

# Grass-roots Imaging: A Case Study in Sustainable Heritage Documentation at Chersonesos, Ukraine

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## Abstract

This paper documents a joint project of the Institute of Classical Archaeology (ICA) of the University of Texas at Austin, Cultural Heritage Imaging (CHI), and the National Preserve of Tauric Chersonesos in Crimea, Ukraine. The project centered on a workshop in which staff of the National Preserve learned to use Reflectance Transformation Imaging (RTI) to document unique objects from the Chersonesos museum. RTI creates interactive relightable images with 3D content. The Chersonesos project serves as a case-study of the potential of this technique for a sustainable, locally-directed program of heritage imaging and documentation at a site without independent access to complex and expensive digital resources. In the West, developments in archaeological documentation are now frequently driven by technological advances: digitally-minded archaeologists are quick to adopt new and ever more powerful tools, even in the absence of specific questions these tools might help to answer, plans for sustainable digital preservation, or strategies for the dissemination of the results to the public. Approaches to the digital documentation of cultural resources thus often rely on equipment and software available only to a minority of well-funded projects, and disproportionately concentrated in Europe and the United States. When these technologies are applied to sites with limited resources outside Europe and the US, they are usually deployed by teams of Western specialists using software and equipment that are neither affordable nor locally available. Local collaborators can rarely continue such documentation programs without ongoing support, and in some cases, they cannot even use the digital information that has already been generated. Even more often, this digital heritage information is unavailable to the citizens of the country in which the site is located. At Chersonesos, the joint project of ICA, CHI, and the National Preserve centered on the use of relatively inexpensive, easily available equipment and software to create images that capture information interesting for both specialists and the general public, and that can be viewed with conventional web software. The goal of the project was to equip local participants to carry out independently further Reflectance Transformation Imaging of the rich but little-known collection of inscriptions, coins and gems at Chersonesos so that these interactive images could be shared with the Ukrainian and international public. We discuss the results of the workshop, the reactions of the participants and the National Preserve community, and perspectives on the future role of this imaging technique in the on-line dissemination of heritage information at the site. The applications of Reflectance Transformation Imaging for the monitoring of the condition of unstable objects and for the exchange of information between conservation professionals are also considered.

**Keywords:** *imaging, photography, documentation, dissemination, sustainability, preservation, relighting.*

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## 1 INTRODUCTION

Greek colonists founded Chersonesos on the shore of the Black Sea, in what is now Crimea, Ukraine, in the fifth century B.C. (fig.1). The city would be occupied continuously for almost 2000 years before its final destruction. Later, its 40-hectare urban core and 10,000 hectare agricultural territory would be the object of archaeological investigation for more than 180 years, from 1827 to the present. The long occupation of the site and its extensive excavation in the modern period have combined to produce an unusually rich material record of the Greek, Roman, and Byzantine past.<sup>1</sup> Despite vast numbers of finds of interest to archaeologists and ancient historians, and despite a long and impressive tradition of research at Chersonesos, the site was little known in the West for most of the twentieth century. Excavation results were often

published in summary form in Russian journals with limited circulation, and illustrations were not always of high quality. Even now, its treasures are inaccessible to most as a result of their geographic location, and threatened by the lack of funding for their proper conservation and curation.

Over the course of a 17-year collaboration with the National Preserve of Tauric Chersonesos, the Institute of Classical Archaeology (ICA) of the University of Texas at Austin has sought sustainable ways to protect the site's riches and bring them to the attention of Western scholars and the general public.<sup>2</sup> From the beginning, one of the most important goals of the collaboration has been the documentation and preservation of objects, monuments, and records in danger of deterioration or destruction.

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<sup>1</sup>For an illustrated overview in English, see Joseph Coleman Carter and Glenn Mack, eds., *Crimean Chersonesos* (Austin: National Preserve of Tauric Chersonesos and Institute of Classical Archaeology, 2003).

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<sup>2</sup>Details of ICA's activities at Chersonesos over the last two decades can be found in its Annual Reports, available on-line at [www.utexas.edu/research/ica](http://www.utexas.edu/research/ica).



**Figure 1.** Modern Ukraine and the Black Sea; Chersonesos, with its ancient agricultural territory (inset), is located just outside the center of the city of Sevastopol (map by Jessica Trelogan).

Equally important has been the dissemination of the resulting information to as broad an audience as possible. When Joseph Carter, ICA's director, began to work with the director of the National Preserve, Leonid Marchenko, and Deputy Director Galina Nikolaenko in the early 1990s, the joint project focused on the rapidly-disappearing archaeological remains in the ancient agricultural territory, and on a unique group of painted Hellenistic stelai and funerary monuments.<sup>1</sup> When the project began to receive the generous support of the Packard Humanities Institute in 2000, it was able to expand its focus to the digitization of some of the rare and delicate holdings of the National Preserve's library and archives. This initiative, dubbed the Megarika project, has proceeded since then under the able direction of librarian Ludmilla Grinenko, and has recently begun to implement a more ambitious program to disseminate information about archaeology at Chersonesos over the World Wide Web.<sup>2</sup>

<sup>1</sup> Joseph Coleman Carter et al., "The Chora of Chersonesos in Crimea, Ukraine," *American Journal of Archaeology* 104.4 (2000): 707–41; Adam Rabinowitz, Tatiana Yashaeva, and Galina Nikolaenko, "The Chora of Chersonesos: Excavations at Bezmyannaya, 2002," in *Archaeology at Kyiv-Mohyla Academy* (Kyiv: National University of Kyiv and Institute of Classical Archaeology, 2005), 146–57; Joseph Coleman Carter, ed., *Gravestones of Chersonesos. Research and Conservation* (Istanbul: National Preserve of Tauric Chersonesos, Packard Humanities Institute, and Institute of Classical Archaeology, 2006).

<sup>2</sup>For background information on the project, see [www.utexas.edu/research/ica/chersonesos/09ch\\_megarika.htm](http://www.utexas.edu/research/ica/chersonesos/09ch_megarika.htm). The project has produced a number of on-line resources to date, including the multilingual website of the National Preserve ([www.chersonesos.org](http://www.chersonesos.org)); a website for the National Preserve

The National Preserve's digitization and dissemination program has been very successful, but it has never been self-sustaining, and has relied on the ongoing financial support of PHI and the provision of high-tech equipment by ICA. The state funding necessary to support the National Preserve's digital infrastructure has not yet become available. So the will to digitize and share the National Preserve's vast collections and the human resources to do it are in place—but the money is not. To make a lasting documentation and dissemination strategy viable, the joint project has had to seek solutions that rely more on people than on equipment, and more on freely-available or open-source software than on processor-intensive or proprietary tools. When ICA encountered the digital techniques pioneered by non-profit organization Cultural Heritage Imaging (CHI), it was immediately clear that they offered just such a solution. At the same time, the difficult conditions at Chersonesos offered CHI an excellent test-case for the adaptability of their methods, and a chance to see whether training in these methods could lead to a sustainable program of heritage documentation at an institution like the National Preserve. All three parties thus leaped at the chance to collaborate, and over the following years built a relationship that culminated in a CHI workshop offered with support from the Packard Humanities Institute at the National Preserve in the summer of 2008. The preliminary results of this workshop suggest that CHI's documentation methods are indeed sustainable at Chersonesos, and will contribute significantly to the dissemination of useful digital information about the extraordinary holdings of the National Preserve.

## 2 PROVIDERS AND CONSUMERS

The range of digital tools available for the documentation of the world's cultural heritage has increased exponentially in the last decade. As equipment costs come down and processing speed goes up, tools and techniques that were once reserved for the best-funded and most experimental projects have been adopted by a somewhat broader section of the archaeological community. As these technological innovations are applied to more and more projects in North American and European archaeology, three important issues have emerged.

First, many of today's digital imaging tools, including some methods of 3D geometry capture, were developed

library, which includes downloads of some rare and early holdings ([www.library.chersonesos.org](http://www.library.chersonesos.org)); a website presenting the archival reports and illustrations of early excavator K. K. Kostyushko-Valyuzhinich ([www.kostyushko.chersonesos.org](http://www.kostyushko.chersonesos.org)); an online exhibit focused on early archaeological photography at Chersonesos ([www.archaeo-photo.Chersonesos.org](http://www.archaeo-photo.Chersonesos.org)); and a website that is intended to present photo-graphs and archival reports from excavations at Chersonesos in the first half of the twentieth century ([www.discovering.Chersonesos.org](http://www.discovering.Chersonesos.org)).

for the entertainment industry and designed to create special effects for movies and television, computer animations, video games, and multimedia products. These tools were designed for use by high technology artists and thus rely on the judgment and specialized knowledge of these technologists during the entire image generation workflow. This works well for the production of entertainment products. In archaeology, however, this model—in which a separate class of technology-savvy digital documentation “providers”, using tools that are complex, costly, and usually proprietary, service the documentary needs of professional archaeology “consumers”—has proven expensive and cumbersome. While a few thousand high-profile cultural objects and sites have been documented in this way since the processes became available more than a decade ago, the dependence on outside technical experts created by the producer/consumer model has meant that many new imaging technologies are still available only to a relatively small number of archaeological projects and heritage institutions.

This is much less true of technologies that are accessible enough to be deployed by archaeologists and cultural heritage workers themselves. Such technologies have seen more widespread adoption in North America and Europe, especially when they are compatible with existing working cultures. GIS and digital photography are prominent examples. Digital technologies, particularly in the field of 3D representation, will see widespread adoption when they can be used independently by cultural heritage workers for capture, processing and analysis, without technologists looking over their shoulders.

The second issue has long been reflected in the topics of sessions at recent CAA meetings, including the session in which this paper was delivered. When projects do use sophisticated digital imaging tools, how can the enormous and complex datasets they produce—datasets often held in proprietary formats and accessible only through very high-powered computer systems—be shared with the wider cultural-heritage community and with the general public?

The third issue is equally important, but generally receives much less attention. In the first world, high-tech tools, proprietary software, and fast computers are increasingly within the financial reach even of projects without lavish funding. This is not the case in second- and third-world countries, however, where both state funding and the resources of educational institutions are severely limited, and where a very small number of bright, dedicated, but poorly paid professionals are responsible for vast quantities of archaeological material, much of it unique and important but poorly published and often threatened with damage or destruction. In these contexts, local projects often cannot afford digital cameras, let alone laser scanners, and while many countries—especially the former Soviet states—have highly skilled programmers and computer scientists, they cannot obtain the platforms and

proprietary software that would enable them to carry out the sort of digital documentation applied to cultural resources in the West.

If we are agreed that we should be working together to increase the amount of information about cultural heritage resources available to a broad public over the internet, we must also consider how we may include participants outside or at the periphery of the first world. In many cases, museums and cultural-heritage institutions in this category have both the desire and the human resources to present their holdings digitally—but they lack the means to sustain programs of digital data collection and the computing power necessary to present complex documentation over the web.

Attempts to address these problems in many second- and third-world states reveal a familiar pattern: following the service provider/consumer model, a well-funded and highly-trained team of American or European experts arrives with the latest equipment to carry out a specific program of research. The most conscientious of these projects also make a point of training local participants and students in digital techniques and Western archaeological practices, but few of them can leave expensive equipment and software, and the resources to maintain them, with their local collaborators. When the project is over, the tools and the expertise disappear, the trained local operators have few opportunities to pass on their knowledge, and the results become accessible only through publication or display in the West. At best, the digital documentation is stored appropriately in the host country by local collaborators and disseminated broadly by the research team. Even under these ideal circumstances, however, the bulk of the information collected remains inaccessible both to scholars and to the community to which the cultural resources belong.

### **3 SUSTAINABLE DIGITAL METHODS AT CHERSONESOS**

These issues became an increasing concern for ICA and the National Preserve as the joint project’s goals became more ambitious and its reliance on digital tools more pervasive. Participants on both sides realized that many of the digital methods and systems developed in the course of the collaboration would be difficult to maintain at the National Preserve without high levels of ongoing funding. ICA therefore began to look for ways in which it could transfer lightweight, sustainable documentation technologies that could be put into practice by the National Preserve itself with or without outside help. There were very particular requirements for such technologies: they had to function without complicated and expensive equipment; they had to be adaptable in difficult conditions (the National Preserve’s electrical supply, for example, is erratic, sometimes surging and sometimes cutting out); they could not involve expensive software or ongoing licensing costs;

and they could not rely on the newest and fastest computer equipment, which neither the National Preserve nor ICA could provide or support. Finally, it had to be possible for local participants to be fully trained in these technologies and carry them out on their own without assistance.

When ICA and CHI came in contact at the 2006 CAA conference, the encounter turned out to be providential. CHI is specifically dedicated to the use of innovative, low-cost photographic and digital techniques to capture and share information about cultural heritage. Working with Tom Malzbender from HP Labs,<sup>1</sup> CHI had invented an inexpensive, lightweight approach to the production of Reflectance Transformation Images (RTIs)—still, 2D images in which the light source direction can be changed interactively and continuously by the user. This dynamic interplay of light and shadow enables the user to perceive the true 3D surface features of the depicted object.<sup>2</sup>

The applicability of this technique to the material at Chersonesos was immediately apparent. The study of the painted Hellenistic stelai carried out by Richard Posamentir in the 1990s and early 2000s had included the use of raking light to identify, for example, the differences in chisel use between different workshops.<sup>3</sup> The flat surfaces of these objects and the relief created with applied paint also seemed likely to lend themselves to the creation of RTIs (fig. 2).

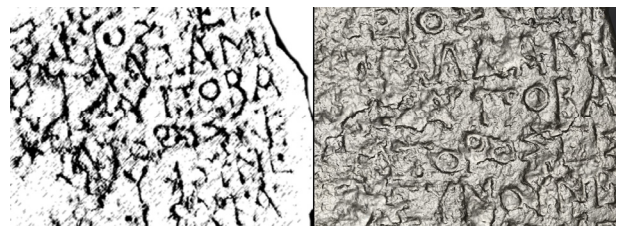
At the same time, other collaborators had been experimenting with digital techniques for the study of the National Preserve's extensive epigraphic collection (fig. 3). Many of these inscriptions are damaged or weathered, and these experiments had centered on the enhancement of digital photographs to elucidate hard-to-read sections, or to create simple 3D models for web-viewing. RTI files, which are easily mounted on the internet and permit the viewer to manipulate lighting, seemed better suited for both tasks.

In the summer of 2007, University of Texas Historic Preservation student Sarah Duffy, with CHI's support, carried out some preliminary investigations of the

suitability of CHI's Reflectance Transformation Imaging techniques for material at Chersonesos. She also administered a survey to students, scholars, and Preserve staff to gauge their interest in the technique. She reported on this work in her Master's thesis for the Program in Historic Preservation of the School of Architecture of the University of Texas.<sup>4</sup>



**Figure 2.** Museum installation of Hellenistic stelai currently in the Packard Laboratory at Chersonesos (photo by Chris Williams).



**Figure 3.** Comparison of image acquired through digital manipulation of still photo (right) and capture from highlight RTI of the same object.

Ms Duffy's research cemented ICA's interest in these methods, and in the summer of 2008, ICA, with the generous support of PHI, invited Mark Mudge and Carla Schroer from CHI to Chersonesos to carry out a ten-day workshop on Reflectance Transformation Imaging. The participants in this workshop were a diverse group of cultural-heritage professionals and students from across Ukraine and Europe. They included National Preserve staff from the departments of archaeology, conservation, and photography; members of the Megarika digitization project; a representative of the Fonda Demetra, an archaeological institute in Kerch; Ms. Duffy and other local and foreign ICA collaborators; and students from Kyiv-Mohyla Academy University and the Institute of Archaeology in

<sup>1</sup> T. Malzbender, D. Gelb, and H. Wolters, "Polynomial Texture Maps," in *SIGGRAPH '01: Proceedings of the 28th Annual Conference on Computer Graphics and Interactive Techniques* (Los Angeles: Association for Computing Machinery, 2001) 519–28.

<sup>2</sup> Mark Mudge et al., "Reflection Transformation Imaging and Virtual Representations of Coins from the Hospice of the Grand St. Bernard," in *VAST 2005: 6<sup>th</sup> International Symposium on Virtual Reality, Archaeology and Intelligent Cultural Heritage*, ed. Mark Mudge (Aire-la-Ville: Eurographics Association, 2005) 29–40.

<sup>3</sup> The results will be published in Richard Posamentir, *Chersonesan Studies I. The Early Hellenistic Necropolis, vol. 1: the Polychrome Grave Stelai* (forthcoming).

<sup>4</sup>Sarah Michelle Duffy, *Innovative Technology and Ancient History: Exploring Polynomial Texture Mapping (PTM) of Larger Objects at Chersonesos, Ukraine* (M.S. thesis, University of Texas at Austin, 2008).



Kyiv, and from the Lviv National Academy of Arts. The results of the workshop, we feel, demonstrate the great potential of this methodology for sustainable programs of cultural-heritage documentation, carried out at low cost by engaged and empowered local participants.

#### 4 WORKSHOP STRUCTURE AND CHALLENGES

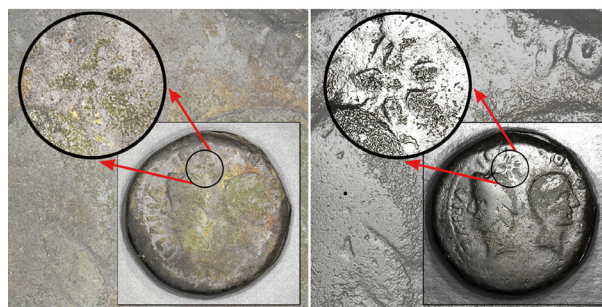
RTIs are made from information derived from multiple digital photographs of a subject shot from a stationary camera position. In each photograph, light is projected from a different known, or knowable, direction. When the lights are in fixed positions (e.g. in a hemispherical apparatus), the direction is known in advance; when an apparatus cannot be used, the highlights in one or two reflective spheres placed in the frame of the photograph can be used to calculate the direction (highlight RTI).<sup>1</sup> In both cases, the process produces a series of images of the same subject with different highlights and shadows. After the light has been projected from a representative sample of directions, all the lighting information from the images is mathematically synthesized to generate a viewpoint-specific, per-pixel reflectance function enabling a user to interactively re-light the RTI representation of the subject's surface.

RTI enables robust 'virtual' examination and interpretation of 'real world' subjects possessing surface relief features. RTI information may also be mathematically enhanced. RTI enhancement has been shown to disclose surface features that are impossible to discern under direct physical examination (fig. 4).

This technique met the requirements for sustainability at Chersonesos, since it relied on equipment of moderate cost (an entire kit, including camera, cost around \$3000) and freely available software that could be downloaded from the websites of CHI and Hewlett-Packard Labs. The basic tools consisted of a Canon EOS 450 digital SLR with 50 and 100mm fixed lenses; a set of Kenko extension tubes; a monopod on which was mounted an Elinchrome studio light synced to the camera; a Gitzo G1320 tripod for the camera; two light stands with umbrella brackets, on which were mounted black billiard balls; and two fixed studio lights.

The software consists of a program to calculate the position of the light-source from the highlight on the reflective billiard-balls, and a second program that uses the position information and the series of photographs taken to calculate the range of reflectance values of each pixel in the image, producing an RTI that can be viewed and manipulated with a simple viewer. Both programs

are free-ware and thus do not entail initial purchase costs or ongoing licensing fees.<sup>2</sup>



**Figure 4.** Reflectance transformation image revealing important detail in a Roman coin. Left: the coin seen in natural light, with the detail (the 'Julian Star') poorly visible; right: the "Julian Star" viewed in the RTI with specular enhancement.



**Figure 5.** Two views, with different lighting, derived from a single RTI of an intaglio gemstone.

The techniques used to capture RTI information are also very flexible, and thus meet another requirement for sustainability at Chersonesos. The equipment can be set up in various locations and configurations without difficulty, and it can be used to capture information from objects ranging in size from a few millimeters to more than two meters. The largest item documented in the course of the workshop was a two-meter high inscription; the smallest was an intaglio gemstone 8mm in length (fig. 5). Finally, the results are particularly well-suited for web-based dissemination, since the resulting files can be sized for easy download and free viewers are available.

A third requirement for sustainability is that the technique can be used independently by fully-trained local participants, with limited or no external support. The goal of the workshop was therefore to transfer knowledge, software, and the basic kit to the Preserve staff, to the point where they became able to create such images without assistance and with equipment on hand.

<sup>1</sup>For the highlight RTI technique, see Mark Mudge et al., "New Reflection Transformation Imaging Methods for Rock Art and Multiple Viewpoint Display," in *VAST06: The 7<sup>th</sup> International Symposium on Virtual Reality, Archaeology, and Intelligent Cultural Heritage*, ed. M. Ioannides et al. (Nicosia: Eurographics, 2006) 195–202.

<sup>2</sup>Links to both software and free viewers can be found at [c-h-i.org/web\\_resources/misc/misc\\_downloads.html](http://c-h-i.org/web_resources/misc/misc_downloads.html).

An unspoken goal was also to transmit enough excitement about the technique that the local participants would be inspired to continue to create RTIs and share them with the public through the Web. By including students from several different Ukrainian universities, we hoped that knowledge of the technique could be distributed more widely across Ukraine.

The objects on which the workshop focused were selected to present a range of sizes, types, and reflectivity properties. Some of these objects were portable and some not; some were aligned horizontally and some vertically; and several stelai were in awkward positions for photography (fig. 6). This created interesting challenges for the workshop participants, who thus had a chance to confront the sorts of issues that could be expected to arise if they continued to use the technique on their own. For example, the minimum recommended distance from the light to the subject is four times the diameter of the subject. In the crowded storerooms and display areas of the National Preserve, sufficient clearance is not always available, and thus it was important for the workshop leaders to help the students develop creative solutions to such problems.

The workshop itself faced a different set of challenges, not least of which was the lack of a common language (the entire workshop was translated into Russian, which was then sometimes translated into Ukrainian—and in the more technical discussions, retranslated *from* Russian *into* Russian by a Ukrainian computer specialist who had more experience with the digital concepts than the translator). Trying to work with local equipment also required creative approaches: since Preserve staff rarely have access to laptops, CHI experimented with a desktop workstation borrowed from a Preserve office. This computer made the process substantially slower, but it set a useful baseline for minimum computing criteria. The capture of digital photographs requires less memory and processor speed than the processing of the images for the creation of an RTI, but under normal circumstances both tasks can be accomplished comfortably by a computer less than four years old with at least 500MB of RAM.

Other problems arose in relation to the spaces available for photography. In RTI production, the camera must remain absolutely still. On the loose wooden floors of most of the Preserve buildings, however, the slightest movement of the photographer would move the floor and shift the camera, and the workshop was thus limited to buildings with cement floors. Occasionally participants also moved the camera or tripod during a shoot. Normally, one would stop there and simply reshoot the sequence. But the participants in the workshop sometimes hesitated to admit that they had accidentally disturbed the setup, and thus the error was often only uncovered after that shoot was complete and a new shoot had been set up. This increased the amount of time lost, since an entirely new setup was then required to re-shoot the unsuccessful capture. The

hesitance to admit a misstep may have been a cultural factor. In any case, it suggests that it should be made as clear as possible to participants that mistakes are expected, and that calling attention to a mid-process bump will win praise rather than reproach.



**Figure 6.** Positioning the reflective spheres for the capture of an RTI of a stela displayed in a tight corner (photo by Kira Zykova).

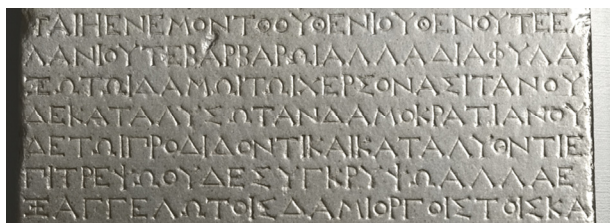
## 5 WORKSHOP RESULTS

Over the course of the ten-day workshop, participants and trainers collected photographic series of 30–50 shots for each of 36 RTIs involving at least 25 objects, and completed final files, at multiple resolutions, of 18 of those RTIs. Appropriately enough, one of the objects documented is an inscription of fundamental importance in the study of democracy and civic engagement. This inscription preserves one of the most complete civic oaths known to us from the Greek world (fig. 7). Fittingly, then, the culmination of the workshop was an RTI shoot of the oath open to the entire Preserve community and run entirely by the Ukrainian participants.

Many members of the Preserve staff came for longer or shorter periods to hold the flash or click the shutter, and thus to be involved as a community in sharing this



unique monument with the world. The results of their collective work are now displayed to the public on CHI's website.<sup>1</sup>



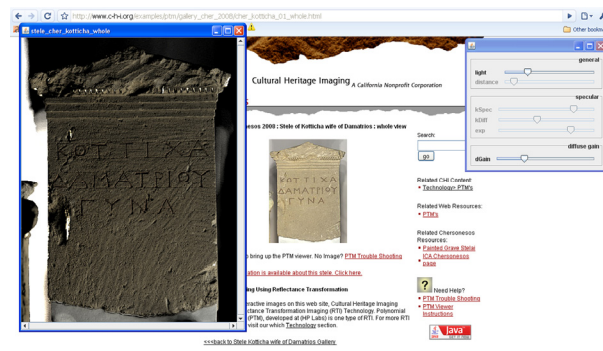
**Figure 7.** Detail from RTI of civic oath, with specular enhancement: here the oath-taker swears not to overthrow the democracy at Chersonesos.

As an institution, the National Preserve is interested in Western methods, but often wary of technical innovations and slow to change traditional practices. Perhaps the best measure of the success of the workshop, then, came at the very end, when one of the Preserve staff members responsible for the object collections appeared at the workshop holding a ceramic plate with relief decoration and requesting that an RTI be made. At the end of the workshop, both personal conversations and a written exit survey established that the participants had learned enough to carry the work out on their own and were eager to do so. All twelve participants who attended the entire workshop agreed that reflectance transformation imaging was a useful or very useful technology, and all felt strongly or very strongly that it could be used to gather new information. Eleven of the twelve agreed or agreed very strongly that they had learned the technique well enough to carry it out independently.

The workshop also demonstrated that RTIs of objects from Chersonesos can be easily mounted on-line, and that even lower-resolution files suitable for dissemination over the internet can provide additional interactive possibilities that print publication cannot. While raking-light photographs of the Hellenistic stelai will accompany discussions in the final publication of the tool-marks left by different ancient workshops, for example, the web-based RTIs of the same objects allow viewers to explore for themselves the patterns left by chisels (fig. 8).

These images do not replace first-hand expert autopsy, nor do they provide the same interpretive information as an academic study. They do make it possible, however, for general public to engage more directly with the objects, and they offer the potential to enhance research and scholarly communication, especially for those

objects whose interpretation depends on a close reading of surface detail.



**Figure 8.** Screen capture of RTI of Hellenistic stele, accessed on-line at CHI's website.

## 6 FUTURE PROSPECTS

Inscriptions, of course, are just such objects, and are of great importance both to archaeologists and ancient historians. In the course of archaeological research at Chersonesos, more than 600 epigraphic documents have been found. The real test of the sustainability and usefulness of this technique at Chersonesos will thus be a project funded by PHI, but run entirely by a National Preserve team, to image the National Preserve's vast epigraphic collection. This will not be the first time the epigraphic record at Chersonesos has been documented. In 1916, inscriptions from the ancient cities of the north shore of the Black Sea, including many from Chersonesos, were published by V. Latyshev as the *Inscriptiones antiquae orae septentrionalis Ponti Euxini Graecae et Latinae* (IOSPE 1<sup>2</sup>). The web has made the material in this once hard-to-find publication more available: not only can it be downloaded in its entirety from the website of the Preserve, but the texts of the inscriptions it contains have now been published on-line with the support of the Packard Humanities Institute.<sup>2</sup>

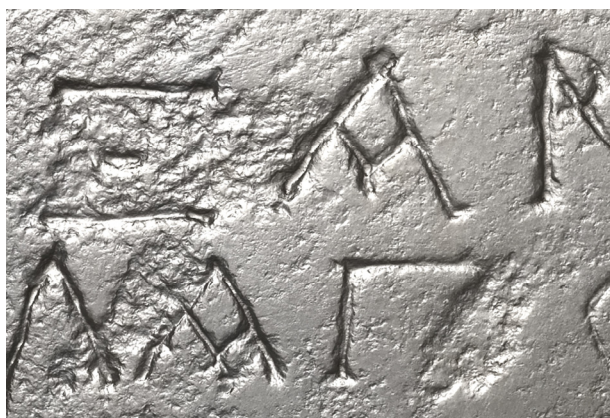
A team of scholars is currently working on a new edition of this corpus of inscriptions, and plans to publish it in an on-line format as well, using the EpiDoc markup language. We have proposed to complement that on-line publication with RTIs of epigraphic documents at Chersonesos, generated by the Preserve team. These digital facsimiles would add substantial value for epigraphers, who must often examine details of individual letters and carving (fig.9).

The RTI process offers additional advantages for such a program of heritage documentation. The photographic and digital image creation tool chain developed by CHI is explicitly designed to enable the highly automated capture of the complete RTI image generation process

<sup>1</sup> Claudia Willen, "Preserving and Sharing Ancient Treasures with Cultural Heritage Imaging Technology," [www.c-h-i.org/featured\\_projects/feat\\_proj\\_cher\\_2008.html](http://www.c-h-i.org/featured_projects/feat_proj_cher_2008.html). An on-line gallery of RTIs of stelai can be found at [http://www.c-h-i.org/examples/ptm/gallery\\_cher\\_2008/index\\_chersonesos\\_2008.html](http://www.c-h-i.org/examples/ptm/gallery_cher_2008/index_chersonesos_2008.html).

<sup>2</sup>A scanned version of the original IOSPE 1<sup>2</sup> can be found at [www.library.chersonesos.org](http://www.library.chersonesos.org); the inscriptions it contains can be searched at [epigraphy.packhum.org/inscriptions/](http://epigraphy.packhum.org/inscriptions/).

metadata—essentially a scientific imaging “lab notebook” that describes how the image was built and provides links to the original photographic empirical data.<sup>1</sup>



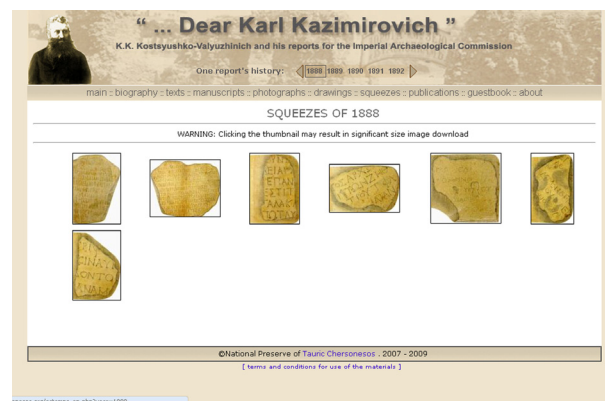
**Figure 9.** Detail from RTI, with specular enhancement, of recarved letters on a funerary monument.

The next generation of RTI imaging tools includes powerful new imaging capabilities and a new RTI file format optimized for semantic metadata management. If integrated into the Preserve’s own digital catalogues and archives, these digital objects could provide a bridge between the published epigraphic texts and the contexts in which the inscriptions were found. This would fit well with the Megarika project’s current on-line initiative to publish archival information related to the excavations of the early twentieth century.<sup>2</sup>

Much of the epigraphic corpus of Chersonesos was recovered during that period, including a large number of inscriptions found by Karl Kostsyushko-Valyuzhinich, the excavator of Chersonesos in the 1890s and early 1900s and the founder of the site’s first antiquarium. During Kostsyushko-Valyuzhinich’s lifetime, and for many decades afterwards, the only tool scholars had to preserve and share inscriptions in full detail involved the creation of paper-pulp squeezes—1:1 physical facsimiles of the stones themselves, created by hammering the pulp into the depressions in the stone and allowing it to dry. The resulting documents are durable—Kostsyushko-Valyuzhinich’s own squeezes are still kept in the archives of the Preserve—but eventually require conservation themselves, and a researcher must still be physically present to use them.

Today’s epigraphers rarely have the option of making their own collection of squeezes, since the process of

making a squeeze can damage the original inscription, and Western conservators therefore now frown on the practice. The web has made up for this problem to a certain extent: for example, many of Kostsyushko-Valyuzhinich’s squeezes can now be seen in digital form on one of the websites of the National Preserve (fig. 10). RTIs of these monuments, however, would come much closer to reproducing the form and function of squeezes, while being accessible to epigraphers anywhere in the globe.



**Figure 10.** Scanned images of some of Kostsyushko-Valyuzhinich’s original squeezes, courtesy of the National Preserve of Tauric Chersonesos ([www.kostsyushko.chersonesos.org](http://www.kostsyushko.chersonesos.org)).

An RTI project focused on the epigraphy of Chersonesos would create a new record that provides deeper and richer information that is easier to share and to preserve. If this project is successful, it will provide an even more compelling validation of the grassroots principles both CHI and ICA espouse. It will be a locally-managed and sustainable initiative that produces material of immeasurable importance to scholars and of great interest to the general public. To our knowledge, Chersonesos would be the first ancient site to document its epigraphic collection in this way, but given the ease and power of the technique, and the way it has been embraced at a place where many factors work against such efforts, we can expect that it will not be the last.

## 7 EPILOGUE

As this paper goes to print, a pilot project to use Reflectance Transformation Imaging to document part of the epigraphic collection of the National Preserve has gone forward, with the support of the Packard Humanities Institute. The project is being carried out entirely by local participants in the workshop described in this paper, with the support of the authors and Moscow-based epigrapher Igor Makarov. The workflow has been divided among various departments of the National Preserve, with staff from the collections and research departments and local ICA collaborators carrying out imaging and processing, and members of the Megarika project arranging for the on-line display of

<sup>1</sup>Mark Mudge et al., “Image-based Empirical Acquisition, Scientific Reliability, and Long-term Digital Preservation for the Natural Sciences and Cultural Heritage,” in *Eurographics 2008 Tutorial Notes* (Crete: Eurographics, 2008).

<sup>2</sup>Preliminary results, including several hundred images, can now be seen at [www.discovering.chersonesos.org](http://www.discovering.chersonesos.org).



the RTIs produced. The project's goal is to create, and to display on-line, RTIs of at least 35 epigraphic objects of various periods by the end of 2009.

Adam Rabinowitz, acting as ICA liaison, coordinated the initial set-up of the project during a visit to Chersonesos, and relayed initial questions from the Russian-speaking participants to Mark Mudge and Carla Schroer. All three authors will continue to be involved digitally as the project moves forward. This remote collaboration is made possible in part by the linguistic abilities of the participants: several collaborators at the National Preserve and Dr. Makarov are fluent in English, and ICA can rely on the services of skilled local interpreters. The inevitable questions and difficulties that will arise as the work continues will thus be translated and transmitted to CHI, which will pass back answers in English for translation as necessary.

To the extent that this pilot project still relies on interactions with CHI facilitated by ICA interpreters, it is not yet fully self-sustaining. The range of objects

being imaged in this phase, however, will allow the local participants to confront most potential problems early on, and issues related to on-line display will also have been worked out by the end of the pilot stage. If the project continues after 2009, therefore, veteran local participants will have the full range of knowledge and experience necessary to carry out further work with little or no external support.

Our experiences thus suggest that a follow-up project, however limited or preliminary, is very important for the consolidation of the skills acquired during the workshop and the development of the practical experience and confidence necessary for more ambitious local projects. In our case, the costs of such a pilot project, in both equipment and support, have been very reasonable, and the local team has quickly reached a high degree of independence. This seems, therefore, a viable model for the transmission of sustainable digital technologies for heritage documentation and dissemination to institutions with limited resources.

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#### BIBLIOGRAPHY

- Carter, Joseph Coleman, ed. *Gravestones of Chersonesos. Research and Conservation*. Istanbul: National Preserve of Tauric Chersonesos, Packard Humanities Institute, and Institute of Classical Archaeology, 2006.
- Carter, Joseph Coleman, Melba Crawford, Paul Lehman, Galina Nikolaenko, and Jessica Trelogan. "The Chora of Chersonesos in Crimea, Ukraine." *American Journal of Archaeology* 104 (4) (2000):707–741.
- Carter, Joseph Coleman, and Glenn Mack, eds. *Crimean Chersonesos*. Austin: National Preserve of Tauric Chersonesos and Institute of Classical Archaeology, 2003.
- Duffy, Sarah Michelle. *Innovative Technology and Ancient History: Exploring Polynomial Texture Mapping (PTM) of Larger Objects at Chersonesos, Ukraine*. M.S. thesis, University of Texas at Austin, 2008.
- Malzbender, T., D. Gelb, and H. Wolters. "Polynomial Texture Maps," in *SIGGRAPH '01: Proceedings of the 28th Annual Conference on Computer Graphics and Interactive Techniques*, 519–28. Los Angeles: Association for Computing Machinery, 2001.
- Mudge, Mark, Tom Malzbender, Carla Schroer, and Marlin Lum. "New Reflection Transformation Imaging Methods for Rock Art and Multiple Viewpoint Display," in *VAST06: The 7th International Symposium on Virtual Reality, Archaeology, and Intelligent Cultural Heritage*, edited by M. Ioannides, D. Arnold, F. Niccolucci, and K. Mania, 195–202. Nicosia: Eurographics, 2006.
- Mudge, Mark, Tom Malzbender, A. Chalmers, R. Scopigno, J. Davis, O. Wang, P. Gunawardane, M. Ashley, M. Doerr, A. Proenca, and J. Barbosa. "Image-based Empirical Acquisition, Scientific Reliability, and Long-term Digital Preservation for the Natural Sciences and Cultural Heritage," in *Eurographics 2008 Tutorial Notes*. Crete: Eurographics, 2008.
- Mudge, Mark, Jean-Pierre Voutaz, Carla Schroer, and Marlin Lum. "Reflection Transformation Imaging and Virtual Representations of Coins from the Hospice of the Grand St. Bernard," in *VAST 2005: 6th International Symposium on Virtual Reality, Archaeology and Intelligent Cultural Heritage*, edited by Mark Mudge, 29–40. Aire-la-Ville: Eurographics Association, 2005.
- Rabinowitz, Adam, Tatiana Yashaeva, and Galina Nikolaenko. "The Chora of Chersonesos: Excavations at Bezymyannaya, 2002," in *Archaeology at Kyiv-Mohyla Academy*, 146–57. Kyiv: National University of Kyiv and Institute of Classical Archaeology, 2005.
- Willen, Claudia. "Preserving and Sharing Ancient Treasures with Cultural Heritage Imaging Technology," Cultural Heritage Imaging. [www.c-h-i.org/featured\\_projects/feat\\_proj\\_cher\\_2008.html](http://www.c-h-i.org/featured_projects/feat_proj_cher_2008.html) (accessed May 31, 2009).