CAMBRIDGE
Cambridge University Press & Assessment
978-1-009-26726-7 — Underground Mathematics
Thomas Morel
Frontmatter
More Information

Underground Mathematics

Thomas Morel tells the story of subterranean geometry, a forgotten discipline that developed in the silver mines of the Holy Roman Empire. Mining and metallurgy were of great significance to the rulers of early modern Europe, required for the silver bullion that fuelled warfare and numerous other uses. Through seven lively case studies, he illustrates how geometry was used in metal mines by practitioners using esoteric manuscripts. He describes how an original culture of accuracy and measurement paved the way for technical and scientific innovations, and fruitfully brought together the world of artisans, scholars, and courts. Based on a variety of original manuscripts, maps and archive material, Morel recounts how knowledge was crafted and circulated among practitioners in the Holy Roman Empire and beyond. Specific chapters deal with the material culture of surveying, map-making, expertise, and the political uses of quantification. By carefully reconstructing the religious, economic, and cultural context of mining cities, *Underground Mathematics* contextualizes the rise of numbered information, practical mathematics, and quantification in the early modern period.

THOMAS MOREL is Professor of the History of Mathematics at the University of Wuppertal, Germany.

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE
Cambridge University Press & Assessment
978-1-009-26726-7 — Underground Mathematics
Thomas Morel
Frontmatter
More Information

Underground Mathematics

Craft Culture and Knowledge Production in Early Modern Europe

Thomas Morel
University of Wuppertal

CAMBRIDGE UNIVERSITY PRESS

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE

Cambridge University Press & Assessment
978-1-009-26726-7 — Underground Mathematics
Thomas Morel
Frontmatter
More Information

CAMBRIDGE
UNIVERSITY PRESS

Shaftesbury Road, Cambridge CB2 8EA, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India

103 Penang Road, #05–06/07, Visioncrest Commercial, Singapore 238467

Cambridge University Press is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

We share the University's mission to contribute to society through the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781009267267

DOI: 10.1017/9781009267274

© Thomas Morel 2023

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press & Assessment.

First published 2023
First paperback edition 2025

A catalogue record for this publication is available from the British Library

ISBN 978-1-009-26730-4 Hardback
ISBN 978-1-009-26726-7 Paperback

Cambridge University Press & Assessment has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE
Cambridge University Press & Assessment
978-1-009-26726-7 — Underground Mathematics
Thomas Morel
Frontmatter
More Information

For my parents

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE
Cambridge University Press & Assessment
978-1-009-26726-7 — Underground Mathematics
Thomas Morel
Frontmatter
More Information

Contents

List of Figures *page* viii
Acknowledgements x

Introduction 1

1 Of Scholars and Miners 20

2 A Mathematical Culture: The Art of Setting Limits 50

3 The Mines and the Court 83

4 Writing It Down: Innovation, Secrecy, and Print 118

5 'So Fair a Subterraneous City': Mapping the Underground 149

6 How to Teach It? Finding the Right Direction 183

7 'One of Geometry's Nicest Applications': Crafting the Deep-George Tunnel (1771–1799) 213

Conclusion 243

Bibliography 253
Index 281

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE
Cambridge University Press & Assessment
978-1-009-26726-7 — Underground Mathematics
Thomas Morel
Frontmatter
More Information

Figures

I.1	Frontispiece of Nicolaus Voigtel's *Geometria subterranea* (1686)	2
1.1	Measuring the depth of a shaft according to Agricola's *De re metallica* (1556)	33
1.2	Mine surveying as presented in the *Schwazer Bergbuch* (1554)	35
1.3	Working document of subterranean surveyor Hans Dolhopp (ca. 1603)	36
1.4	Measuring the depth of a well according to Oronce Finé's *Protomathesis* (1532)	39
1.5	Measuring the depth of a shaft according to Erasmus Reinhold's *Vom Marscheiden* (1574)	44
2.1	Preliminary survey of a mine concession	57
2.2	Mining concessions on the outskirts of Altenberg	60
2.3	Setting of concession limits in the gallery, as presented on a surveyor's manuscript	63
2.4	Title page of Cyriacus Spangenberg, *On Dr. Martin Luther* (1574)	72
2.5	Frontispiece of Peter Eichholtz's *Spiritual Mine* (1655)	80
3.1	Allegorical view of the mining city of Freiberg during the silver rush	87
3.2a	Map of the Schwarzenberg mining district	95
3.2b	A detail from Figure 3.2a showing the mining compass in the legend to the map of the Schwarzenberg mining district	96
3.3a	Principle of the spiderweb surveying method acording to Lehmann's *Historischer Schauplatz* (1699)	108
3.3b	Use of the spiderweb surveying method in a map by Matthias Öder (1608)	109
3.4a	Surveying instrument by Christoph Trechsler (1589)	112
3.4b	Drawing of the 'astronomical device' used by Melchior Jöstel in 1604	113
4.1	Title pages of two subterranean geometry manuscripts	122
4.2	The right triangle, also known as 'master of mathematics'	125
4.3	Mine survey by Jobst Henning Tolle (1699)	127
4.4	Subterranean geometry certificate of Gottfried Klemm	132

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE
Cambridge University Press & Assessment
978-1-009-26726-7 — Underground Mathematics
Thomas Morel
Frontmatter
More Information

4.5 Register of the 'written books' of the late surveyor Sartorius 146
5.1 Portrait of Abraham von Schönberg 150
5.2 Sketch of an abandoned draining gallery 158
5.3 First page of Johann Berger's *Freiberga subterranea* (1693) 161
5.4 The mining pits *Zscherper* and *Consolation of Israel* 162
5.5 Frontispiece of Berger's *Freiberga subterranea* (1693) 166
5.6 Geometrical draft plan of the *Holy Father* gallery 168
5.7 Frontispiece of Abraham von Schönberg's *Ausführliche Berg-Information* (1693) 172
5.8 Portraits of Georg Friedrich von Schönberg and Caspar von Schönberg 181
6.1 'Drawing problems' solved by an applicant for a Freiberg mining grant 188
7.1 The Harz mines in Héron de Villefosse, *De la richesse minérale* (1819) 214
7.2 Field book of Johann Christian Heinrich Länge (1774) 221
7.3 Prospective plan of the *Deep-George* draining tunnel drawn by surveyor Länge 222

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE
Cambridge University Press & Assessment
978-1-009-26726-7 — Underground Mathematics
Thomas Morel
Frontmatter
More Information

Acknowledgements

This book has been a very long time in the making, building on intuitions first developed ten years ago at the end of my PhD thesis. I am indebted to many people, first of all to my *Doktorvater* Pascal Duris, whose enthusiasm and rigour shaped my historical understanding, warning me against teleology and far-fetched conclusions. This is how I learned that 'anything goes' in the history of science, as long as you find interesting archives and read them with an open mind – a piece of advice I hope I have followed here. The present project would not have even begun without Friedrich Steinle and Gerhard Rammer, who back in 2013 accepted the postdoc application of a young French graduate, dealing with a topic esoteric even for seasoned German historians of science. Thanks to them, I spent two great years at the Berlin Center for the History of Knowledge, navigating between the TU Berlin and the Max Planck Institute for the History of Science (MPIWG). Numerous discussions with Cesare Pastorino, Giuditta Parolini, and many other colleagues cemented my interest in useful knowledge and its history. During this time, I collected a good part of the archive material that eventually became the basis for the present book. Ideas and arguments slowly matured during the following years, as I tried to tie together the large, slow developments of early modern practical mathematics with a set of specific case studies about the knowledge and craft culture of the German mining states.

In the final stretch of completing the manuscript, the University of Lille granted me a much-welcomed sabbatical, while the MPIWG funded my research stay in Berlin. This is where the first draft of this book was completed, largely isolated from the outside world by a global pandemic, in the strange, at times ethereal atmosphere of a near-empty building. I would like to thank the institutions that generously provided me travel grants for archival research over the years, most notably the German Academic Exchange Service (DAAD), the Fritz Thyssen Foundation, and the International Commission on the History of Mathematics (Grattan-Guinness travel grant). My home institutions, first the Laboratoire de mathématiques de Lens and now the University of Wuppertal, provided invaluable material assistance and intellectual support. Archivists in Germany, Austria, and Slovakia were incredibly helpful in enabling me to access and understand their collections, most notably Angela Kugler-Kießling – as well as the Freiberg Institute

© in this web service Cambridge University Press & Assessment www.cambridge.org

CAMBRIDGE
Cambridge University Press & Assessment
978-1-009-26726-7 — Underground Mathematics
Thomas Morel
Frontmatter
More Information

for Industrial Archaeology, History of Science and Technology (IWTG) – Christiane Tschubel (Bergarchiv Clausthal), Patrick Kennel (University and State Library of Tirol), and Annett Wulkow Moreira da Silva (Freiberg University of Mining and Technology). Björn Ivar Berg was kind enough to send me the certificate of surveyor Gottfried Klemm from the Norwegian Mining Museum (Norsk Bergverksmuseum), while Peter Konečný's historical knowledge proved invaluable when I nearly got lost in the archive of Banská Štiavnica.

A different version of Chapter 1 appeared as 'De Re Geometrica: Writing, Drawing, and Preaching Mathematics in Early Modern Mines', *Isis* 111 (March 2020): 22–45, © by the History of Science Society. All rights reserved. I thank the University of Chicago Press for permission to reprint, as well as Floris Cohen and the editorial team for their useful comments.

Most of the following chapters have been presented in one form or another at workshops and conferences over the years, at the MPIWG and the TU Berlin of course, but also at the University of Wuppertal, during a workshop of the *Revue d'histoire des mathématiques* in Strasbourg, as well as in Barcelona, Freiberg, and Oberwolfach. Karine Chemla, Christine Proust, and all the participants of the 'Histoire des sciences, histoire du texte' seminar in Paris were very helpful, taking the time to discuss very specific points on several occasions. Antoni Malet, Jeanne Peiffer, Samuel Gessner, Tina Asmussen, Pierre Desjonquères, Jim Bennett, Sebastian Felten, and Liliane Hilaire-Perez helped me better understand the complex nature of early modern practical knowledge, during informal talks and in studying their great articles. Pamela Long and Margaret Schotte both served as unwitting writing mentors as I perused their books time and again to understand how to square the circle of writing a short and readable book without sacrificing depth or historical scholarship. A session about practical mathematics in early modern Europe, which I organized for the History of Science Society in Utrecht in 2019, was a good opportunity to present and test several hypotheses presented in this book.

Peter Konečný, Michael Korey, Ursula Klein, Wolfgang Lefèvre, and Thomas Préveraud all read various chapters of the book, and their encouraging criticisms helped me clarify my arguments on many occasions. Rachel Blaifeder and Lucy Rhymer from Cambridge University Press encouraged me with this somewhat unconventional project, helping to turn it into a more compact and clearer manuscript. Thanks to Melanie Gee, who produced the index, as well as to Narmadha Nedounsejiane and the CUP production team for their great professionalism. While numerous people helped me develop the original draft into a coherent whole, all remaining mistakes are obviously my own.

Finally, Typhaine accompanied me during the long gestation of this book, at times kindly reminding me of the existence of a real world above subterranean silver mines. Together with Margaux and Juliette, they never failed to keep me as happily occupied at home as I am at work.

© in this web service Cambridge University Press & Assessment www.cambridge.org