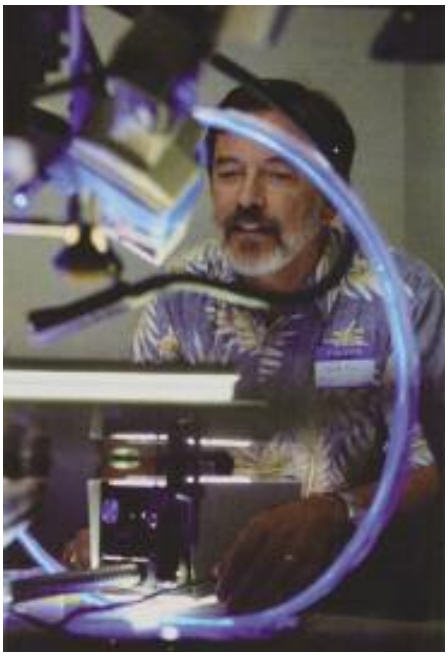
Archimedes and Company

Dr William Noel, *Curator of Manuscripts at the Walters Art Museum, Baltimore, discusses the project to retrieve the unique classical texts in the 'Archimedes Palimpsest' – a manuscript that contains treasures undiscovered for centuries.*

IN 1899 A. Papadopoulos-Kerameus catalogued the contents of the library of the Metochion of the Holy Sepulchre in Istanbul. Ms 355 in his catalogue was a thirteenth-century prayer book – a euchologion. It was clear to him that much of the book was palimpsest; the scribe of the euchologion had recycled parchment from other codices to make his book, and some of the under-text was still visible. Indeed, Papadopoulos-Kerameus transcribed a small section of one of these texts. It was mathematical in nature, and was brought to the attention of Johan Ludwig Heiberg, Professor of Classical Philology at the University of Copenhagen. Heiberg recognized it as the work of Archimedes, and so went to the Metochion to investigate further in the summer of 1906. He discovered that the manuscript was from the tenth century and contained the only surviving Greek version of *On Floating Bodies*, and two lost works by Archimedes – the *Method of Mechanical Theorems*, and the *Stomachion*. The manuscript is Codex C in the apparatus for the critical edition of Archimedes' works that Heiberg published from 1910–1915. Heiberg briefly noted that there were other palimpsested texts in the manuscript, which he could not identify.

The manuscript is of the utmost importance in the transmission of Archimedes texts, being the oldest extant Archimedes manuscript in Greek by 500 years. And yet, despite this, it has been unavailable to scholars throughout most of the twentieth century. It disappeared from the Metochion in the 1910s or 1920s, and spent most of the century in the hands of a private French family. It was auctioned on 29 October 1998, and purchased by an anonymous American collector. This collector deposited the manuscript at the Walters Art Museum in Baltimore, and since then has funded a project to conserve, image, and decipher the texts in the manuscript. The British Academy has greatly facilitated the decipherment of many of these texts, some of which have turned out to be spectacularly important.

The right-hand page of the Palimpsest contains the text of Archimedes' Method, *proposition 14. All you can see is the prayer book text*



Left: *Keith Knox, Chief Scientist at the Boeing Corporation at Maui, who invented the algorithm by which the Archimedes text was revealed.*
Below: *Abigail Quandt, Senior Conservator of Manuscripts and Rare Books at the Walters Art Museum, mends a damaged leaf of the Palimpsest*

The Archimedes Palimpsest Project is an integrated campaign of conservation, imaging and scholarship, managed by Michael Toth of R.B. Toth Associates. It got off to a slow start, principally because the book is in appalling condition. To image the manuscript, the codex had first to be disbound and conserved. This was undertaken by Abigail Quandt, Senior Conservator of Manuscripts and Rare Books at the Walters Art Museum. There were three particularly severe problems. The first was that more than half the spine of the book was covered in a polyvinyl acetate adhesive. This was undoubtedly put on after World War II to secure the structure of the codex. However, the glue was tougher than the parchment of the book that it was designed to protect. It had to be carefully removed using a mixture of isopropanol and water, and it took four years. The second problem was that the manuscript had suffered severely from mould damage. Parchment is tough, but mould will break down the collagen that makes it so, and much of the book now has the strength of tissue paper. The third problem was that, sometime after 1938, forged miniatures of the Evangelists were painted on four of the pages. It was decided not to remove these forgeries, and this presented the imagers with their most serious challenge.

Top: A pseudo-colour image of the Hyperides text in the Palimpsest. Note this text is written in one column, while the Archimedes text is in two. The lower image shows detail of the third unique text in the manuscript in natural light

It took four years to disbind the Archimedes Palimpsest. This is a rare action shot. There were particular problems removing the tough polyvinyl acetate adhesive used some time after World War II to secure the structure of the codex

The imaging programme started while the conservation was still underway. Quandt prepared 15 bifolia for imaging every six months, starting in December 2001. The imaging was undertaken by Roger Easton, Professor of Imaging Science at the Rochester Institute of Technology, Keith Knox, Chief Scientist at the Boeing Corporation at Maui, and William A. Christens-Barry of Equipoise Imaging LLC. They created processed images that enabled the scholars to begin their work. The creation of useful images was an iterative process: the input of scholars was critical in the development of algorithms that were necessary to create optimal images for the scholars. Dr Natalie Tchernetska, who at the time was a postdoctoral fellow at Trinity College, Cambridge, and Reviel Netz, Professor of Ancient Science at Stanford University, played particularly important roles in this respect.

The techniques used by Easton, Christens-Barry and Knox were extremely effective on most folia of the Palimpsest. However, the forged pages, and pages that were particularly dirty were impervious to optical techniques. Following a conference in April 2004, it was decided to try a different approach: X-ray fluorescence imaging. After preliminary experiments conducted by Gene Hall, Professor of Chemistry at Rutgers University, and Robert Morton, Research Scientist at ConocoPhillips, substantial sections of text were recovered at the Stanford Linear Accelerator Center, using the Synchrotron. This X-ray imaging was conducted under the supervision of Dr Uwe Bergmann, Staff Scientist at SLAC.

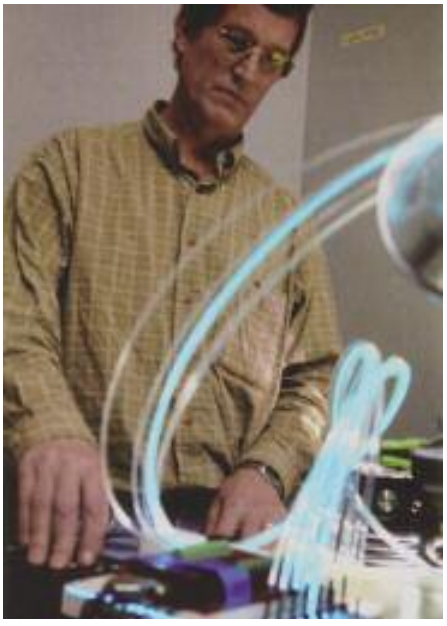
Since 2001 a steady stream of discoveries has poured forth from scholarly analysis of images of the Archimedes Palimpsest. The transcription of the Archimedes text was undertaken by Nigel Wilson FBA, and Reviel Netz. The success of the imaging has been such that they deem it necessary to produce new critical editions of the three unique Archimedes texts in the book. Moreover, the new readings of these texts have had a profound impact on scholarly understanding of the ancient mathematics. In *Method Proposition 14*, Archimedes calculated with infinite sets, and the *Stomachion* has been plausibly reinterpreted as the earliest surviving treatise on combinatorics.

The insights provided by the new readings of Archimedes works have been far reaching. But further revelations soon followed. Dr Natalie Tchernetska was working on the palimpsested texts that accompanied Archimedes' treatises in the euchologion, and in 2002 she identified fragments of two treatises by Hyperides, and it soon became apparent that ten folia of the euchologion were from the Hyperides codex. This was a major discovery, and an unexpected one. Hyperides was an Athenian orator, and a contemporary of Aristotle and Demosthenes. He was a prolific speechwriter, and seventy-seven speeches were attributed to him in antiquity. However, unlike those of Demosthenes, Hyperides speeches did not fare well in the transition that all ancient texts had to make from roll to codex. In the ninth century, in his *Bibliotheca*, Photius gives an account of the works of Hyperides, and it is possible that a manuscript survived at least until the sixteenth century in Hungary. But the twentieth century only knew Hyperides from quotations by later authors, and from papyrus finds in Egypt between 1847 and 1897. Dr Tchernetska had discovered the only extant Hyperides codex. Meanwhile, Netz and Wilson had turned their attention to another unidentified text. Between them, they identified that it was philosophical in character, and Wilson recognised the name of Aristotle.

Enter the British Academy. It soon became apparent that the work of deciphering the texts was so difficult, and the implications of the discoveries so wide ranging, that the enterprise would benefit from the scholarship and counsel of a large and international group of classicists. Professor Eric Handley FBA and Professor Patricia Easterling FBA approached the British Academy who kindly agreed to sponsor a one-day colloquium on the decipherment of the texts, and this was scheduled for February 2006. The result was exciting and rewarding for all those involved. Some progress was made on both texts during the day, but more importantly, the work of decipherment was allotted to specific groups of scholars, and a series of meetings were scheduled in anticipation of the progress that

would result. Many helped in the process, but the principal task of transcription of the remaining Hyperides text was allotted to Natalie Tchernetska herself, to Professor Chris Carey of University College London, Professor Mike Edwards, Director of the Institute of Classical Studies in the School of Advanced Study, University of London, Professor Judson Herrman of Allegheny College, and Professor Laszlo Horvath and his colleagues Zoltan Farkas, Tamas Meszaros and Gyula Mayer at the University of Budapest. The principal champions of the philosophical text at the meeting were Professor Richard Sorabji FBA and Professor Robert Sharples of University College London. Others who have contributed greatly to the understanding of this text are Reviel Netz and Professor Marwan Rashed of the Sorbonne.

An extraordinary amount has been achieved since that date, and the expectations of the scholarly community have been fully realized. Natalie Tchernetska has already published one of the two fragmentary speeches by Hyperides, *Against Timandros*,



Bill Christens-Barry, of Equipoise Imaging LLC, demonstrates the narrow band imaging system that he designed.

which concerned litigation over a disputed guardianship. The second speech, *Against Diondas*, turned out to be political in nature. In it Hyperides defends the anti-Macedonian stance that he took immediately before the Battle of Chaeronea in 338 BC. Following

Archimedes Palimpsest, folios 144v–145r photographed in natural light.

Philip's triumph at the battle, Hyperides and his fellow orator Demosthenes both became subject to criticism. Demosthenes response was his masterpiece, *De Corona*; the speech in the Palimpsest is, so to speak, the sister-speech by Hyperides. A critical edition of this speech will shortly be published in the *Zeitschrift für Papyrologie und Epigraphik*.

Retrieving the Hyperides text was an extraordinary labour; retrieving more of the philosophical text mentioning Aristotle has proven to be even more challenging. Even here, however, remarkable progress has been made. The text appears to be an otherwise unknown commentary on Aristotle's *Categories*, produced in the immediate circle of Alexander of Aphrodisias, in the late second or early third century AD.

This very brief summary of the ongoing discoveries about the Archimedes Palimpsest stretches the bounds of credulity, and makes one wonder about the circumstances in which this extraordinary book was produced. Stefano Parenti, Professor of Byzantine Liturgy from the Papal Athenaeum S. Anselmo, analysed the texts in the euchologion, and noted that several were rare, and indicated that they were specific to liturgical use in the immediate vicinity of Jerusalem. Professor John Lowden, of the Courtauld Institute was the first to observe that on the verso of the very first folio of the manuscript was a colophon that dated the prayer book to April 14, 1229. Subsequent X-rays of this page revealed the name of the scribe, one Ioannes Myronas. One can only speculate how it was that Ioannes Myronas came to have parchment taken from such extraordinary books. However, one thing is for sure: he had joy in his heart when he wrote over these literary treasures — less than two months before, Frederick II, *stupor mundi*, had liberated Jerusalem from Muslim control.

The project to retrieve the texts from the Archimedes Palimpsest is now in its eighth year, and it is changing in its emphasis from text discovery to text publication. On 8 May 2007 Reviel Netz and William Noel's *The Archimedes Codex*, which recounts the history of the project thus far, was launched at the Academy, but comprehensive publication of all the results of this extraordinary project is currently being planned through the British Academy itself. Beginning in the autumn of 2010, these publications will begin to appear. They will include a definitive account of the conservation, imaging, and scholarship conducted on the palimpsest, a digitally enhanced facsimile of the entire manuscript, together with a complete transcription, and critical editions of many of the texts, including Archimedes' *Method, Stomachion*, and *On Floating Bodies*. These publications will coincide with a major exhibition of the codex and the work undertaken on it. Venues for this exhibition are currently being sought both in the United States and in Europe.

Dr William Noel held a British Academy Post-doctoral Fellowship between 1993 and 1996. *The Archimedes Codex* by Reviel Netz and William Noel is published by Weidenfeld and Nicolson.

Further information on the Archimedes Palimpsest Project can be found at www.archimedespalimpsest.org