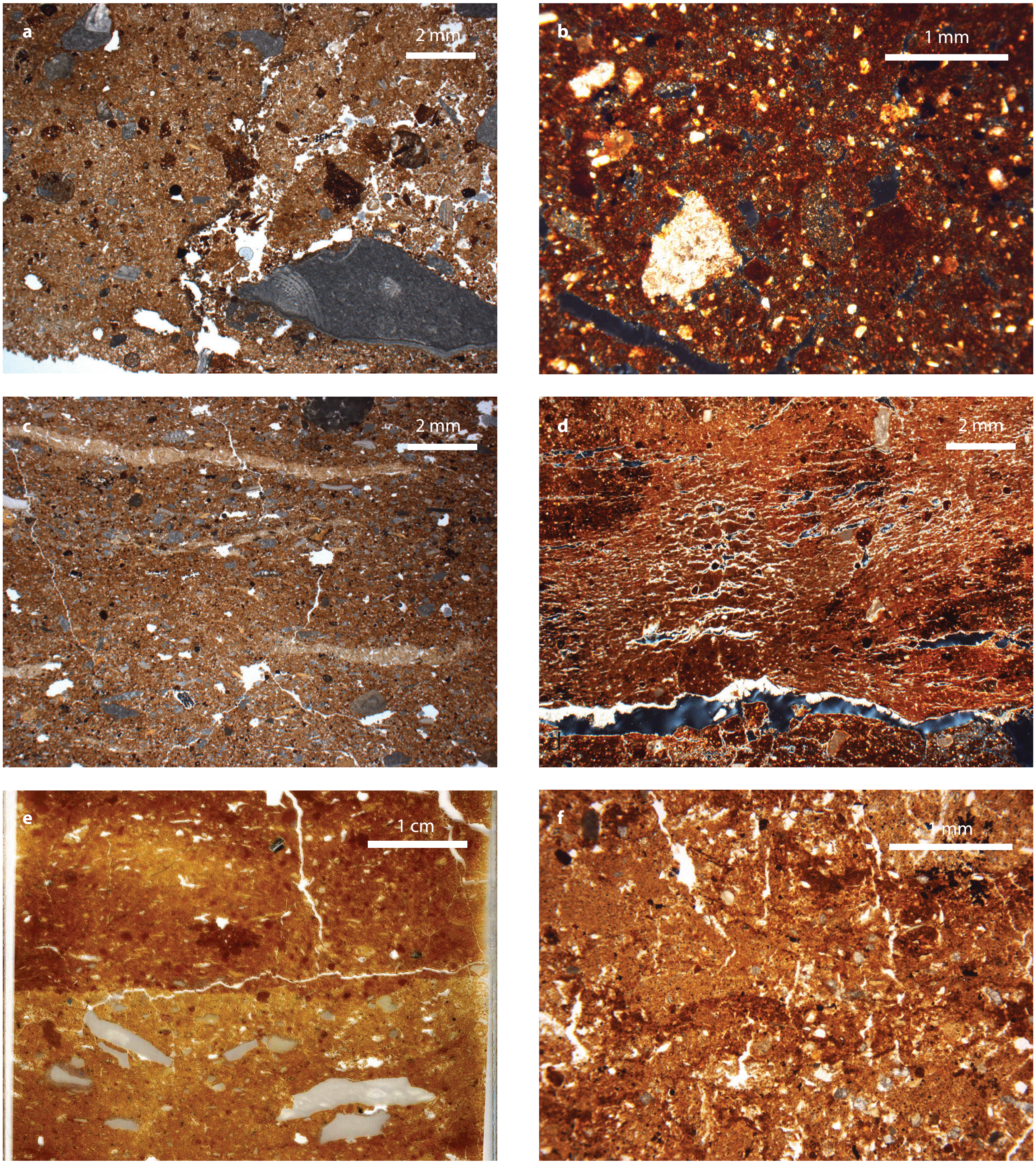

Figure 2.7. *Exemplar photomicrographs of features in the Haua Fteah sediments: (a) limestone sand and gravel interpreted as roof spall, in silty clay material, PPL; (b) stipple- to mosaic-speckled b-fabric, indicating shrink-swell processes, interpreted as occurring through drying of inwashed soil material, XPL; (c) dung lenses and fine mineral material laminations marking ephemeral surfaces, interpreted as being deposited in 'dusty' environments, PPL; d) micritic and sparitic calcitic precipitation linked to persistent wetting of the sediments, XPL; (e) erosive lower boundary between 'inwash' unit overlying 'dusty' unit, slide scan; (f) clayey infillings indicating drainage of clay and silt-rich water down-profile below boundary shown in (e), PPL. Adapted from Inglis* et al. *2018, figs. 6,7. Image: Robyn Inglis.*

transport or slumping may rework both archaeological material and palaeoenvironmental proxies such as pollen, and apparently blur or sharpen the interpreted cultural or environmental transitions (Stein 1987; 2001; Hunt *et al*. 2015). This was illustrated in Haua Fteah's Layer XXV where the MSA/LSA transition had been located in the 1950s excavations, interpreted as potentially showing interleaving between assemblages of the two technologies (McBurney 1967, 138). This layer contained dark reddish inwash layers, which may have had the energy to rework and truncate material, interleaving with paler silty 'dusty' layers, thus blurring the cultural and environmental histories preserved in this part of the sequence, the assessment of which in the new excavations has been hampered by low artefact density (Rabett *et al.* 2013; Farr *et al*. 2014).

At every stage of the interpretation of cave sequences, therefore, be it in terms of palaeoenvironmental reconstruction or human activity traced through the changing densities of artefacts in a sequence, the geomorphological processes that formed these sequences must be built into frameworks of interpretation. As with the surface record, in some instances this may mean circumscribing research questions as to the environmental conditions during a specific period if that layer of sediments does not offer a clear proxy of external environmental change or accommodating the presence of hiatuses or truncations.

Conclusions

The examples above have highlighted the fundamental nature of the principles of the essay outlined in the introduction – geomorphology and geoarchaeological frameworks are key to understanding the formation of the archaeological record that we observe today, be it through excavation or surface survey. This is not to say that geomorphological processes are a filter that can easily be screened out, leaving a pristine archaeological record. Geomorphological processes are unavoidably bound up with the very creation of the archaeological record. When interpreting the spatial distribution of artefacts, if large areas of landscapes have been buried, obscuring the artefact record they contain, these areas cannot be dismissed as unattractive in narratives of human occupation and dispersals due to their lack of artefacts. Similarly, in stratified sequences, palaeoenvironmental interpretation of the stratigraphy must take into account the environmental conditions that may not leave positive signatures in these sediments. Lastly, changes in geomorphological processes may drive hiatuses, changing rates of sedimentation and truncations that must all be built into chronologies of site occupation and activity if we are to use these stratified sequences to provide a temporal scaffold to regional chronologies. Returning to the undergraduate essay, only by taking an explicitly geoarchaeological approach to building narratives of past environmental and cultural change can we begin to robustly answer the question of why we see what we see where we see it, and if not, why not?

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Inspired geoarchaeologies

Geoarchaeological research captures dimensions of the past at an unprecedented level of detail and multiple spatial and temporal scales. The record of the past held by soils and sediments is an archive for past environments, climate change, resource use, settlement lifeways, and societal development and resilience over time. When the McDonald Institute was established at Cambridge, geoarchaeology was one of the priority fields for a new research and teaching environment. An opportunity to develop the legacy of Charles McBurney was bestowed upon Charles French, whose 'geoarchaeology in action' approach has had an enormous impact in advancing knowledge, principles and practices across academic, teaching and professional sectors. Many journeys that began at Cambridge have since proliferated into dozens of inspired geoarchaeologies worldwide. This volume presents research and reflection from across the globe by colleagues in tribute to Charly, under whose leadership the Charles McBurney Laboratory became a beacon of geoarchaeology.

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