KECK GEOLOGY CONSORTIUM

PROCEEDINGS OF THE TWENTY-SECOND ANNUAL KECK RESEARCH SYMPOSIUM IN GEOLOGY

April 2009
Franklin & Marshall College, Lancaster PA.

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2008-2009 PROJECTS

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Faculty: *WILLIAM H. PECK*, *BRUCE W. SELLECK* and *MARTIN S. WONG*: Colgate University
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PALEOECOLOGY & PALEOENVIRONMENT OF EARLY TERTIARY ALASKAN FORESTS, MATANUSKA VALLEY, AL.
Faculty: *DAVID SUNDERLIN*: Lafayette College, *CHRISTOPHER J. WILLIAMS*: Franklin & Marshall College
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Students: *LAUREN D. ANDERSON*: Lehigh University; *STEFANIE GUGOLZ*: Beloit College; *HENRY E. KERNAN*: Williams College; *ADRIENNE LOVE*: Trinity University; *KAREN TEKVERK*: Haverford College

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Students: *AVERY R. COTA*: Minnesota State University Moorhead; *JANE DIDALEUSKY*: Smith College; *ROWAN HILL*: Colorado College; *ANNA PENDLEY*: Washington and Lee University; *MAIJA SIPOLA*: Carleton College; *STACEY SOSENKO*: Franklin and Marshall College

GEOLOGY OF THE HÖH SERH RANGE, MONGOLIAN ALTAI
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BLOCK ISLAND, RI: A MICROCOSM FOR THE STUDY OF ANTHROPOGENIC & NATURAL ENVIRONMENTAL CHANGE
Faculty: *JOHAN C. VAREKAMP*: Wesleyan University and *ELLEN THOMAS*: Yale University & Wesleyan University
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Keck Geology Consortium: Projects 2008-2009
Short Contributions – ITALY

GEOARCHAEOLOGY OF THE PODERE FUNGHI, MUGELLO VALLEY ARCHAEOLOGICAL PROJECT, ITALY

Project Director: ***ROB STERNBERG***: Franklin & Marshall College
Project Faculty: ***SARA BON-HARPER*****:** Monticello Department of Archaeology

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AVERY R. COTA**:** Minnesota State University Moorhead
Research Advisor: Dr. Rinita Dalan

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Research Advisors: Bosiljka Glumac and Robert Newton

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ROWAN HILL: Colorado College
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ANNA PENDLEY**:** Washington and Lee University
Research Advisors: Dr. Sara Bon-Harper, Dr. David Harbor, and Dr. Robert Sternberg

GEOMORPHIC AND ANTHROPOGENIC IMPACTS ON ARTIFACT DISTRIBUTION WITHIN THE PLOWZONE IN THE PODERE FUNGHI, TUSCANY, ITALY

MAIJA SIPOLA**:** Carleton College
Research Advisor: Mary Savina, Carleton College

MAGNETOMETRY IN THE PODERE FUNGHI AT THE ETRUSCAN ARCHAEOLOGICAL SITE OF POGGIO COLLA

STACEY SOSENKO: Franklin and Marshall College
Research Advisor: Rob Sternberg

Funding provided by: Keck Geology Consortium Member Institutions and NSF (NSF-REU: 0648782)

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GEOARCHAEOLOGY OF THE PODERE FUNGHI, MUGELLO VALLEY ARCHAEOLOGICAL PROJECT, ITALY

Project Director: ROB STERNBERG, Department of Earth and Environment, Franklin & Marshall College
Project Faculty: SARA BON-HARPER, Monticello Department of Archaeology

INTRODUCTION

Archaeological research has come to increasingly utilize the application of techniques from the natural sciences. This subdiscipline has been called archaeometry, or archaeological science (Brothwell and Pollard, 2001). Although originally used more in the domain of prehistoric archaeology, archaeometric methods have become increasingly applied in classical archaeology (McGovern, 1995). The term geoarchaeology has often been used in a narrow sense to refer to study of the sediments, stratigraphy, and landforms in which archaeological sites are embedded. Here we use geoarchaeology to refer to the application of any method from the geosciences to archaeology. In this respect, geoarchaeology becomes similar to archaeometry, because of the wide range of descriptive and analytical methods utilized in the geosciences (Goldberg et al., 2001). Although it has long been recognized that geophysical surveys at archaeological sites benefit from the use of different and complementary geophysical methods (Gaffney and Gater, 2003), our project follows a more recent trend to integrate layers of data from multiple geophysical, geochemical, geoarchaeological, and survey archaeology techniques (Rimmington, 2000; Sarris and Jones, 2000; Kvamme, 2003; Sarris et al., 2004; Marwick, 2005; Persson, 2005; Venter et al., 2006; Yerkes et al., 2007; Simpson et al., 2008). The six student papers in this Keck project span the converging boundaries between archaeometry and geoarchaeology and contribute to an established archaeological project with roots in classical archaeology.

Our project ran from June 22-July 19, 2008, in coordination with the Mugello Valley Archaeological Project (http://smu.edu/poggio/) outside the town of Vicchio, in the province of Florence, region of Tuscany, Italy (Fig. 1). This project continued the proud Keck Geology Consortium tradition of projects in geoarchaeology (Savina, 1994; Sternberg et al., 1999). Each of these has involved either the collaboration (Nancy Wilkie, for Greece 1993) or active participation (James Delle, Jamaica, 1998; Sara Bon-Harper, this project) of an archaeologist. Our intrepid crew is shown in Figure 2.

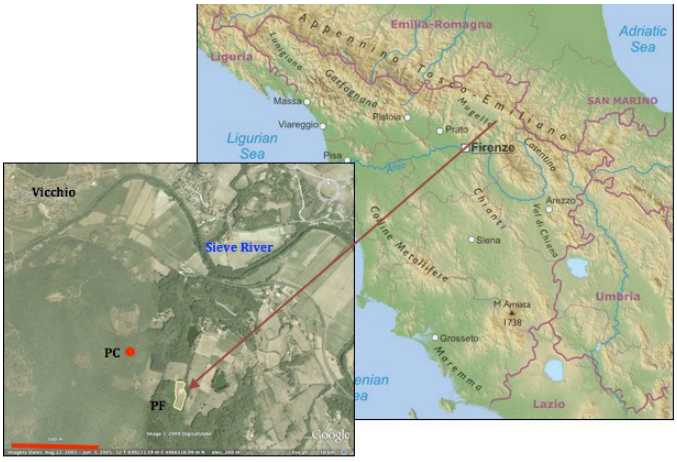

Figure 1. Map of the area around Poggio Colla, Tuscany, including the Northern Appenines, Arno River, modern city of Florence (Firenze), and the Mugello Valley. Inset shows Poggio Colla (red dot) and the Podere Funghi (yellow outline) above the Sieve River and the modern town of Vicchio. Map of Tuscany from http://www.freeworldmaps.net/europe/italy/tuscany.jpg; base map for inset from http://maps.google.com.

GEOLOGIC BACKGROUND

The site is in the Arno Valley, beneath the Tuscan-Emilian Apennines. The Apennine Mountains, running down the spine of the Italian peninsula, are a fold and thrust chain, formed as a result of the convergence of the European and African plates. The Northern Apennine arc was built by both compres-

Figure 2. From left to right: Sara Bon-Harper, Stacey Sosenko, Maija Sipola, Rowan Hill, Avery Cota, Anna Pendley, Jane Didaleusky, and Rob Sternberg.

sional and extensional phases. The Mugello Valley, ca. 30 km north of Florence, is 25 km long by 25 km wide, with a WNW–ESE structural trend (Fig. 3). The Mugello Basin consists of tectono-sedimentary units piled up in an imbricated thrust-sheet system developed throughout the Tertiary in a continental collisional setting. Extensional phases resulted in the formation of grabens that were filled by alluvial and lacustrine Plio-Pleistocene siliciclastic sediments. The Mugello is one of several intermontane basins which have been often interpreted as half-grabens (Martini and Sagri, 1993; Benvenuti, 2003; Sagri et al., 2004).

ARCHAEOLOGICAL BACKGROUND

The research design of the Mugello Valley Archaeological Project and Poggio Colla Field School combines excavation, geoarchaeological survey, and archaeometry as part of an interdisciplinary regional landscape analysis of the Etruscan site of Poggio Colla and the surrounding area (Warden et al., 2005). The project is co-directed by Prof. P. Gregory Warden, a classical archaeologist and Associate Dean of the Meadows School of the Arts at Southern Methodist University, and by Dr. Michael L. Thomas of the University of Texas at Austin. Sponsoring institutions include the Meadows School of the Arts at Southern Methodist University, Franklin and Marshall College, and the University of Pennsylvania Museum of Archaeology and Anthropology. Provost and Shirley Watkins Steinman Professor of Classics Ann Steiner of F&M is the Director of Research. The Director of Materials is Gretchen Meyers, Assistant Professor of Classics of Franklin and Marshall College.

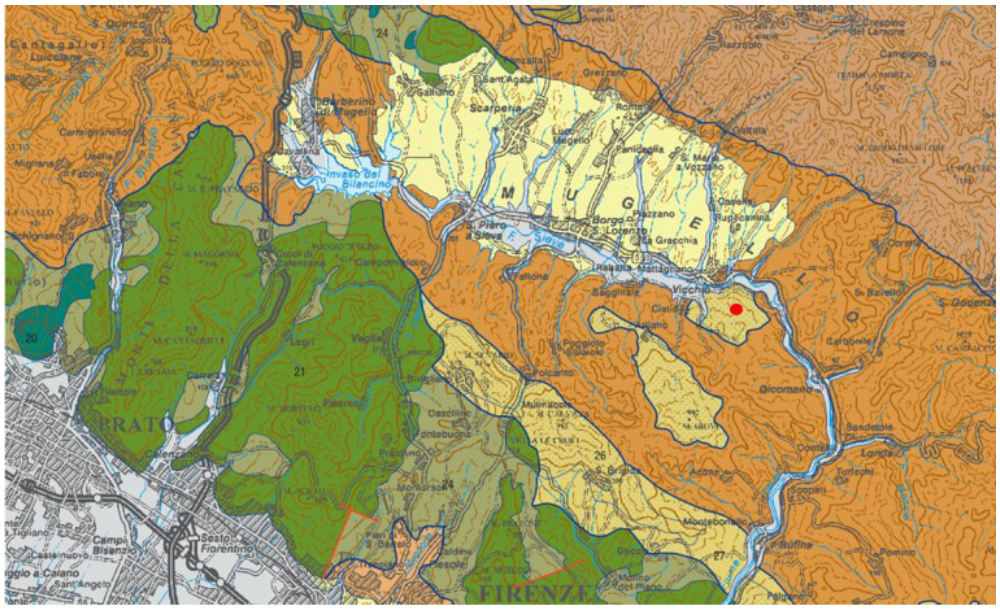

Figure 3. Geologic map of the Mugello Valley area (from Carmignani and Lazzarotto, 2004). The major units by map color are: the yellow of the Mugello Basin (Pliocene-Quaternary fluvial-lacustrine sediments); the yellow-brown around Poggio Colla (unit 26; Oligocene-Miocene sandstones and conglomerates); the reddish-brown surrounding Poggio Colla (unit 30; Oligocene-Miocene sandstone flysch); the chocolate brown to the northeast of the Apennines (unit 42; Miocene arenaceous marly flysch); the dark green (unit 21; Paleocene-Eocene flysch), the light brown (unit 24; Cretaceous-Paleocene shales, sandstones, and conglomerates), and the green-blue (unit 20; Jurassic ophiolites). The red dot indicates the location of Poggio Colla and the Podere Funghi. Scale is 1:250,000.

The project seeks to contribute significantly to the understanding of Etruscan culture. The Etruscans were an Iron Age people who inhabited central Italy during the first millennium BCE. The Etruscans adopted certain aspects of Greek culture while retaining their own language, religion, and customs. Etruscan culture had a profound impact on the development of Roman society (Bonfante, 1996). Poggio Colla seems to have been inhabited by the Etruscans at least as early as the seventh century and was abandoned or destroyed in the early second century BCE.

Excavation of non-ritual Etruscan sites has been rare, although in the past few decades some important habitation and craft production sites (for instance, Murlo and Acquarossa) have increased our knowledge of Etruscan life substantially (Nijboer, 1998). Still, the Etruscans are known primarily from funerary remains, and much of our knowledge of the Etruscans comes from the wealthy southern centers of Veii, Caere, and Tarquinia. One of the problems is that the Etruscans chose their sites so strategically that the major centers were repeatedly built upon in the Medieval and later periods. We know where the Etruscans had their major cities (e.g., Volterra, Orvieto, Cortona, and Fiesole), but these sites are covered over with modern towns or cities and are therefore almost impossible to excavate. Poggio Colla offers an exceptional opportunity to excavate and study an important Etruscan settlement and its context in the physical and social landscape, and to do so with up-to-date methods and technologies. A long-term goal of the MVAP is an interdisciplinary regional landscape analysis of the area around Poggio Colla through the integrated use of geomorphology and archaeology (both survey and full-scale excavation). The Podere Funghi research emphasized by Keck project members is a portion of this landscape approach.

The site of Poggio Colla should prove singularly important for the information it will provide about Etruscan urbanization, architecture, and daily life. The surrounding countryside also has the potential to add enormously to what is known of Etruscan economic and social systems. Our Keck project addresses these topics with a focus on a ceramic production center (400-200 BC) in a field known as the Podere Funghi, approximately 0.5 km from Poggio Colla. A ceramic producing workshop, including four kilns, and a nearby midden were excavated by the MVAP at the Podere Funghi since the site's discovery in 1998 (Warden et al. 2005). Our research goals include understanding the exploitation of the ancient geologic resources used in the ceramic production, the relationship of the Podere Funghi production site with the Poggio Colla ritual center, and the nature and extent of the ceramic production itself. These questions are especially resonant given the project's location in the Mugello Valley, a region on the edge of the Northern Apennines and at the northeastern periphery of Etruscan territory. This area is less well known archaeologically than the central Etruscan territory and could provide important information about Etruscan connections and trade routes with their Italic neighbors to the north and along the Adriatic coast to the east.

PREVIOUS RELATED WORK AT MVAP

The 2008 Keck project research was built on several seasons of preliminary investigations. The results of these studies and goals of the larger Mugello Valley Archaeological Project helped form the direction of the research presented here. Sternberg and Fred Martino (F&M '08) focused on magnetometry and magnetic susceptibility. They demonstrated that high magnetic susceptibility on an excavated floor is an indicator of burned areas such as kilns, that high magnetic susceptibility correlates with intensity of habitation, as observed in the profile of an excavation, and that magnetic kilns have an observable and distinctive magnetic survey signature (Martino, 2005). As a controlled experiment, they measured a distinctive magnetic anomaly over a previously found, backfilled kiln. Another anomaly in the Podere Funghi area was highly suggestive of a buried kiln.

During the 2007 season, Sternberg and Erin Bradley (F&M '09), carried out more intensive magnetometry in the Podere Funghi, primarily to locate kilns and kiln wasters (Bradley, 2007). Nearly 80,000 data

points were collected using a G858 magnetometer, covering 1.6 hectares. This survey identified 11 significant anomalies, several of which were consistent with the signatures expected from kilns. Other investigators have completed unpublished electrical resistivity (http://www.smu.edu/poggio/resistivity-prospection.html), and electromagnetic and ground penetrating radar (http://www.smu.edu/poggio/frankventoproject.html) studies at the site.

The 2007 geophysical surveys were carried out in tandem with systematic shovel testing in the Podere Funghi supervised by Bon-Harper (discussed below), and a broader geoarchaeological coring survey designed to identify buried archaeological strata in the immediate vicinity of Poggio Colla, which was led by other MVAP staff members (http://smu.edu/poggio/07_coringsurvey.html).

Previous work also includes a field visit from soil scientist Neil Tabor in 2005 (http://www.smu.edu/poggio/soils_neiltabor.html). In 2007 Alessandra Pecci, a specialist in the chemical analyses of floor surfaces within archaeological sites, and in the study of organic residues within vessels, advised Sarah Hartman (F&M '08) as part of an independent study project applying high performance liquid chromatography to organic residues in cooking vessels from Poggio Colla.

Materials analysis is widespread in archaeometry for purposes of provenancing raw materials, artifact characterization, and technology studies (Brothwell and Pollard, 2001). A study by Winkler et al. (2005) used petrography on Poggio Colla and Podere Funghi ceramics to identify six basic pottery types according to matrix and temper, and plasma emission spectroscopy on raw clays from the area and kiln wasters and sherds from Poggio Colla and the Podere Fundhi to provisionally define compositional types. Isaac Weaver (F&M, '05) worked with Prof. Stan Mertzman on a geochemical project, using XRF to characterize the geochemistry of 69 ceramic sherds in order to consider the relationships among different ceramic types (Weaver et al., 2006). The results of this preliminary study suggested that the ceramics produced at the Podere Funghi had a distinctive chemical composition. Weaver et al. (2006) also compared the chemistry of the Podere Funghi ceramics to the chemical data of 21 Bucchero fragments from Poggio Colla; the chemistry of most of these Bucchero samples is quite similar to that of the Podere Funghi ceramics.

The field surrounding the Podere Funghi ceramic workshop and midden was largely unexplored other than a test excavation area in the vicinity of a surface scatter of artifact noted when the field was tilled using deep-plowing methods in the 1990s (Fig. 4). To address the potential of additional activity

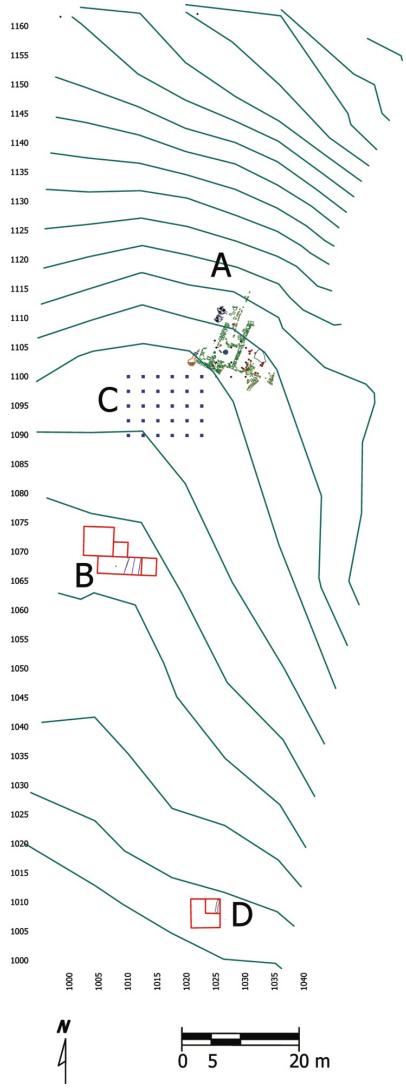

Figure 4. The Podere Funghi showing excavated workshop (A), midden excavation area (B), preliminary grid of STPs at 2.5 m intervals (C) and test excavation in the area of an observed surface scatter (D). Site grid easting and northing values are marked on those axes.

areas surrounding the workshop and to assess the potential of plowzone spatial data contributing the understanding of such sites, Bon-Harper proposed a plowzone sampling program across the Podere Funghi. This research was designed using the results of a preliminary grid of 30 shovel test pits (STPs) spaced at 2.5 m intervals balanced with estimates of time required for testing. The result was a systematic shovel-test sampling of plowzone at 5 m intervals that was carried out in 2007 and 2008 (http://smu.edu/poggio/08_shoveltestpit_bon-harper_project.html).

The excavation of a 50 cm diameter STP into the plowed sediments with screening through quarter-inch mesh reveals the stratigraphy at each point and the presence, absence, and nature of archaeological artifacts. The study of artifacts in plowzone is based on interpretable relationships between the locations of plowed artifacts and the locations of underlying archaeological features (O'Brien and Lewarch, 1981; Dunnell and Simek, 1995). This intra-site survey of the entire field provides systematic testing in all areas that had not been excavated between 1998 and 2005, regardless of prior assumptions about artifact presence/absence provided by surface distributions visible during the last years of plowing. It is designed to produce an image of activity zones and work areas across the site (cf. Bon-Harper et al., 2004; Bon-Harper and Wheeler, 2005), and it revealed several areas of high artifact density other than the known ceramic workshop and dump (Bon-Harper, 2008). The first 93 STPs on the 5 m grid were excavated in 2007 and a further 193 were completed in 2008 by the Keck team and Poggio Colla Field School students. The spatial sampling was conducted with support from the Etruscan Foundation in the form of the 2008 Etruscan Foundation Research Fellowship for Bon-Harper.

The spatial sampling originally provided a basis of comparison for geophysical research in 2007 and then formed the first layer of a multi-layered dataset produced by the Keck students' research in 2008. Encouraging correlations were noted in the maps of magnetic measurements and STP finds (Fig. 5). The data also suggest that there is only a limited relationship between artifact densities and the depth of plowzone.

Figure 6 presents weights of artifact assemblages and plowzone depth to examine whether areas of deeper plowzone have larger artifact assemblages, which would indicate that areas of high artifact density are

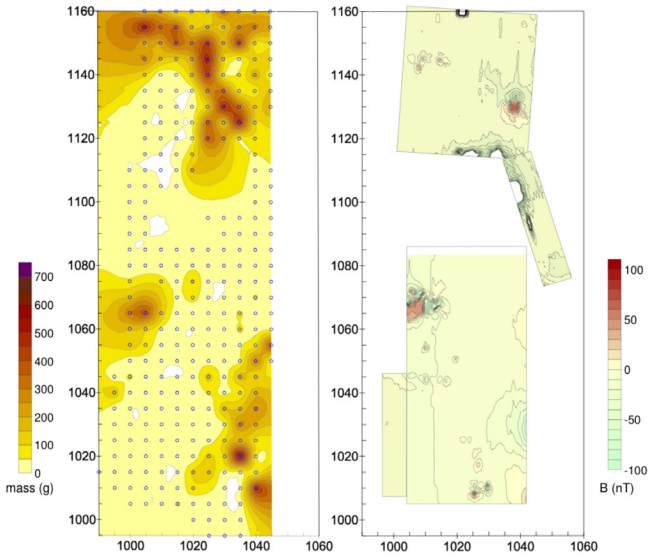

Figure 5. Podere Funghi STP finds from the 2007-08 field season (left), compared with the magnetics maps from the 2007 field season (right), based on measurements by Bradley (2007). The area cut out of the center of the magnegics map corresponds to the area previously excavated and its immediate surroundings. From Sternberg and Bon-Harper (in press).

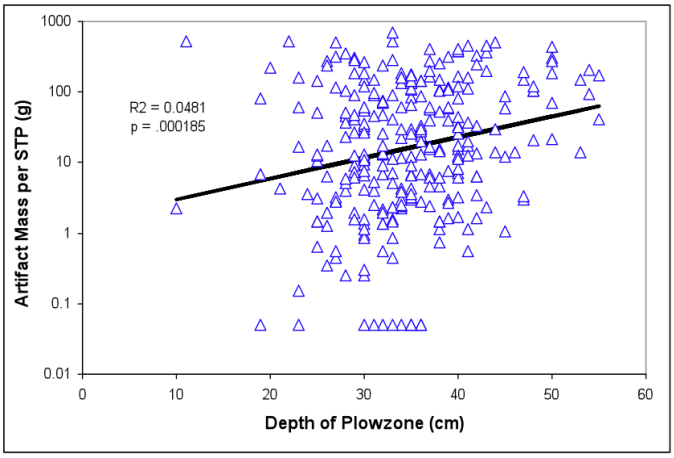

Figure 6. Artifact assemblage weight (in log of values of mass in grams) for each STP is plotted against the depth of plowzone. There is a correlation between the two measurements, but depth of plowzone accounts for only 4.8% of the variability in artifact assemblage weight.

the result of colluviation. In exploring the relationship between STP depth and the total mass of artifacts per STP, we regressed log values against plowzone depth. The reason for using logs is that the range of assemblage weights and was large, and the distribution of their values was highly skewed. The log values normalize the distribution of residuals from the fitted line. The fitted line only accounts for 4.8% of the variation in the logged values of mass, with an R2 value of .048 ($F(1,284) = 14.35$), $p < .0002$. There is a significant relationship between plowzone depth and assemblage mass, but this is not a substantive one. In other words, the depth of plowzone accounts for only a small portion of the variation in assemblage weight. From this exploration, we can state that colluviation is likely not an important factor in artifact distribution, although there is an underlying relationship. We suggest that it may contribute mostly in the areas of deepest plowzone at the foot of the hill in the north. The relationship between assemblage mass and depth of plowzone as well as the correlation between magnetometer and STP results implies that human activity rather than colluviation is responsible for artifact distributions.

STUDENT PROJECTS, 2008

In addition to individual student research project goals, the objectives for the 2008 field season were to complete the STP data collection in the Podere Funghi, to generate a better magnetic data set, and to collect other layers of information that could complement the STP and magnetic data.

Our Keck project sought to maximize interaction between the archaeological and the geoarchaeological components of the work at Poggio Colla by running the Keck project simultaneously with the Poggio Colla Archaeological Field School. This provided various opportunities for the geology and archaeology students to work together and interact, which is the model for the best collaborative efforts in any archaeometric research. Archaeology students assisted with the STP project. Keck students had an opportunity to participate in the archaeological excavation and also attended some of the evening lectures presented by the field school staff.

As will be more fully described in the following papers, the six Keck projects fell into three general categories:

1. Magnetics. The magnetics survey project by Stacey Sosenko had several goals: to acquire a higher resolution and more complete data set for the Podere Funghi, to get higher resolution data in the vicinity of a prominent dipolar anomaly in the field to the north of the Podere Funghi identified by Bradley (2007), and to begin work in other areas identified as interesting by the archaeologists. Avery Cota's project used magnetic susceptibility, which is being increasingly used in archaeology as an indication of human habitation and activities. The grid of magnetic susceptibility readings where magnetometry was also done could be used to look for correlations between the two data sets and to better understand the sources of magnetic anomalies, which can be caused by susceptibility contrasts. Avery not only measured susceptibility on the surface but also made downhole measurements to generate a three-dimensional array of susceptibility readings. Selected samples were returned to the laboratory for further analyses with a laboratory susceptibility probe.

2. Soils. Soils are the matrix in which archaeological sites and artifacts occur; soils sediments, and landscapes are the focus of traditional geoarchaeological research, which attempts to place archaeological sites into their geological context. Maija Sipola characterized the soils in the Podere Funghi to better understand the geomorphic evolution of this parcel of land, essential to an understanding of potential artifact movement, and to relate it to the findings of the coring survey over a larger area. Rowan Hill examined the phosphate signature in these soils, since soil chemistry and phosphate in particular can be a proxy indicator of human activity in an archaeological landscape.

3. Materials. Jane Didaleusky continued the ceramic and clay characterization of earlier work by further exploring the area around the Podere Funghi for possible ceramic clay sources, and looking at a

different cohort of ceramic samples. The chemistry of the samples, x-ray diffraction of the clay minerals, and the petrographic examination of course inclusions in the ceramics were all considered. Anna Pendley took a more careful look at the spatial relationships of artifacts recovered from STPs, including size distributions, and implications for the possible source areas of these artifact scatters.

CONCLUSION

Integration of the various data sets is a task yet to be done. One thing learned already is that the STP work and the geophysical methods can be effective complementary methods. STPs are labor intensive, yet recover artifacts that are temporally diagnostic. Geophysics is rapid, but says little about the age of the sources of the anomalies. We plan to strategize how to optimize the use of these methods together for future work in another field adjacent to the east of the Podere Funghi.

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