The Herculaneum Scrolls

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Abstract

In 1752 antiquity hunters were tunneling down into a large villa on a hill overlooking Herculaneum and the Bay of Naples when they made the discovery of manuscripts. This villa probably once belonged to the wealthy Roman aristocrat Lucius Calpurnius Piso Caesoninus, a well-known Roman politician, who was a patron of Epicurean philosophers. The villa was lost from history in A.D. 79 in the catastrophic eruption of Mt. Vesuvius when it was buried by tons of thick volcanic mud that gradually hardened to a concrete-like consistency. Workers searching for artistic treasures in the villa were rewarded by the discovery of many important works of art-in particular a series of bronze busts. Rather than excavating the villa in the traditional manner which would have meant removing the huge layer of volcanic debris that covered the villa, they simply tunneled down through the concrete-like volcanic mud and then around the villa. In the course of their excavations they discovered the carbonized remains of a library of some 1500 papyri rolls-thus the name Villa of the Papyri. Due to the intense heat of the volcanic flow and pressed by the weight of the mud, lava, pumice, and the rubble these rolls were in various states of carbonization-some resembled sticks of charcoal others lumps of coal. Many of the papyri have now been unrolled, read, and published. A team from Brigham Young University were asked to apply Multispectral Imaging technology (MSI) to help scholars transcribe the texts. The images have now provided valuable assistance in reading these ancient texts.

Introduction

Many of the Herculaneum scrolls still remain rolled up because the layers are fused together. Some scrolls were cut apart with a knife and the fragments were then peeled from the lumps of carbonized papyri. This was destructive because of the necessity of scraping away each layer, after recording the limited amount of visible text on it, in order to access the next layer. The last remaining layers called "scorze" in some cases are the only remaining portion of these scrolls that have been preserved. However hundreds of the carbonized pieces of scrolls have been unrolled and in many cases their contents are still unidentified because of their burned condition. Those unrolled scrolls that can be read however, reveal the ancient library's contents and its importance. It is a remarkable collection of Epicurean philosophical texts written in Greek, and a lesser amount of Latin texts. In particular there is an extensive collection of the works of the Epicurean philosopher Philodemus of Gadara (in present day Jordan), who came to Italy in about 80 B.C. Multispectral imaging is now allowing scholars to decipher these ancient texts with far greater confidence.

Figure 1. Villa of the Papyri

Figure 2. Carbonized Herculaneum Scroll

The Herculaneum Scrolls

Philodemus was an ancient writer who, until this discovery, was only known through his poetic works. The Herculaneum papyri contain several of Philodemus's important prose treatises on Music, Rhetoric, and Poetics, as well as on other ethical and theological works. Recently fragments have been identified among the Latin papyri of Lucretius's poem "On the Nature of Things and Ennius' Annales." In addition there are a few works by Stoic philosophers and other literary texts from the period. The significance of this discovery of papyri is unparalleled in the classical world. It has been called "the only library preserved from the classical world," and some have rightly compared it to the discovery of the Dead Sea Scrolls because of the extraordinary amount of previously unknown information these texts provide about ancient philosophy and philosophers from the period 300 B.C. to A.D. 79. Due to recent advances in the technology of unrolling the scrolls and in Multispectral imaging there is renewed interest in the Herculaneum Papyri.

Work on the Herculaneum Papyri

Il Centro Internazionale per lo Studio dei Papiri Ercolanes (CISPE) under the direction of Professor Marcello Gigante, continues the international effort to publish the texts and the archaeology of the Villa in its journal Cronache Ercolanesi. This effort is joined by a the Philodemus Project which consists of a group of scholars under the direction of Professors David Blank, of UCLA; Richard Janko, University College, London, and Dirk Obbink, Christ Church, Oxford who are studying the works of Philodemus. The conservator of the papyri, Professor Knut Kleve, has himself developed technology to open the scrolls. Each year for the last several years he has successfully opened 10-20 new pieces of the carbonized papyri adding more data about the ancient library. In 1986 archaeological excavations were begun again at the Villa dei Papiri, under the direction of Antonio de Simone. Already there have been significant new discoveries. It is hoped that one day the Villa will be completely uncovered and restored to its former splendor. Archaeologists have discovered that the Villa has other levels which have not yet been explored, giving them hope that there may be more papyri to be discovered in future excavations.

In August of 1998 Gene Ware and Steve Booras, part of Brigham Young University's Center for the Preservation of Ancient Religious Texts (CPART) team to Amman, Jordan, presented the preliminary results of their work on the Petra Papyri at an international congress of the Association Internationale de Papyrologues in Florence, Italy. Their work was noted by Professors Marcello Gigante, director of the publication team for the Herculaneum Papyri (CISPE) and emeritus professor at the University of Naples, and Professor Knut Kleve, professor of Classical and Romance Languages, University of Oslo, and conservator of the Herculaneum Papyri.

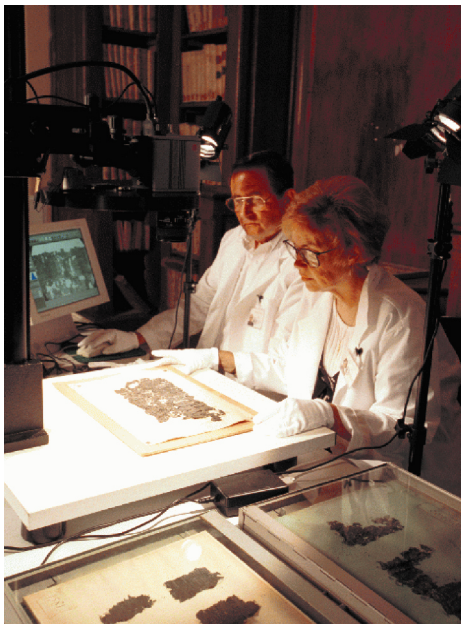

Figure 3. MSI Imaging Scrolls in the Biblioteca Nazionali, Naples, Italy

In the early spring of 1999 the CPART team, which now included professor David Seely of BYU, went to Naples, Italy to test and apply MSI on the Herculaneum papyri. At this time test imaging was performed using electronic tunable filters (ETF). These filters were used for diagnostic work to determine what results could be obtained and where in the electromagnetic spectrum would provide the greatest results. The ETFs, controlled by special computer software, allow imaging at any wavelength desired quickly. Once the tests were completed the appropriate fixed-wave length filters could be applied to gain the greatest results to enable the whole library to be imaged.

Using MSI the team was able to provide bene-ficial results for scholars working on the burned papyri. In the fall of 1999, the CPART team were again invited to Naples to perform MSI imaging on the complete Herculaneum collection, a process which took 11 months.

The Herculaneum papyri were imaged using a scientific grade Kodak Mega Plus 6.3i, 2k x 3k, 8 bit digital camera. Attached to the camera was a filter wheel system that contained 8 filters. The filters were narrow bandpass fixed wave length Corion filters. These coated filters allowed only a narrow band of light to pass through to the charged coupled device (CCD) of the camera. The filters ranged from 450 nm to 1000 nm. The filter wheel would move the desired filter into position as needed by a motor drive. Standard Nikon camera lenses were be mounted to the filter wheel. Lenses ranged from 50 mm macro, 100 mm macro, to a 35-70 zoom depending on the size of the targeted fragments and resolution desired. Image-resolution ranged from 300 to 600 dpi. Multiple sets of images were taken of each papyri fragment.

The camera system was attached to an image-capture card mounted in a Pentium III 800 MHz computer with 60 gig removable hard drives, 256 meg of RAM with Windows NT operating system. Specially designed software developed at BYU was used to control the camera settings and capture parameters. Some of the controls included an AOI (area of interest) cropping option, light saturation gain, camera exposure, and histogram settings (black control). Once the images were captured on the removable hard drive the disk was transferred to a second computer for archiving. The archiving system would create 2 sets of CDs and 2 sets of AIT tape. One set of tapes were archived on the NT platform the second set on TAR98 platform.

A Dedo variable power lighting system manufactured in Germany was used to illuminate the papyri. It is a cool lamp which did not allow the carbonized papyri to accumulate heat of more that 85 degrees Fahrenheit. The lighting system operated under 3,500 degrees Kelvin color temperature. Four lamps were targeted on the trays of papyri, one on each corner on a diagonal lighting pattern to prevent "hot spots" to occur on the shiny grain of the papyri. The burned papyri generally exhibited a shiny surface appearance while the ink pigment was a dull flat black.

The Herculaneum scroll images are now being used by scholars working on the Philodemus Project. Texts have already been revised and additional data is now being transcribed because of the use of multispectral images that are revealing additional writings.

Herculaneum Results

The Herculaneum Papyri are mounted in a collection of 4000 trays or "cornice" now housed in the Officina dei Papiri Ercolanesi at the Biblioteca Nazionale in Naples, Italy. The results of the test images of the Herculaneum Papyri produced by the CPART team has far exceeded expectations. The first images taken in the 450 nm light range produced a very dark image with little contrast between the ink and the carbonized papyrus. These images were not much better than looking at the papyrus with the unaided eye. The quality of images steadily improved as images of the texts progressed towards the Infrared. As the images were seen through the 800 nm filter the black papyri started to drop out and the ink remained. Through the filter at 950 nm the ink of the papyrus became very distinct with good contrast between the black ink and the blackened papyri and the texts becomes very readable without any computer enhancement. The results of even simple computer manipulation and enhancement suggest that the multispectral images preserve enough data to make further work in computer enhancement possible to vastly improve the reading of the text.

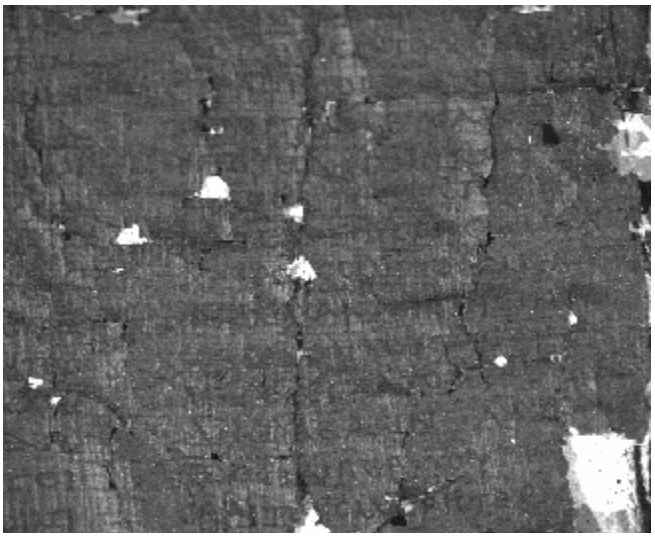

Figure 4. PHerc 1669 Imaged in Visible Light Spectrum with a 450 nm Narrow Band Filter

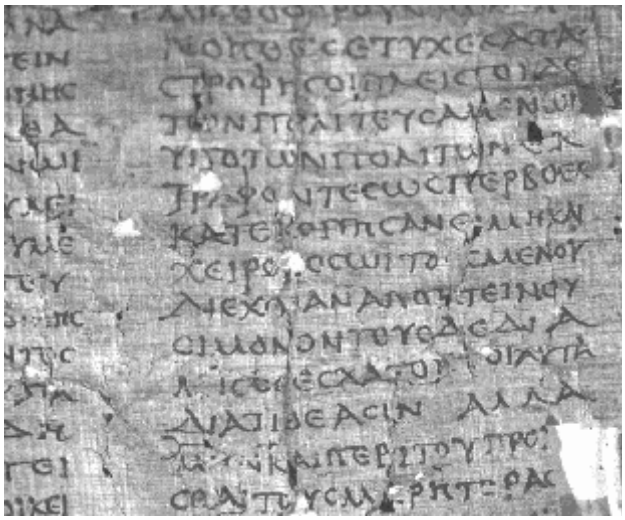

Figure 5. PHerc 1669 Imaged in Infrared Spectrum with a 950 nm Narrow Band Filter

Herculaneum Papyri responded better to MSI, and it was possible to obtain a higher contrast between the ink and the papyri than the images at Petra. It is not clear why this is the case. In addition, for some reason the Petra scrolls generally responded better when the images were taken through the filters at the lower end of the light spectrum while the Herculaneum Papyri clearly responded better to the higher end of the spectrum. It could have some relation to the degree of temperature, how hot the papyri became, or the length of time the scrolls were heated as they became carbonized. The different contrast responses may also be the result of how the scrolls were unrolled or some other variable affecting the reflectivity of the fragments. Recently however the illuminating light temperatures may have been an important factor in the response of the images.

Figure 6. PHerc 1084 Imaged in Visible Light Spectrum with a 500 nm Narrow Band Filter.

Figure 7. PHerc 1084 Imaged in Infrared Spectrum with a 1000 nm Narrow Band Filter

Professor Kleve, who has much experience with the photography of the scrolls through the years, reviewed the results of the multispectral imaging tests and made some very appreciated observations. In a letter he sent to the Biblioteca Nazionali he describes the results of the preliminary tests, "The quality of [the MSI] images lies far above that of the hitherto available conventional photographs of the papyri. . . . An electronic presentation of the texts also opens for enlargements and other enhancements ad libitum. It would mean a real progress for the study of the papyri ooutside the Officina, and the papyri themselves could be spared deterioration by handling and shuffling. Scholars' visits to the Officina might be reduced to just control reading.

The images produced will be a secure archive of the collection, preserving the images against the deterioration of the scrolls that can be used by scholars throughout the world as they work on the Herculaneum Papyri. It is hoped that these images, and those produced by further computer enhancement, will provide the best possible readings of the texts to further the scholarly enterprise for decades to come.

Acknowledgments

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Biography

Steven W. Booras received a BS from Brigham Young University. He has applied the first MSI technology in Ancient Maya Murals in Bonampak, Mexico with the National Geographic Society. He has traveled to Jordan to apply MSI on the Petra Scrolls and to Naples, Italy working on the Herculaneum Papyri. He has managed the “Dead Sea Scrolls on CD-ROM” project and written other articles published by E.J. Brill, Netherlands. He is Imaging Project Manager for the BYU Institute for the Study and Preservation of Ancient Religious Texts.