

CENTER FOR ANCIENT MIDDLE EASTERN LANDSCAPES (CAMEL)

Emily Hammer

The Center for Ancient Middle Eastern Landscapes (CAMEL) engages in a number of regional research and cultural heritage projects. The goals of these projects are to train graduate and undergraduate students in the use of geographical information systems (GIS) for archaeological, historical, and cultural heritage research, to provide student research, publication, and presentation opportunities, and to collaboratively develop innovative methods and approaches within the field of Near Eastern landscape archaeology. Projects continuing from last year include the Archaeological Heritage of Afghanistan Mapping Project, the Anatolian Atlas Project, and a historical elevation model methodology project. Newly begun projects include the LandCover6K project and the Desert Kites of Eastern Jordan project.

Alongside of these research projects, we undertook several infrastructural projects in coordination with other units of the Oriental Institute, including a database migration and web development for the public face of the new database, the production of new maps for parts of the Oriental Institute Museum, and the presentation of CAMEL work in the museum. I detail the goals, products, and accomplishments of these projects below in a thematic order.

Archaeological Heritage: The Afghanistan Mapping Project

The satellite imagery analysis methods used in landscape research are an important way to continue archaeological research and to monitor cultural heritage preservation in conflict zones across the Middle East and Central Asia. CAMEL devoted most of its research efforts this year towards cultural heritage projects concerning the sites and monuments of Afghanistan. CAMEL's preliminary work on this topic in 2014–2015 culminated in a successful application for generous federal funding. The Afghan Heritage Mapping Partnership is a three-year project (October 2015–October 2018) supported by an institutional grant from the US Department of State to the Oriental Institute. The first-year award for this grant was just under one million dollars. The Partnership draws on satellite imagery and other geospatial technologies to build a comprehensive GIS database of identifiable archaeological sites across Afghanistan. The goals in creating this database are to inventory and map known and previously unknown archaeological heritage sites, especially in areas threatened by future mining development, urban expansion, and looting; to document the current state of archaeological site preservation and analyze spatial and temporal patterns in looting; to create a planning tool that allows heritage protection to be incorporated into mining, economic, and urban development projects; and to train a cohort of Afghan information technology specialists and heritage professionals in the use of GIS technology for cultural heritage management.

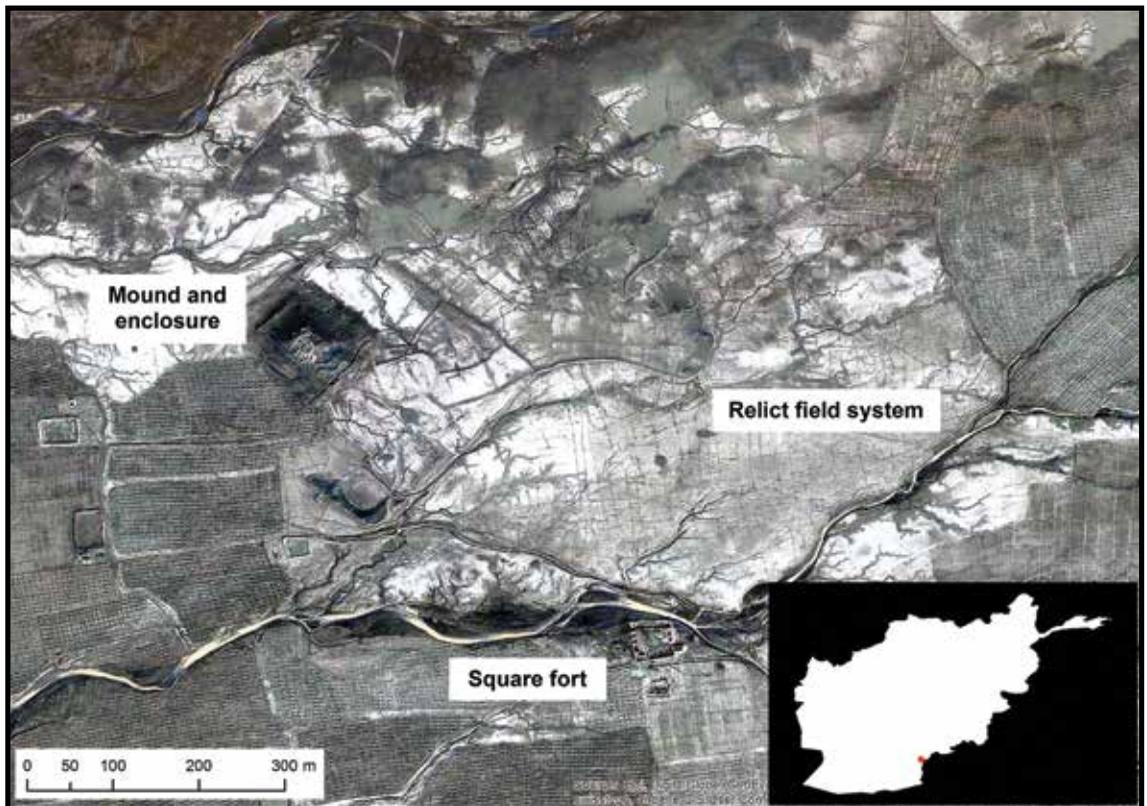
Much of the work for the grant has taken place remotely in Chicago. Completion of grant tasks required that CAMEL staff receive specialized training in the use and interpretation of satellite imagery. In addition to the ongoing training provided by the CAMEL Director and Assistant Director (Emily Hammer and Anthony Lauricella) as well as a GIS Analyst (Kathryn

Franklin), we offered an intensive training program with a visiting Afghanistan expert, David Thomas of LaTrobe University in Australia. Thomas spent a week in the CAMEL lab in January 2016 working with students and staff individually and in small groups. This training increased everyone's ability to recognize archaeological sites in satellite imagery and also gave CAMEL the opportunity to solicit Thomas' useful advice on various aspects of our Afghanistan projects, from database structure to data sources.

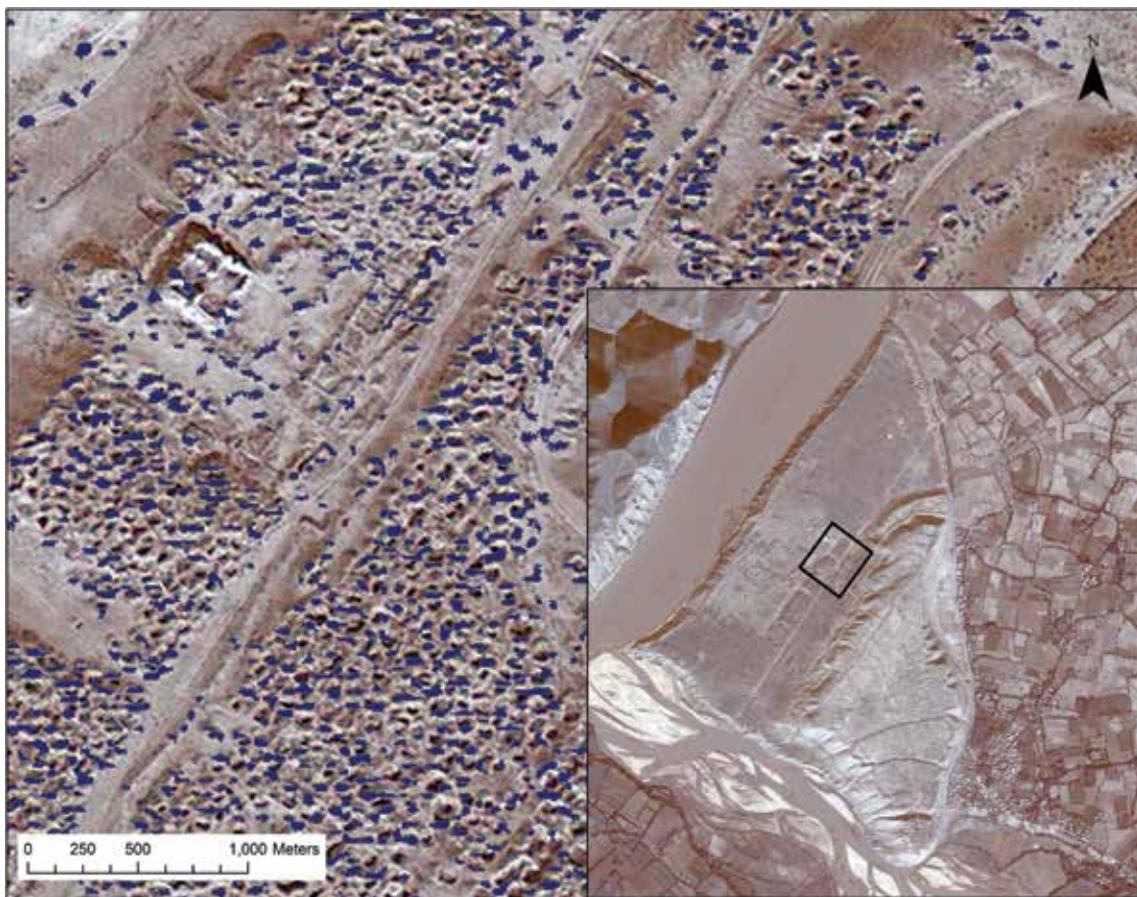


CAMEL staff and students during a satellite imagery interpretation training session with visiting Afghanistan expert, David Thomas (January 2016)

The first step of our database development has involved the correction and expansion of data on sites inventoried in the 1982 Archaeological Gazetteer of Afghanistan (authored by Ball and Gardin). Before the start of the grant, in 2014–2015, we had built a preliminary GIS



A newly identified archaeological site near Spin Boldak, southeastern Afghanistan. Imagery from DigitalGlobe



Looting analysis applied to Ai Khanoum (Alexandria-on-the-Oxus), northeastern Afghanistan (figure by Anthony Lauricella). Imagery from DigitalGlobe

database of the 1,286 sites in that Gazetteer. The spatial data published in the Gazetteer was produced before civilian use of GPS for mapping and has long been known to be inaccurate. Each of the gazetteer sites' coordinates has now been "verified": the site was located in modern DigitalGlobe satellite imagery and more precisely mapped using both points and polygons to represent the sites' center points and areal extent. This corrected dataset has already been used to help the US Committee of the Blue Shield (directed by Patty Gerstenblith, Research Professor of Law at DePaul University) develop a geospatial no-strike list that aids in planning military action such that it does not harm major heritage sites.

The second step of our database development and grant research involves identifying previously unmapped archaeological sites using both maps and satellite imagery. We pursued site identification in several different areas of the country including Spin Boldak in the south-east, Herat in the west, and Balkh in the north. These areas were chosen for remote survey on the basis of their potential to yield important previously unmapped sites and on the basis of information suggesting sites in those locales have been/will be threatened by looting, urban growth, intensive agriculture, and/or mining.

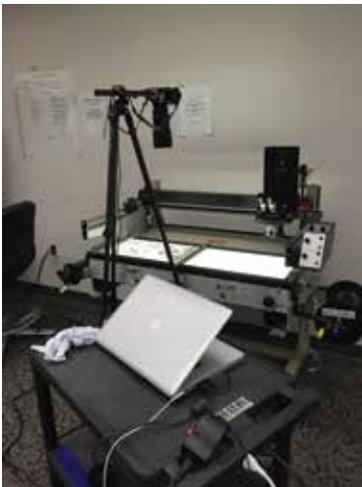
The third component of the project aims to diachronically document destruction of archaeological sites through looting, development, and other processes. We used time-series of high-resolution DigitalGlobe imagery, made available to use through State Department-



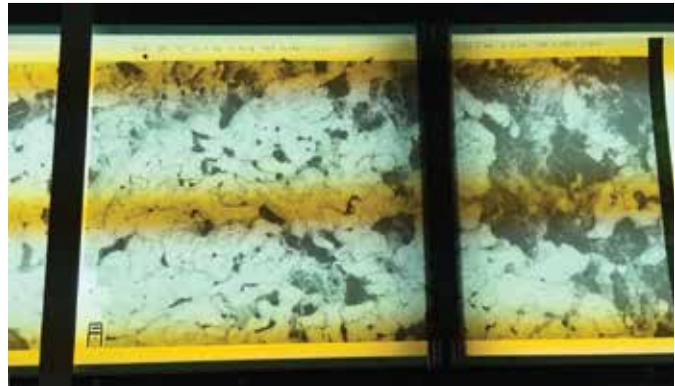
Emily Hammer presenting a satellite image of the archaeological site of Balkh to the chancellor and GIS faculty of Kabul Polytechnic University during a meeting to discuss training of Afghan archaeologists (photo by Gil Stein, July 2016)

provided access to an online repository, to record types and severity of destruction at 137 significant sites from the 1982 Gazetteer.

Various project participants have and will continue to present the results of these projects at upcoming conferences and publications, significantly increasing the visibility of the lab and



a



b

Re-photographing U2 aerial film in the National Archives' Aerial Film Section (December 2015). (a) Equipment set-up; (b) Close-up of U2 film on the light table

its programs. Graduate students Anthony Lauricella and Joshua Cannon, alongside current and former CAMEL directors Emily Hammer and Scott Branting, gave a conference paper at the last American Schools of Oriental Research (ASOR) Annual Meeting in November 2015 on a new method to automatically detect looters' pits on the surfaces of sites in Afghanistan. In June 2016, they submitted an article to the journal *Antiquity* on the development of this method and its application to the site of Ai Khanoum (Alexandria-on-the-Oxus, Takhar Province in northeastern Afghanistan). Emily Hammer also gave a conference paper at the 2015 ASOR meeting on the relationship between Bronze and Iron Age sites in Afghanistan and the mineral sources surrounding them. This paper modeled mineral trading networks using the locations of known mines, known sites, and environmental factors such as topography. In the upcoming fall, Emily Hammer and Anthony Lauricella will present the results of their analysis of pre-Islamic forts in Balkh at the "Limits of Empire" conference to be held at the Oriental Institute in October 2016 and at the ASOR Meeting in November 2016. Kathryn Franklin and Anthony Lauricella will present the results of our country-wide looting analysis and of our remote survey of Spin Boldak at the ASOR Meeting in November 2016.

The State Department grant also funds a GIS training program for archaeologists and cultural heritage specialists in Afghanistan. In July 2016, Emily Hammer, Gil Stein, and Steve Camp traveled to Kabul to arrange the details of this training program, which will be carried out in collaboration with the GIS faculty of Kabul Polytechnic University (KPU). KPU has two GIS laboratories outfitted with one hundred computers powered by stored solar energy and loaded with GIS software. These laboratories were created with support from a US Embassy in Kabul grant led by Hussein Abaza (Kennesaw State University, Atlanta). The Oriental Institute will provide teaching resources and curricula in order to extend KPU's expertise to archaeological applications of GIS and to inform students who will work in the urban planning and mining sectors about cultural heritage concerns. We are grateful to have such terrific infrastructure and partners to facilitate our training program, which is slated to begin in the coming year.

Environmental Archaeology: LandCover6K

The methods of landscape research allow archaeologists to pursue questions about ancient environment and land-use, which connect the field to other disciplines, including climate modeling. CAMEL has expanded its research interests to include environmental archaeology through participation in a global collaborative working group called LandCover6K (<http://www.pages-igbp.org/ini/wg/landcover6k/intro>; <http://landuse.uchicago.edu/>). Humans have been one of the forces shaping global climate for thousands of years. A major weakness of current global climate models is that they do not incorporate historical or archaeological data concerning pre-modern human transformation of the environment. The LandCover6K project aims to address this weakness by bringing together researchers from three communities: paleoecologists who examine past vegetation changes through the study of pollen and other plant remains preserved in sediment sequences, archaeologists and environmental historians who study ancient and historical patterns of human land-use, and climate modelers. CAMEL is playing an important role in the land-use component of the project, which is directed by Professor Kathleen Morrison (Anthropology Department). Emily Hammer and the lab staff are working with other historians and archaeologists to map land-use in different periods over the last 6,000 years in the Middle East. The project relies on GIS in order to create maps of

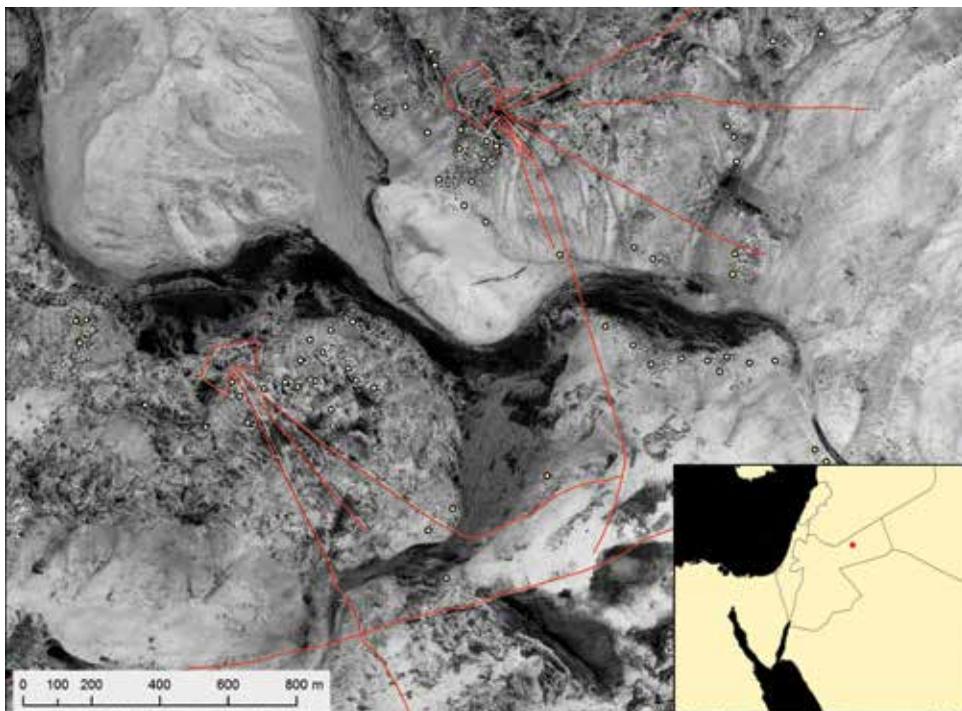


An array of georeferenced U2 aerial photographs covering areas with desert kites in eastern Jordan (U2 CHESS Mission 1554, January 1960)

different land-use zones at different historical moments and to build a database of different characteristics of land-use practices through time. CAMEL serves as the global data manager for the land-use component of the project, integrating data collected from teams working on different geographical regions. In October 2015, Emily worked with an international group at the UChicago Center in Paris, France, to develop a global land-use classification scheme and to decide upon a list of variables that all teams will encode in order to allow for generalized modeling in the future.

Historical Aerial and Satellite Imagery: New Data Sources, Mapping Desert Kites, and Generating Historical DEMS

Historical aerial and satellite imagery, especially declassified Cold War-era “spy” imagery, has transformed the field of Near Eastern archaeology over the last decades by providing a window into the past, before the destructive effects of development and intensive agriculture destroyed or obscured archaeological sites in many rural areas. The use of CORONA imagery — from a spy satellite program that took high-resolution images from the late 1960s to early 1970s — has become widespread in archaeology since its declassification in 1996. The availability, quality, and usefulness of CORONA imagery has been a factor shaping the regions and topics pursued by landscape archaeologists in some Middle Eastern regions. CORONA is not high resolution enough to be of use everywhere, and in some areas CORONA images post-date development programs that had already re-shaped the landscape.



Desert kites and other stone features traced in U2 aerial photos (U2 CHESS Mission 1554, January 1960)

Over the last two years, CAMEL has been at the forefront of efforts to access and utilize new sources of historical imagery that were recently declassified in 2013, particularly U2 aerial imagery (mostly captured 1959–1960) and HEXAGON satellite imagery (captured 1971–1984). These new sources of imagery are exciting for Near Eastern landscape archaeology because they often provide higher resolution coverage than that available from CORONA images. U2 aerial images also provide a picture of the landscape that is 5–13 years older than that provided by the highest resolution CORONA images. Archaeologists have yet to use U2 and HEXAGON imagery because, unlike CORONA imagery, it has not been scanned and is not available for online purchase and download. Accessing this imagery requires traveling to the National Archives’ Aerial Film Section, examining physical film rolls on light tables, and re-photographing film negatives. These photographs are then georeferenced back in the CAMEL lab. In December 2015, Emily Hammer spent two weeks in Greenbelt, Maryland, re-photographing U2 and HEXAGON imagery for various projects. Ongoing CAMEL projects that are starting to use these new imagery sources will lay the logistical and methodological framework for them to be more widely used in Near Eastern archaeology.

CAMEL has most extensively used these new sources of historical imagery for a project focused on desert kites and other stone structures preserved on the surface of the basalt desert (*harra*) of eastern Jordan. Desert kites are widely believed to have served as mass-kill hunting traps, where groups of wild ungulates were herded from the wide to the narrow end of the trap. Kites often resemble Christmas trees, stars, or jellyfish when viewed from above, and are often spatially associated with other stone structures like corrals, small building foundations, and circular structures with radiating “spokes” that archaeologists call wheels. These features are visible in high-resolution modern and historical satellite imagery because

later land-use has not been intensive enough to erase earlier sites from the landscape. They have been studied for decades, but until recently were never systematically mapped. Various projects, most notably the French Globalkites collaboration (<http://www.globalkites.fr/>), have begun to undertake regional-scale analysis of desert kites. CAMEL students and staff have been using U2 imagery captured in January 1960 to systematically map kites and their surrounding features. As the project moves forward, we plan to employ environmental GIS analyses to better understand the positioning of these traps and settlements in relationship to the landscape. In particular, we have been examining the relationship of kites and settlement to areas where surface or groundwater seasonally pools. Such pools have been identified on the basis of multi-spectral satellite imagery and precipitation records.



CAMEL students learned geophysics methods in Naxçivan, Azerbaijan, in March 2016, as part of Emily Hammer's survey project. Graduate students Anthony Lauricella (foreground) and Sam Harris (background) collect magnetometry data next to the Middle Bronze and Iron Age fort of Qizqala

Historical satellite imagery has uses beyond visual analysis: if multiple images are available from different angles, these images can be used to generate a historical topographical model. Historical topographic models are important for the detection of mounded archaeological sites as well as for the study of ancient landscape features such as canals. Building on a project begun last year in collaboration with Jesse Casana (then at the University of Arkansas; now at Dartmouth College), CAMEL continued to refine a methodology for building historical digital elevation models using CORONA imagery. This methodology has been tested using imagery from various places in the Middle East, but found its first research application on a project in southwest China. Emily Hammer worked with Associate Professor Alice Yao (Anthropology Department) to develop a 1968 topographic model of the area that Yao surveyed in the Dian Basin. This area has since been covered by dense urban development, but CORONA imagery and the historical topographic model derived from it preserve a record of the location and volume of various ancient settlement mounds that Yao endeavored to map.

GIS and Historical Geography: The Anatolian Atlas Project

Contributed by Joshua Cannon

GIS has useful but largely unexplored applications in the field of historical geography. A project preliminarily begun in 2014–2015 and significantly expanded this year, the Anatolian Atlas, seeks to bring together GIS, philology, and historical geography. The aim of the



The geophysics team celebrating Novruz (spring equinox/New Year) in Naxçıvan, Azerbaijan. From left to right: Dr. Jason Herrmann (geophysics expert, University of Tübingen), Michael Johnson (graduate student, NELC), Vəli Baxşəliyev (Naxçıvan State University), our local driver, Anthony Lauricella (graduate student, NELC), and Sam Harris (graduate student, NELC)

project is to create an online atlas of Anatolian archaeological sites that can serve as a useful research tool as well as a venue for displaying new research conducted in CAMEL. Graduate student Joshua Cannon and undergraduate researcher Rolland Long are creating a website that displays geographic and bibliographic data on central Anatolian archaeological sites in order to highlight and re-assess debates in historical geography literature for the Hittite period. Their preservation and re-assessment of these debates equally draws on recent textually based methodological advances in Bronze Age Anatolia historical geography by authors such as Barjamovic (*A Historical Geography of Anatolia in the Old Assyrian Colony Period*, 2011) and Kryszewski (*A Historical Geography of the Hittite Heartland*, 2014) and on GIS analyses of movement. The spatial data for the project derives from recent regional archaeological surveys and topographic analyses. The GIS assessment of travel times between known sites, combined with textual analysis, allows for the generation of hypotheses regarding the location and the route and stopping points of the AN.TAḪ.ŠUM festival documented in Hittite texts. Joshua and Rolland will present this research at the upcoming ASOR meeting in November 2016 and also intend to make their website public by that time.

Database Migration

Over the last two decades, CAMEL has greatly benefitted from its ever-expanding database, which now contains around 20,000 georeferenced maps, satellite images, and other spatial

datasets relevant to the archaeology and history of the Middle East. Since 2014, we have been working to make this data available to the whole Oriental Institute and to the public by transitioning towards use of the Oriental Institute's Integrated Database (IDB). With the dedicated guidance of IDB project managers Foy Scalf and Anne Flannery and the financial support of a two-year IMLS grant (2014–2016), CAMEL Assistant Director Anthony Lauricella oversaw the migration of our old custom-built database to the new IDB software. This involved continual testing of migrated data to find mistakes in the programming and to find inconsistencies in the structure of our data. The IDB team also worked with the university's IT services to design a web interface that will allow the public to search and download certain categories of CAMEL data. This web interface is currently being programmed, and we expect it to be online by fall 2016 — look for the “CAMEL” option under the “Search all” drop-down box at <http://oi-idb.uchicago.edu/>.

CAMEL and the OI Museum

CAMEL has a close relationship with the Oriental Institute Museum and frequently contributes materials to permanent and temporary exhibits. The maps for the museum orientation area and for the Nubian exhibit needed to be updated in their appearance and content, and CAMEL participated in the design and production of the new maps that are now on display. Graduate student Émilie Sarrazin worked to incorporate new research on the spatial distribution of cultures into the new maps for the Nubian gallery. The exhibit currently in the museum's temporary space, “Persepolis: Images of an Empire,” includes a video of a historical 3D model of Persepolis that graduate student Jennifer Altman-Lupu produced in 2014–2015 using Erich Schmidt's 1936 aerial photos. The video is also available online on the Oriental Institute YouTube channel (<https://www.youtube.com/watch?v=ujf5bnHUIQw>).

Acknowledgments

Students and grant staff are the heart and blood of CAMEL's research programs. Many committed individuals ensured our success this year. Our student staff for general laboratory projects included Anthony Lauricella (Assistant Director), Samuel Cahell, Corey Husak, and Émilie Sarrazin. Joshua Cannon and Rolland Long carried out all work on the Anatolian Atlas project. Afghanistan grant staff included Emily Boak, Danielle Brown, Shaheen Chaudry, Michael Fisher, Michael Johnson, and Gwendolyn Kristy. The efforts of Kathryn Franklin (Heritage Analyst and Student Coordinator for the Afghanistan Heritage Mapping Project) were essential to all of our grant-related database-building and research projects. Anthony Lauricella deserves a second and final mention for his skillful, patient management of lab staff and his dedicated, creative work on every project that CAMEL and I have carried out this year.
