INNOVATIVE VAULTING IN THE ARCHITECTURE OF THE ROMAN EMPIRE

This book studies six vaulting techniques employed in architecture outside of Rome and asks why they were invented where they were and how they were disseminated. Most of the techniques involve terracotta elements in various forms, such as regular flat bricks, hollow voussoirs, vaulting tubes, and armchair voussoirs. Each one is traced geographically via GIS mapping, the results of which are analyzed in relation to chronology, geography, and historical context. The most common building type in which the techniques appear is the bath, demonstrating its importance as a catalyst for technological innovation. This book also explores trade networks, the pottery industry, and military movements in relation to building construction, revealing how architectural innovation was influenced by wide-ranging cultural factors, many of which stemmed from local influences rather than imperial intervention.

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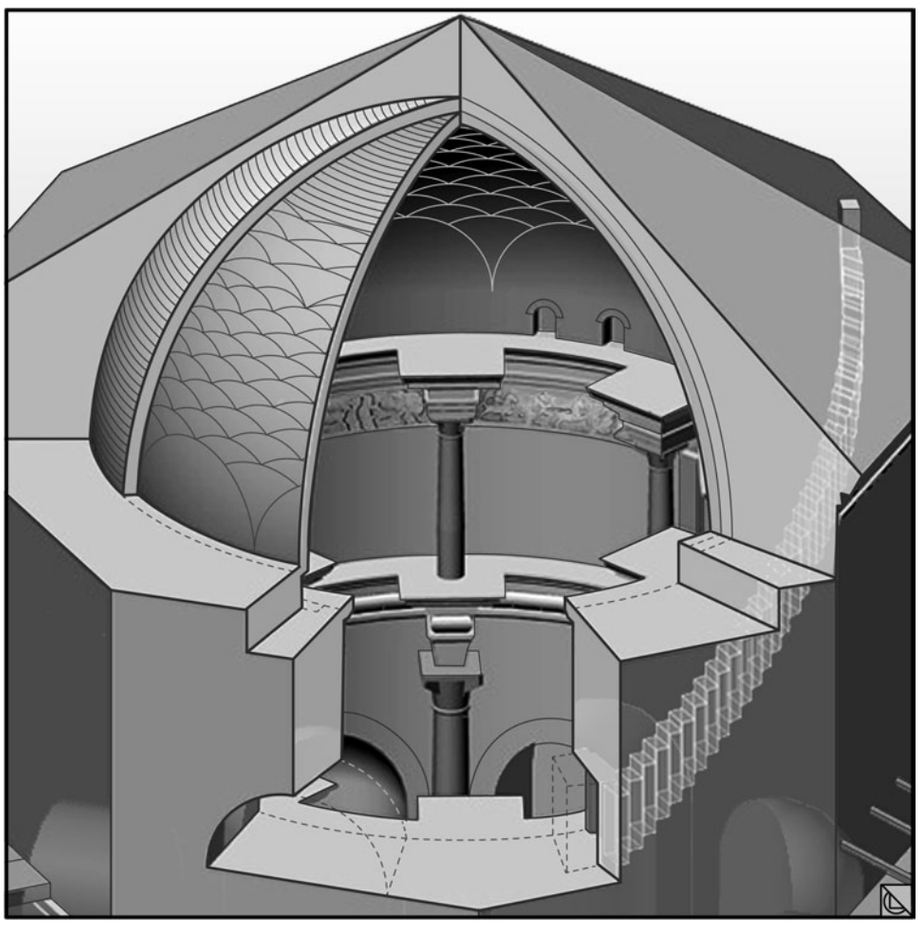

Frontispiece. Drawing of the dome of the Mausoleum of Diocletian at Split (detail of Figure 60).

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1st to 4th Centuries CE

LYNNE C. LANCASTER
Ohio University

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In memory of my grandmother, Bertha Seigler (1898–1985),
who was determined for me to see the world

Sherlock Holmes to Dr. Watson:
"It is a capital mistake to theorize before one has data.
Insensibly one begins to twist facts to suit theories,
instead of theories to suit facts."
– Sir Arthur Conan Doyle, *A Scandal in Bohemia* (1891)

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PREFACE

This book is a sequel to my earlier book, *Concrete Vaulted Construction in Imperial Rome: Innovations in Context* (Cambridge 2005). After completing that project, I knew that I wanted to continue the study of vaulted construction outside of Rome and Italy, but was not sure what form that study would take. Fortunately, in 2005 John Oleson invited me to contribute a chapter on Roman engineering and construction for the *Oxford Handbook of Engineering and Technology in the Classical World* (Oxford 2008). While preparing this chapter, I discovered that there were great lapses in the synthesis of building techniques outside of Rome. Of the many regional studies, few considered the differences and similarities between various areas of the Roman Empire or how and why a technique occurred in some places and not others. There was a clear need to put this material into a broader context. I completed the book chapter knowing that there were many questions still to be answered and that some things that I wrote could change in the future. Yet that project provided me with the framework for this book, and the contributions of the other authors to that volume helped shape my approach.

During the fall of 2005, I was in Rome working at the American Academy library in a cluster of carrels alongside Brian Rose, Fikret Yegül, and Philip Stinson, all of whom were shocked that I had not yet visited Turkey. They offered much encouragement and advice on where to go and what to see. So the following summer, my husband and I rented a car and made a month-long tour of the major sites of Asia Minor; it was one of the more life-changing trips I have made. Fikret and Phil kindly met us and accompanied us on visits to Sardis and Aphrodisias, respectively.

In spite of the magnificent architecture I encountered on that trip, I began to realize that what interested me were the differences between regions, rather than the unique aspects of any one of them. Therefore I began to make lists of examples of vaulting techniques that I encountered in both my readings and travels. During my stay in Rome in 2008, I met Stefan Zink, then a graduate student at the University of Pennsylvania, who showed me a GIS project that he was working on with Lothar Haselberger. After I shared with him an overview of my own project, he quickly convinced me that GIS would be the perfect tool for the "lists" I had made. The use of GIS added yet another dimension to the project and provided a much-needed organization tool.

Another seminal event that affected the approach taken in this book was a workshop on port networks in March 2008 held at the British School at Rome and organized by Simon Keay and Timmy Gambin,

which I attended as a spectator rather than presenter. There I came into contact with a group of scholars working on ports, navigation, connectivity, and trade in terracotta products. Exposure to the conversations and the issues that came up made me realize that some of the same questions could be directed at material relating to building techniques. The papers from the conference have now been published in *Rome, Portus, and the Mediterranean* (London 2012).

This project required a great deal of traveling throughout the territories of the Roman Empire: In the past decade it took me to Turkey, Egypt, Tunisia, Greece, France, Croatia, and Britain. After that first trip to Turkey in 2006, I was fortunate to have been invited as a visiting professor on a TUBITAK grant to the University of Mersin in the fall of 2007. My host, Professor Emel Erten, steadfastly took care of me for my three-week stay and provided excellent companionship as she introduced me to the sites of Cilicia. In addition to a few other visits to Turkey, in 2013 I made a second "grand tour" of the major sites in Asia Minor. Nick Cahill generously hosted me at Sardis, and Alexander Solicek and Allison McDavid gave up precious time before their season began to accompany me around Aphrodisias. At Ephesus, I am grateful to Sabine Ladstaetter, director of the Austrian excavations there, for arranging access to both Terrace Houses and for her hospitality over dinner at the Austrian Institute. Dennis Murphy helped me find the elusive and beautiful site of Rhodiapolis, which took two trips and ultimately a GPS device. Margaret Miles at the American School in Athens was also very helpful during one of my trips to Greece in search of information on Hadrian's Aqueduct at Athens.

I am indebted to Sean O'Neill for his guidance in setting up our Egypt trip in December 2010, which ended only a few weeks before the revolution broke out. Traveling outside of a group tour in Egypt is challenging to say the least, but thanks to contacts Sean provided, everything went as smoothly as possible given the circumstances. I am also grateful to Sebastian Enceina at the Karanis Archives at the Kelsey Museum, who helped me find all the information that I needed on the early University of Michigan excavations in the Fayum; that help was invaluable because I discovered on my trip there that most of the structures have long been reburied under the sands.

The study of hollow voussoirs (Chapter 6) required visits to numerous museum collections in Britain. I was a graduate student at Oxford in the 1990s, but I was not remotely interested in the archaeology of Roman Britain at that point, so when I returned in the summer of 2011, I was entering a new world. I found the scholars and museum curators incredibly generous in sharing their expertise and access to materials. Above all Ian Betts at the Museum of London has been my mentor in all things regarding bricks and tiles of Roman Britain. I also received invaluable help and guidance from James Kenny at the Chichester District Museum and Ernest Black of the Relief-Patterned Tile Research Group. Roger Tomlin at Wolfson College Oxford kindly advised me on the interpretations of tile graffiti. The following museum curators were also very generous with their time and access to collections: Anooshka Rawden at Chichester District Museum, Robert Symmons at Fishbourne, Juliet Nye at the Littlehampton Museum, Susan Fox at the Museum of Bath, Paul Roberts and Richard Hobbs at the British Museum, and Emma O'Connor at Barbican House at Lewes.

For the study of the materials used in *opus caementicium* (Chapter 2) I benefited enormously from my collaboration with a group of geologists in Rome: Fabrizio Marra, Guido Ventura, and Gianluca Sottili. Without their expertise, the rock analyses and provenance identifications would not have been possible. They also made excellent travel companions for our day trips into the countryside around Rome and on a particularly memorable trip in which we spent a

few days living in the Vesuvius Observatory on the flanks of the volcano as we collected our samples. During that trip, we were also fortunate to have Ferdinando De Simone act as *cicerone* for our excursions to the quarries and sites of his home territory along the north flanks of Vesuvius.

Another memorable research trip was one to Argos, Greece, with Carla Amici, Paolo Vitti, and Paolo's (very patient) wife Isabel, who was content to let the three of us obsess about the bricks and walls of the amazing cult complex there. It was a rare pleasure and privilege to be able to immerse myself in the minutia of construction with other enthusiastic experts. Carla and Paolo were also tremendously supportive of this project with both their time and ideas.

Occasionally during one's travels, happy coincidences occur. That was the case during a visit to Croatia in 2012, when I went into a bookstore near the Mausoleum of Diocletian in Split and asked if they had any publications by Goran Nikšić, an architect whose works I had read. The shop owner responded, "No, but his wife works next door if you want to talk to her." So I found her and she took us to his office. My husband and I then spent all that day and part of the next in Goran's company as he took us to every nook and cranny of ancient Split and, most importantly, to climb up to the inner cornice of the dome of the mausoleum from where I took the photograph in Figure 57.

I owe great thanks to a number of people who devoted their time and energy to reading and commenting on various chapters of this manuscript: Carla Amici (Ch. 1, 3, 7), Jim Anderson (Ch. 1-9), Ian Betts (Ch. 6), Barbara Burrell (Ch. 3, 4), Stefano Camporeale (Ch. 5, 7), Tom Carpenter (Ch. 1-9), Tim Clerbaut (Ch. 7), Lothar Haselberger (Ch. 1–7), John Ochsendorf (Ch. 1, 8), John Oleson (Ch. 1, 2), Jane Shepherd (Ch. 5, 7), Paolo Vitti (Ch. 1, 3, 4), Mandy White (Ch. 1, 2), and Greg Woolf (Ch. 7). I am grateful to all of them for saving me from embarrassing mistakes and generally making the book better and more user friendly. They bear no responsibility for the opinions expressed.

This project would not have been possible without help from numerous scholars with various types of expertise. Hazel Dodge, who taught my course on Roman architecture at Oxford, was an early influence who drilled into my head that architecture outside of Rome was important, even when I was completely focused on the capital itself. Many other people shared with me their expertise and research, both published and unpublished: Martin Bachmann, Hansgeorg Bankel, Jacopo Bonetto, Kim Bowes, Evelyne Bukowiecki, Macarena Bustamonte, Manfred Deiler, Janet DeLaine, Richard Etlin, Michalis Kappas, Nikolaos Karydis, Amanda Kelly, Sandra Lucore, Marcello Mogetta, Bob Meyer, Naomi Norman, Jennifer Palinka, Ted Peña, Nigel Pollard, Ursula Quatember, Margareta Steinby, Lea Stirling, David Stone, Hilke Thür, Monica Trümper, Barbara Tsakirgis, Pier Luigi Tucci, Roger Ulrich, Massimo Vitti, Susan Walker, Peter Warry, John Wilkes, Andrew Wilson, Roger Wilson, Mark Wilson Jones, and Ulrike Wulf-Rheidt. Colleagues who generously allowed me to reproduce their photographs include William Aylward, Jane Biers, Stefano Camporeale, Miles Lewis, Sandra Lucore, Goran Nikšić, Evan Scherer, Miriam Shadis, Phil Stinson, and Ulrike Wulf-Rheidt. I am indebted to Glenn Bugh, Barbara Burrell, Steve Hays, and Bill Owens for helping with Greek translations. I am ever grateful to John Ochsendorf at MIT, who has guided me through the process of thrust line analysis over the years. Special thanks are due to Jim Anderson, Lothar Haselberger, John Oleson, Bob Ousterhout, and Fikret Yegül for their steadfast support of this project over the years.

Finishing the drawings for this book during the summer of 2014 was a Herculean task. Ultimately I

could not do it alone in the time I had, and I am extremely grateful to two undergraduate students, Theo Peck-Suzuki (Brown University) and Kendall Markley (Ohio University), for helping me out with their skills in Adobe Illustrator and for their willingness to take on some of the more tedious aspects of the creation process. I also appreciate all the help I received from the staff of the Inter Library Loan Department at Alden Library at Ohio University and from my two main research libraries at the University of Cincinnati and at the American Academy in Rome.

My sabbatical year in Rome in 2007–08 was generously funded by the National Science Foundation. The Department of Classics and World Religions and the College of Arts and Sciences at Ohio University also provided funding for my many travels. I am especially grateful to my editor at Cambridge University Press, Beatrice Rehl, for her unwavering belief in and support of both this project and my first book when opinions of reviewers wavered. Most importantly my husband, Tom Carpenter, made it all possible with his companionship during all of our travels, as well as his unflagging support and encouragement, especially after the economic crisis of 2008 when research funding at all levels disappeared. We ultimately decided that an unpaid leave of absence from university duties during the 2011–12 academic year was necessary for this project to be completed in a timely manner. He also took the time to read the entire manuscript (at least twice) while completing his own book project.

Finally, I dedicate this book to my grandmother, Bertha Seigler (1898–1985), who was determined that I would see the world and made sure that I did. She lived long enough to see me set off for my first overseas trip as a study abroad student during the summer of 1985.