Geological Society, London, Special Publications

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Geological Society, London, Special Publications 2011; v. 352; p. 97-107
doi: 10.1144/SP352.8

Notes

Holocene land use in western Sicily: a geoarchaeological perspective

CHAD HEINZEL[1]* & MICHAEL KOLB[2]

[1]*Department of Earth Science, University of Northern Iowa, Latham Hall, Cedar Falls, IA 50614-0335, USA*

[2]*Anthropology Department, Northern Illinois University, DeKalb, IL 60115, USA*

**Corresponding author (e-mail: chad.heinzel@uni.edu)*

Abstract: Geoarchaeological research within Sicily continues to characterize the effects of anthropogenic and geological processes upon the island's Holocene alluvial landscape developments. Interdisciplinary approaches have been used including geomorphological mapping, archaeological survey and excavations to characterize land-use practices though the mid- to late Holocene. Landscape development changes are recorded in the alluvial sediments as a consequence of land use by the indigenous and Roman settlers of Sicilian valleys in the Nebrodi and Polizzo Mountains. A marked change in erosion has been identified during the late Roman occupation of Sicily, probably as a product of intensive pastoralism and land clearing. Sedimentation during indigenous hilltop occupation of north–central and western Sicily was dominated by coarse-grained (cobble or boulder) deposits attributed to flash-flooding. Sedimentation that temporally coincided with the Greek and later Roman occupation of the adjacent valleys is marked by fine-grained deposits. These data continue to support the geological and archaeological interpretations of human–landscape interactions in Sicily. Furthermore, such geoarchaeological data may be used in models to strengthen our present and future landscape conservation methods.

The geoarchaeological sciences provide a useful series of tools and applications that facilitate a deeper understanding of human–landscape interactions through time. As the Earth's current populations continue to face droughts, floods, earthquakes, shortages in natural resources, and other population-forcing factors, geoarchaeology offers an opportunity to view how past natural and anthropogenic events shaped our modern civilizations and diagnostic cultural developments. Western Sicily's Holocene sediments contain a substantial record representing an important segment of the Mediterranean region's prehistoric and historical cultural progression (Leighton 1999; Tusa 1999). Sicily's strategic centralized location within the Mediterranean Sea and abundant natural resources provided the necessary means for survival and the development of productive trade networks. This paper seeks to delineate land-use changes in western Sicily from recent geoarchaeological data (Fig. 1).

Geoarchaeological data in western Sicily

Investigations regarding human–landscape interactions within Mediterranean landscapes have advanced greatly over the past 40 years. The data obtained have led to an increased understanding of the relative roles that anthropogenic and geological processes have had upon the region's landscape developments (e.g. Vita-Finzi 1969; Kraft *et al.* 1977; Pope & Van Andel 1984; Bintliff 1992; Barker 1995; Macklin *et al.* 2006). Recent geoarchaeological research conducted by the University of Cambridge (the Troina Project) in north–central Sicily and the Universities of Northern Illinois and Northern Iowa (the Monte Polizzo Project) in western Sicily have begun to characterize prehistoric and historical human settlement patterns and landscape changes in Sicily. Sicily was a recurrent sphere of contact, exchange, and dispute between indigenous and colonizing peoples during the Late Bronze Age to Early Iron Age transition (Leighton 1999; Tusa 1999; Serrati 2000). Movement of goods such as foodstuffs and exotic items was frequent; movement of people perhaps just as much, given the repeated human expansions from Italy, Iberia, Phoenicia, Attica, and North Africa (Knapp & Blake 2005). The rise and fall of local political centres and later colonization by Phoenicians, Greeks, and Romans testify to this area's importance as an agricultural breadbasket in many key periods of history.

Western Sicily contains a group of Iron Age proto-urban hilltop sites that may provide insight into the relationships between the development of indigenous political centres and 8th to 6th century BC Greek and Phoenician colonization in the Mediterranean. A group of hilltop sites (Segesta, Entella, and Eryx) were developed by indigenous Iron Age

From: WILSON, L. (ed.) *Human Interactions with the Geosphere: The Geoarchaeological Perspective*. Geological Society, London, Special Publications, **352**, 97–107.
DOI: 10.1144/SP352.8 0305-8719/11/$15.00

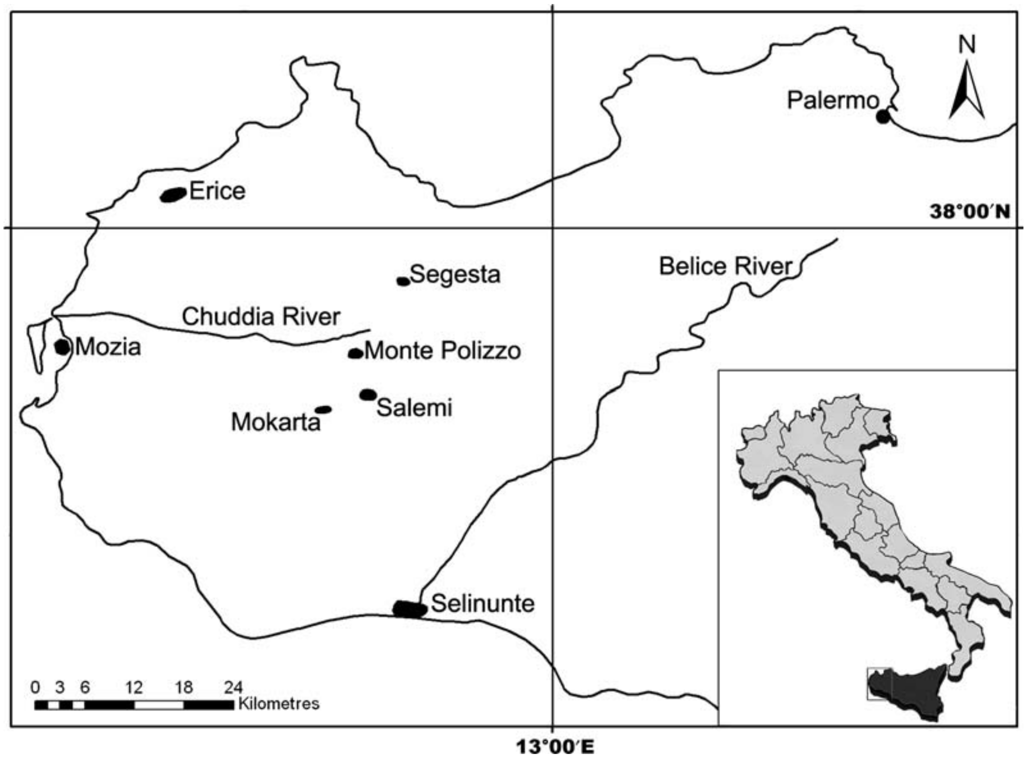

Fig. 1. Map of western Sicily including examples of the region's prominent archaeological sites and rivers.

people known as the Elymi (Leighton 1999; Kolb & Tusa 2001; Morris *et al.* 2002). The exact origins of the Elymi are indistinct. According to Thucydides (*c.* 460–*c.* 395 cal yr BC) and Diodorus Siculus (*c.* 90 to *c.* 30 cal yr BC), the Elymi had established at least three major strongholds in western Sicily [Segesta, Entella (Giustolisi 1985), and Eryx] by 800 cal yr BC. The Elymi appear to be an amalgam of Anatolian or Italic immigrants and an indigenous ethnic group known as the Sicans (Leighton 1999; Spatafora & Vassallo 2002). As a third political power the Elymi were caught between the strengthening coastal colonies of Motya (Phoenician, established 720 cal yr BC) and Selinus (Greek, established 628 cal yr BC).

Northwestern Sicily has been investigated since 1998 by a large multi-national team, exploring Mediterranean Iron Age (EIA) proto-urban settlements under the pressures and influences of Greek and Phoenician colonialism. As very little was known regarding the hinterlands of these proto-urban settlements, Northern Illinois University was charged with conducting a regional archaeological survey. Extensive archaeological survey data based on 4 m surface-spacing revealed a substantial Neolithic to Medieval human presence within the Chuddia River Valley. A geographic information system (GIS) analysis of the distribution of recovered ceramic material revealed a number of large ceramic concentrations as well as other areas of 'off-site' activity.

The Chuddia Valley survey recovered 42 901 non-diagnostic artefacts. These non-diagnostic artefacts (body shards) were visually attributed to general (century) chronologies, but did not possess distinctive rims, handles, or slips or designs that could identify the artefact's function. These bulk artefacts were sorted into major chronological categories, and counted in the field. An additional 3066 diagnostic artefacts, including chronologically (sub-century) precise diagnostic features such as ceramic base, rim, handle, and lamp fragments, were collected from the field and analysed in a laboratory. Other artefacts indicative of site function were also documented, such as bone, ceramic wasters, mosaic tiles, metal slag, glass, abraders, and hammer and grinding implements. The variability of these concentrated plough-soil ceramic zones and their unique suites of cultural materials are interpreted as traceable links to each archaeological site's probable size, and function and occupation. When these survey data are viewed in conjunction with time, regional variability, and geomorphological processes it is also possible to begin interpreting important archaeological developments such as settlement patterns and interaction between distinct cultural groups (trade).

Archaeological data recovered from Monte Polizzo (713 m above sea level) suggest it was a significant Iron Age settlement along with Segesta, Entella, and Eryx. The existence of a complex trade network between western Sicily's Iron Age hilltop settlements has emerged from ceramic analyses (Kolb & Speakman 2005; Polito 2006; Heinzel *et al.* 2009). The Elymi at Monte Polizzo also appear to have been influenced by the Greeks through the adaptation of ceramic styles and writing, but still remained a distinctive ethnic group despite centuries of coastal Greek and Phoenician colonization and the political conflicts that ensued. Recent archaeological excavations in western Sicily have documented an influx of Greek and Greek-imitation ceramic styles within Monte Polizzo's and other local proto-urban cultural material assemblages at *c.* 600 BCE (Morris *et al.* 2002; Spatafora & Vassallo 2002; Kolb & Speakman 2005). A documented set of inscriptions excavated at Segesta (a known Elymian stronghold) was written using Greek styled-script, but has been interpreted as an example of the non-Greek Elymian script (La Rosa 1996).

Landscape analysis

The University of Northern Iowa was charged with characterizing the late Holocene landform sediment-assemblage developments of Monte Polizzo's hinterlands and delineating their interrelationships with western Sicily's evolving Late Bronze to Roman settlement patterns. The hinterlands surrounding Monte Polizzo contained a discontinuous sedimentary record dating from the late Triassic (215 Ma) to the present day. Common bedrock types include limestone, shale, siltstone, sandstone, conglomerate, and gypsum assemblages that reveal deep to shallow Mesozoic marine to Cenozoic nearshore transitional depositional environments. The Quaternary alluvial setting contains prominent alluvial fans that have been dissected by a fluvial drainage system, the Chuddia River. Thirty-four alluvial (13 fan and 21 fluvial) stratigraphic sections were investigated from natural exposures or excavated using a track-hoe (1 m bucket). Each stratigraphic section was measured, described (Eyles *et al.* 1983), and sampled. Each sample was given a label that included a section number, year sampled, and height of sample above the stratigraphic base (e.g. CHS21-02-35 cm; CHS stands for Chuddia River section). Lithofacies logs were measured from the base upward. Three of the fluvial stratigraphic sections were discarded because they had been compromised by modern agricultural practices.

Alluvial fans

A thick assemblage of coalescing alluvial fan deposits (>40 m in thickness) produced the southern slope of Montagna Grande. Modern quarrying for road aggregate has exposed many outcrops. Three alluvial fans were investigated and named after the nearest landowners: the Verme, Armata and Lentini Fans (Fig. 2). Poorly cemented gravel, moderately well- to well-cemented gravel, and clay-rich deposits are the three primary depositional components of these fan-sediment assemblages. As a representative example the Lentini Fan contained a complex sequence of eight stacked Holocene channels (Fig. 3). Each channel cut and fill sequence contained angular to sub-angular limestone gravel. These overlapping channels were incised within well-imbricated pre-Holocene fan gravel deposits. Cross-cutting channel relationships were observed. The channels were distinguished from earlier fan sedimentation by: (1) irregular concave channel shapes; (2) a decrease in cementation within the cross-cutting channels; (3) an overall increase in relative particle size from the underlying pre-Holocene gravel; (4) a prominent increase in organic-rich matrix.

These stacked Holocene channels are archaeologically significant. They contain artefacts including ceramics, snail shells, lithic debitage, bone, and charcoal. The diagnostic ceramics are attributed to the Neolithic and Copper Ages (5000 BC to 3100 cal yr BC). In addition to these geological deposits, a large buried anthropogenic stone wall, an artefact-bearing compacted clay floor and a concentrated layer of ash–charcoal–bone were identified adjacent to the Holocene channel complex's eastern boundary.

Clay-rich deposits (5YR 4/4, dry) with varying degrees of pedogenic development are interbedded within each fans' braided channel networks. Particle size analyses of the sampled sediments revealed that these deposits contained an average of 43% clay, 32% silt, and 25% sand. In some places the reddish clay-rich units within the Montagna Grande fans appear to be highly oxidized and preserved soil horizons. Modern soils developed within the carbonate-rich (limestone) uplands of Montagna Grande often have a characteristic reddish brown terra rossa colour, and are similar in texture and composition to the clay-rich units.

The clay-rich fan units appear to influence the local hydrological conditions. The transition from

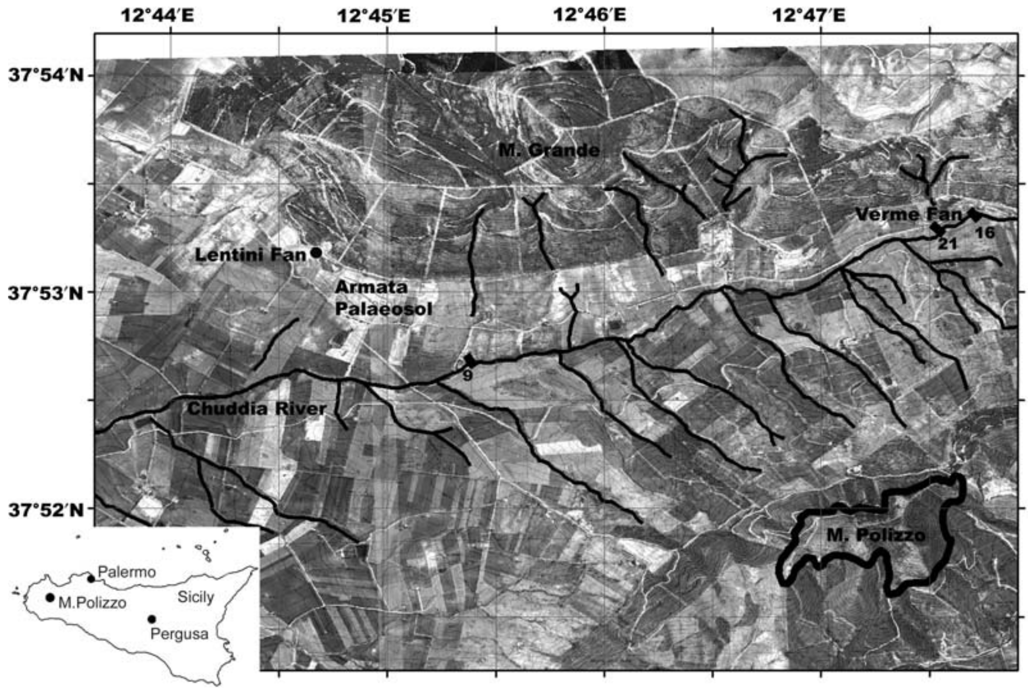

Fig. 2. Map of the study area surrounding Monte Polizzo (archaeological site outlined) and Montagna Grande exhibiting the Armata Fan–Palaeosol, the Lentini Fan, the Verme Fan, and the locations of the fluvial stratigraphic sections (CHS 9, 16, 21) discussed within the Chuddia River valley.

surficial to vadose to groundwater flow is directly influenced by the local geological settings. At present the internal cemented gravel and clay deposits act as aquicludes that redirect flowing vadose and groundwater to leave fan-sediment assemblages as natural springs at various points throughout the fan surfaces. The cemented alluvial deposits were produced during past stable landscapes with prolonged atmospheric exposure and interactions with seasonal high water tables. A carbonate-rich setting produced cements through dissolution and precipitation. This increased cementation has locally reduced the infiltration capacity of the fans. Increased runoff and runoff velocity during intense precipitation events have led to channel incision.

A well-developed palaeosol was preserved in the mid-fan portion of the Armata Fan. This palaeosol indicated a period of fan surface stability. Organic material from the A-horizon of the Armata Palaeosol was radiocarbon dated to 6084–5837 cal yr BC (2σ). Stratigraphic description of this palaeosol revealed that it was developed within the coarse-grained limestone fan particles and was rapidly buried by a well-imbricated, 150 cm thick, gravel deposit. Rapid sheet-wash sedimentation is typical of arid to semi-arid depositional environments (Nemec & Postma 1993) and the burial depth of greater than 150 cm has lessened the possibility of modern root contamination of the radiocarbon sample from the palaeosol.

The Chuddia River

The two sediment source areas for the Chuddia Valley are Monte Polizzo (to the south) and Montagna Grande (to the north). Monte Polizzo was produced during an uplift of the Terravecchia Formation (11.2–6.3 Ma) and provides quartzite pebbles and boulders, sand, and clay. Montagna Grande to the north contributed limestone to meta-limestone particles (very fine pebble to boulder size) to the Chuddia drainage network. Variable percentages of sandstone and limestone particles have produced a bimodal mixture of sediment within the valley. The fluvial stratigraphic contacts (transitions) between deposition and erosion episodes ranged from 2 to 5 cm thick. This range of stratigraphic contact thicknesses indicates either episodic sedimentation, a change in the environmental conditions (discharge variability), or a deposition hiatus leading to landscape stabilization and soil

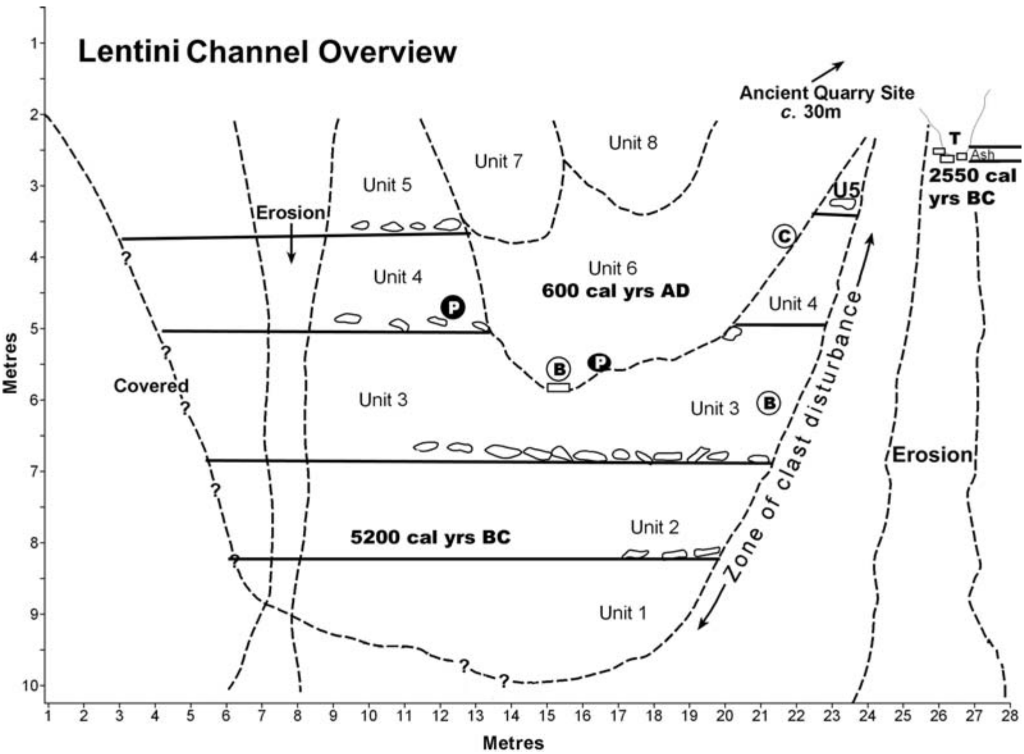

Fig. 3. Stratigraphic units characterizing the younger (Holocene) cut and fill deposits. The channel contained imbricated fining-upward sequences of limestone gravel. The channels contained a high concentration of pottery (P), bone (B), and charcoal (C). Adjacent to the channel an anthropogenic structure or tomb (T) featured a compacted clay floor, ash layer (20 cm), and a variety of artefacts.

development. The 21 fluvial stratigraphic sections contained a variety of basal deposits including clay, a clast-supported, quartzite-cobble conglomerate or an imbricated gravel.

The fine-grained unit (average texture 5% sand, 37% silt and 58% clay) was characterized by a massive blue–grey (7.5YR 5/1) clay. This deposit contained a relatively wide range of textural end members, up to 28% sand and 82% clay, but never contained coarse fragments. The thickness of this fine-grained basal unit ranged between 15 and $\geq$120 cm. Preliminary pollen analyses of these fine-grained sediments indicate the presence of abundant Dinophyceae (marine algae cysts). Charcoal obtained from two of these clay units (CHS16, Unit 1, 80 cm above base) produced an average radiocarbon date of 544–381 cal yr BC (2σ).

The second unit that could be correlated throughout the Chuddia River system was a clast-supported (quartzite-cobble) conglomerate. The clast distribution was predominantly bimodal, with rounded to well-rounded coarse-grained clasts set within a fine- to medium-grained matrix of 56% sand, 14% silt and 30% clay. Snail shells (*Theba pisana*) recovered from a correlative stratigraphic unit (CHS9, Unit 1, 33 cm above the stratigraphic base) gave a radiocarbon date of 1895–1616 cal yr BC, which, when corrected for the ingestion of 'old' carbon from the surrounding Eocene carbonate bedrock, placed this shell between 595 and 316 cal yr BC, well within the statistical range of the other charcoal radiocarbon dates. The coarse-grained depositional Unit 1 of CHS9 contained the first occurrence (inclusion) of ceramic artefacts (Fig. 4). The artefacts recovered from this stratigraphic unit dated exclusively to Sicily's Iron Age period (900–600 cal yr BC). Each successive stratigraphic unit contained chronologically mixed artefact assemblages.

The third primary fluvial stratigraphic unit was classified as an imbricated, clast-supported gravel. CHS21, Unit 2 (60 cm thick) contained a representative angular limestone gravel deposit (Fig. 5). The average ($n = 50$) clast size was 3.5 cm (a-axis), 2.3 cm (b-axis), and 0.7 cm (c-axis). These gravel deposits did not contain measurable

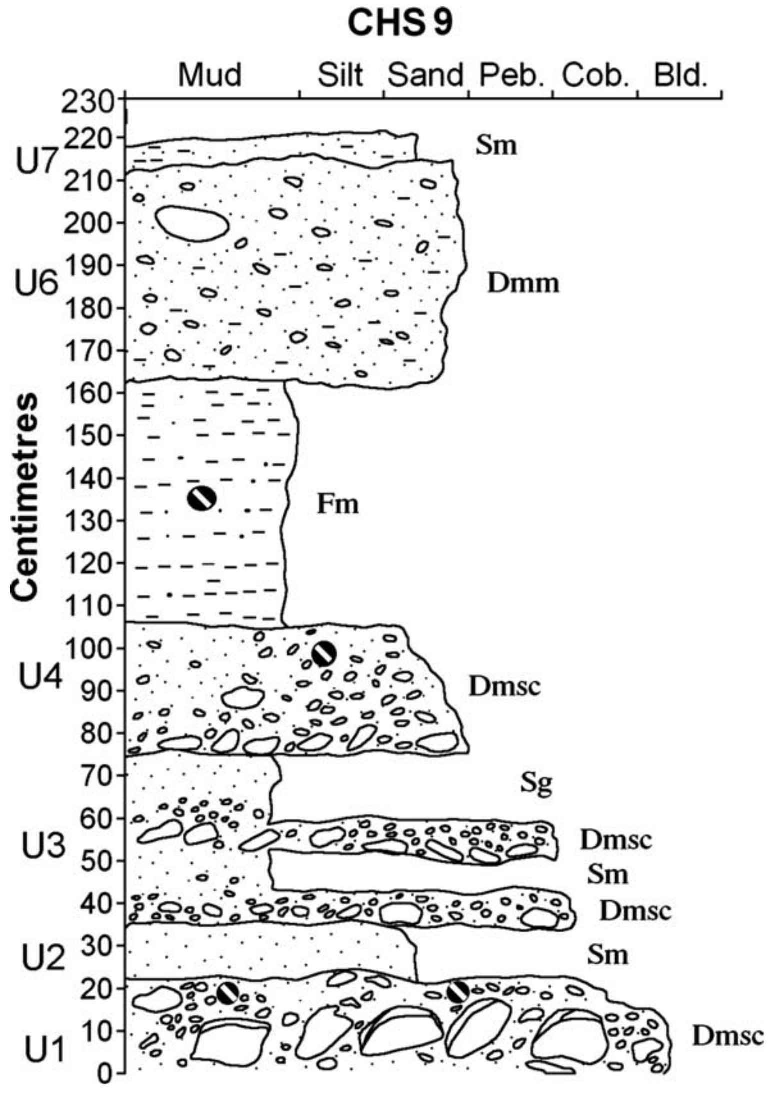

Fig. 4. CHS9 lithofacies column (1:10 cm), This drawing includes the locations of ceramic concentrations and charcoal used to obtain radiocarbon dates (black circles with diagonal white lines). Stratigraphic nomenclature (Eyles *et al.* 1983) was used to characterize the valley's fluvial sediments: Dmsc (D, diamicton; m, matrix supported; s, smooth contact; c, current reworking); Sm (S, sand; m, matrix-supported); Sg (S, sand; g, graded); Fm (F, Fine–clay; m, massive); Dmm (D, diamicton; m, matrix-supported; m, massive). The relative particle size from unit to unit, and the locations and orientations of clasts are also shown.

amounts of matrix. The stratigraphic contact between Units 2 and 3 is abrupt (0.5–2 cm) and inclined at an angle of 5° to the west.

The three distinctive fluvial basal deposits continued at depth, but each section was terminated when it intersected with the current water table. The fluvial stratigraphic units were correlated by combining lithofacies data, the succession of artefact assemblages and radiocarbon data, which facilitated reliable physical and temporal correlations. The alluvial deposits overlying the clay represent an assemblage of floodplain and channel deposits of varying thickness. The channel deposits (medium- to coarse-grained sand) often contain small trough cross-beds and variable amounts of clay. Colluvial limestone gravel was commonly

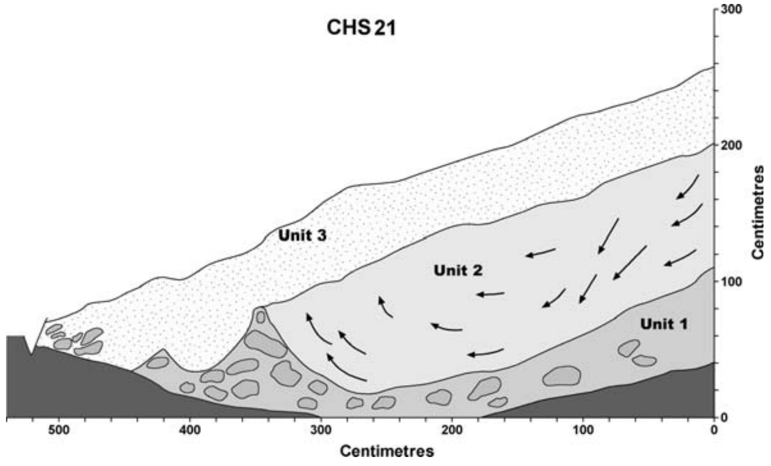

Fig. 5. CHS21 western side wall (1:20 cm). Unit 1 contains coarse-grained quartzite cobble to boulder fluvial sediments. Unit 2 contains imbricated alluvial fan (Verme Fan) limestone gravels from Montagna Grande; the arrows represent average palaeocurrent directions based on 100 clast measurements. Unit 3 contains massive colluvial and sand deposits.

mixed within the coarse-grained channel deposits. The angular nature of the limestone gravel confirmed Montagna Grande as the proximal source area. These stratigraphic and sedimentological data also verified that the alluvial toe slopes of the Verme Fan came into direct contact with the Chuddia Valley's main fluvial channel.

Discussion

Geoarchaeological research is truly an interdisciplinary effort. Geoarchaeology integrates multiple subdisciplines of the archaeological, geological, and biological sciences in an attempt to delineate the interrelationships of an area's causative natural processes and the anthropogenic influences upon a landscape's development. These data are also valuable when interpreting a landscape's effects upon an evolving human population. Defining the scale of a geoarchaeological investigation is critically important given the varying temporal resolutions of geological processes and human life cycles (Stein 1993).

Geoarchaeological investigations within Sicily are in their infancy. The scales of current investigations have yet to achieve resolutions capable of linking specific (decadal to annual) climatic variance to past human lives. This does not mean that these data are not important, it simply necessitates that care be taken when attempting to directly correlate climatic and landscape variables to specific human events. For example, archaeological data suggest that the Elymi thrived on Monte Polizzo beginning around 575 BC and ending abruptly at 475 BC (Morris *et al.* 2002). The reason for the Elymi's abandonment of Monte Polizzo remains a mystery. Was site abandonment a product of sociopolitical change, warfare, sickness, drought, or depletion of natural resources? The Chuddia Valley's landform sediment assemblages do record distinct periods of landscape destabilization during and/or immediately after the Neolithic and Iron Age human occupation periods.

Interpreting the causative factor or factors leading to a settlement's collapse is often equally important and difficult. The archaeological and physical landscapes from the Chuddia River Valley provide a glimpse into the possible environmental and anthropogenic roles leading to the rise and fall of the Elymian settlement at Monte Polizzo. The Chuddia Valley's mid-Holocene (Early to Mid-Neolithic) record begins with the presence of the well-developed Armata Palaeosol (6100–5808 cal yr BC). This palaeosol suggests the mid-Holocene pediments of Montagna Grande were stable and facilitated the development of an organic-rich (10YR 3/1 and 1.81% organic carbon) soil. The dark (3/1) soil colour facilitates an A-horizon designation according to USDA (US Department of Agriculture) criteria. Lacustrine core data from Lago di Pergusa (central Sicily) and Gorgo Basso (south-western Sicily) indicate a period of increased precipitation and coastal forest expansion (Sadori & Narcisi 2001; Zanchetta *et al.* 2007; Tinner *et al.* 2009). These data provide supporting evidence that there was enough precipitation for plant material to grow and decay, supplying organic debris to soil development.

The coastal Neolithic populations of Sicily were probably forced to search for new farmland in the interior hills of Sicily during a climatically induced period of increased rainfall and expansion of evergreen coastal forests (Tinner *et al.* 2009). The Aramata Palaeosol, archaeological survey data and the presence of a Neolithic (5500–4000 cal yr BC) artefact assemblage within the Chuddia Valley serve as records of western Sicily's migrating (coastal to interior) Neolithic population (Kolb & Tusa 2001; Heinzel 2004).

Slope instability processes have continued to shape the Chuddia Valley's landforms since the mid-Holocene. Three primary indications of slope instability were identified within the valley: (1) the burial of the Armata Palaeosol by imbricated fan gravel; (2) the reactivation of the Lentini Fan and channel; (3) the stratigraphic interrelationships between the alluvial fans of Montagna Grande and the main fluvial channel of the Chuddia River. Mid-Holocene landscape destabilization is first recorded with the valley's burial of the Armata Palaeosol, after 5000 BC, by imbricated alluvial fan gravel. A radiocarbon date of 5349–5171 cal yr BC from Unit 2 of the Lentini complex also marks this mid-Holocene landscape instability through the erosion of an older late Pleistocene fan surface through incision and sedimentation within a younger mid-Holocene fan channel.

A Late Copper Age (3000–2500 BC) anthropogenic structure was identified adjacent to the Lentini channel's eastern end. Two charcoal pieces collected from opposite ends of the structure's compacted clay floor gave radiocarbon dates between 2679–2468 and 2886–2620 cal yr BC. This site contained multiple artefacts including lithic (flint) tools, flint debitage, hearth–ash accumulation, and a variety of ceramics. The ceramics associated with this site and the adjacent alluvial channel ranged from Neolithic mobile cooking ware to Late Copper Age house tile and cooking ware with a characteristic red burnish (Heinzel 2004).

Since the mid- to late Holocene Sicily has experienced a general trend of increasing aridity. Vegetative types and concentrations appear to have remained relatively constant until the 850–650 cal yr BC collapse of western Sicily's coastal forests. The extensive and rapid nature of this vegetative change has been attributed to the influx of Greek colonists rather than the trend towards aridity (Tinner *et al.* 2009). Archaeological excavations and surveys have documented an extensive Iron Age (850–475 cal yr BC) indigenous artefact assemblage believed to be linked to an Elymian polity at Monte Polizzo (Prescott *et al.* 1998; Kolb & Tusa 2001; Morris *et al.* 2002). A corresponding Elymian artefact assemblage was recovered from the valley's fluvial stratigraphic units. Charcoal and ceramic artefacts recovered from the massive clay or clast-supported quartzite conglomerate layers of the Chuddia River's sediments provided radiocarbon dates between 600 and 380 cal yr BC, which appears to strengthen the probability of a temporal link between the Elymi at Monte Polizzo (height of site occupation 575–475 BC) and erosion of the valley's upland landscapes and subsequent infilling of the Chuddia River.

The massive grey clay unit (554–383 cal yr BC) is common to seven fluvial stratigraphic sections ($n = 21$) in the river's headwater area. Well-sorted clay-sized sediments are commonly associated with low-energy depositional environments. The Late Iron Age clay deposit suggests two possibilities: (1) adequate precipitation levels and topographic controls led to a lacustrine depositional setting or (2) the presence of an alluvial fan or anthropogenically produced dam created a low-energy depositional environment (Heinzel 2004). The specific contributing climatic and anthropogenic variables present during the formation of the Chuddia Valley's massive clay remain unclear. The only other climatic evidence is offered by the Lake Pergusa core data, which document a return to a lacustrine carbonate setting at 2800 BP, suggesting a slight increase in precipitation relative to the previous 500 years (Sadori & Narcisi 2001).

The specific reasons for the Elymi's abandonment of the Monte Polizzo site continue to be mysterious. However, there is a clear geological change from fine- to coarse-grained sedimentation within the Chuddia River while the Elymi occupied Monte Polizzo or immediately following the site's abandonment (Heinzel 2004). This increase in particle size is documented by the clast-supported quartzite conglomerate and the successive coarse-grained fluvial stratigraphic layers (quartzite conglomerates or imbricated limestone gravel). In addition to the introduction of coarse fragments there is also a notable change in the texture of the fluvial matrix. The massive clay has an average texture of 5% sand, 37% silt and 58% clay whereas the coarse-grained units contain an average of 56% sand, 14% silt and 30% clay (Heinzel 2004).

The archaeological evidence documents that the site was abandoned near 475 cal yr BC. Excavations have not uncovered any evidence of on-site warfare or earthquakes. Recent geoarchaeological studies in southern Europe have characterized complex palaeoenvironmental and archaeological records (e.g. Sadori & Narcisi 2001; Ayala 2004; Heinzel 2004; Magny *et al.* 2007; Tinner *et al.* 2009). Interpreting the relationships between the indigenous peoples of Sicily, Greek and Phoenician colonialism, Holocene climatic variability, and their cumulative effect on human land-use patterns or geomorphological processes is complicated. Using the current data, it is not possible to explicitly state the mechanisms that led to the recorded changes in the Chuddia Valley's fluvial stratigraphy. Identifying the causative variables that produced the identified landscape changes will require additional well-dated and high-resolution geoarchaeological investigations.

Recent palaeobotanical investigations are beginning to shed light upon the mid- to late Holocene relationships between humans and western Sicily's vegetation history (Sadori & Narcisi 2001; Stika *et al.* 2008; Tinner *et al.* 2009). There is still a great need for further geoarchaeological investigations that delineate the relationships between climatic variability and anthropogenic settlement patterns. One method that is capable of providing these climatic proxy data is carbon and oxygen isotopic studies. Western Sicily contains at least two promising sources for obtaining a local high-resolution climate record of temperature and precipitation: speleothems and snail shells. Given the highly variable distribution of precipitation throughout the Holocene and the carbonate bedrock of western Sicily an isotopic investigation may provide the temporal and physical resolution needed to identify the factors leading to the abandonment of Monte Polizzo.

The transition from indigenous to colonial (Greek, Phoenician and Roman) settlement in Sicily is clearly preserved within the island's sedimentary record. The primary difference recorded in sedimentation patterns is shifts in particle size (coarse fragments and matrix). This change in particle size has been recorded in western Sicily, in the Chuddia River Valley, with a change from fine to coarse following the Iron Age (Heinzel 2004). Ayala (2004) also documented a particle size change within Sicily's fluvial record, from coarse to fine grained during the fourth to second centuries BC in north–central Sicily (Troina Valley). Recent attempts using GIS and a variation of the Universal Soil Loss Model Equation (USLE) have also documented the adverse effects of Roman land-use practices in north–central Sicily (Fitzjohn 2003; Ayala & French 2005). These data have shown a significant period of landscape destabilization during the Roman occupation of north–central and western Sicily (as seen in the change from coarse-grained flash-flood sedimentation to fine-grained slopewash). Ayala & French (2005) have attributed this sedimentation change to extensive land clearance during a period of intensive Roman pastoralism. The continuing geoarchaeological investigations within Sicily are using geological, archaeological, historical (ancient literature) and biological data in an attempt to provide a comprehensive characterization of the interaction between humans and the natural world.

Conclusion

Geoarchaeology is an interdisciplinary science that constructs a bridge between the Earth's natural processes and human endeavours past, present and future. The construction of such bridges is complicated by incomplete stratigraphic records, disturbed archaeological material cultures and contrasting temporal scales. The road to a comprehensive understanding of human–environmental interrelationships requires the construction of such bridges no matter how difficult. Recent geoarchaeological data from Sicily and elsewhere are beginning to provide insight into the positive and negative ramifications humankind has upon the Earth. The Chuddia Valley contains a geoarchaeological record that represents nearly 8000 years of human activity and landscape processes. Archaeological and palaeoenvironmental investigations are beginning to delineate the complex interrelationships between humans and their environment.

Three periods of landscape destabilization have been documented in association with the Neolithic, Iron Age and Roman occupation periods in Sicily: (1) the reactivation of alluvial fan surfaces and burial of fertile Neolithic soil horizons near Montagna Grande (Heinzel 2004); (2) a dramatic increase in particle size within the fluvial sediments of the Chuddia River linked to the Elymi's use and/or abandonment of the Monte Polizzo site (Heinzel 2004); (3) a substantial decrease in particle size and increase in rate of sediment supply to the Troina River as a product of intensive land use during the Roman period (Fitzjohn 2003; Ayala 2004; Ayala & French 2005). Although the specific anthropogenic or climatic roles that influenced Sicily's landform sediment assemblages still require further investigation, these sediments and associated archaeological remains provide a means to learn from the past. Striving to understand such interrelationships not only facilitates our understanding of the rise and fall of human populations, but also provides vital data that may be used to lessen the severity of future climatic fluctuations. For example, Tinner *et al.* (2009) have used their geoarchaeological data from Gorgo Basso (southwestern Sicily) and models from the Intergovernmental Panel on Climate Change (IPCC 2007) to predict the expansion of drought-adapted treeless vegetation and desertification in Sicily if global temperatures continue to rise.

Whether human interactions with the environment are recorded by changes in local sediment patterns as in the catchments of Sicily (Ayala 2004; Heinzel 2004) or are recorded within regional to global depositional systems (Ruddiman 2003), interdisciplinary, regional and site-specific studies are critically important when attempting to advance our knowledge of the Mediterranean's prehistoric and historical landscapes, and to enhance our understanding of the causative roles that humans and climate have upon one another and the Earth's dynamic landscapes.

Funding for this research came from the University of Northern Iowa, the Geological Society of America, the National Science Foundation (G1A-62128), and the Soprintendenza BB. CC. AA. Di Trapani, Sezione per i Beni Archaeologici. Our work would not be possible without the dedication and assistance of our Salemi associates: S. Conforto, N. Spagnolo, G. Scememi, S. Cassa, B. Terranova, N. Bascone, V. Scalisi, A. Puma, N. Puma, the Bascone family, and many other wonderful people in and around Salemi.

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