

Contents

| | |
|---|------------------|
| <i>List of Contributors</i> | <i>page viii</i> |
| 1 Introduction to <i>Deep Carbon: Past to Present</i> | 1 |
| BETH N. ORCUTT, ISABELLE DANIEL, RAJDEEP DASGUPTA, DARLENE TREW CRIST, AND MARIE EDMONDS | |
| 2 Origin and Early Differentiation of Carbon and Associated Life-Essential Volatile Elements on Earth | 4 |
| RAJDEEP DASGUPTA AND DAMANVEER S. GREWAL | |
| 3 Carbon versus Other Light Elements in Earth's Core | 40 |
| JIE LI, BIN CHEN, MAINAK MOOKHERJEE, AND GUILLAUME MORARD | |
| 4 Carbon-Bearing Phases throughout Earth's Interior: Evolution through Space and Time | 66 |
| VINCENZO STAGNO, VALERIO CERANTOLA, SONJA AULBACH, SERGEY LOBANOV, CATHERINE A. MCCAMMON, AND MARCO MERLINI | |
| 5 Diamonds and the Mantle Geodynamics of Carbon: Deep Mantle Carbon Evolution from the Diamond Record | 89 |
| STEVEN B. SHIREY, KAREN V. SMIT, D. GRAHAM PEARSON, MICHAEL J. WALTER, SONJA AULBACH, FRANK E. BRENKER, HÉLÈNE BUREAU, ANTONY D. BURNHAM, PIERRE CARTIGNY, THOMAS CHACKO, DANIEL J. FROST, ERIK H. HAURI, DORRIT E. JACOB, STEVEN D. JACOBSEN, SIMON C. KOHN, ROBERT W. LUTH, SAMI MIKHAIL, ODED NAVON, FABRIZIO NESTOLA, PAOLO NIMIS, MEDERIC PALOT, EVAN M. SMITH, THOMAS STACHEL, VINCENZO STAGNO, ANDREW STEELE, RICHARD A. STERN, EMILIE THOMASSOT, ANDREW R. THOMSON, AND YAAKOV WEISS | |
| 6 CO ₂ -Rich Melts in Earth | 129 |
| GREGORY M. YAXLEY, SUJOY GHOSH, EKATERINA S. KISEEVA, ANANYA MALLIK, CARL SPANDLER, ANDREW R. THOMSON, AND MICHAEL J. WALTER | |

| | | |
|----|--|-----|
| 7 | The Link between the Physical and Chemical Properties of Carbon-Bearing Melts and Their Application for Geophysical Imaging of Earth's Mantle | 163 |
| | FABRICE GAILLARD, NICOLAS SATOR, EMMANUEL GARDÉS, BERTRAND GUILLOT, MALCOLM MASSUYEAU, DAVID SIFRÉ, TAHAR HAMMOUDA, AND GUILLAUME RICHARD | |
| 8 | Carbon Dioxide Emissions from Subaerial Volcanic Regions: Two Decades in Review | 188 |
| | CYNTHIA WERNER, TOBIAS P. FISCHER, ALESSANDRO AIUPPA, MARIE EDMONDS, CARLO CARDELLINI, SIMON CARN, GIOVANNI CHIODINI, ELIZABETH COTTRELL, MIKE BURTON, HIROSHI SHINOHARA, AND PATRICK ALLARD | |
| 9 | Carbon in the Convecting Mantle | 237 |
| | ERIK H. HAURI, ELIZABETH COTTRELL, KATHERINE A. KELLEY, JONATHAN M. TUCKER, KEI SHIMIZU, MARION LE VOYER, JARED MARSKE, AND ALBERTO E. SAAL | |
| 10 | How Do Subduction Zones Regulate the Carbon Cycle? | 276 |
| | MATTHIEU EMMANUEL GALVEZ AND MANUEL PUBELLIER | |
| 11 | A Framework for Understanding Whole-Earth Carbon Cycling | 313 |
| | CIN-TY A. LEE, HEHE JIANG, RAJDEEP DASGUPTA, AND MARK TORRES | |
| 12 | The Influence of Nanoporosity on the Behavior of Carbon-Bearing Fluids | 358 |
| | DAVID COLE AND ALBERTO STRIOLO | |
| 13 | A Two-Dimensional Perspective on CH ₄ Isotope Clumping: Distinguishing Process from Source | 388 |
| | EDWARD D. YOUNG | |
| 14 | Earth as Organic Chemist | 415 |
| | EVERETT SHOCK, CHRISTIANA BOCKISCH, CHARLENE ESTRADA, KRISTOPHER FECTEAU, IAN R. GOULD, HILAIRY HARTNETT, KRISTIN JOHNSON, KIRTLAND ROBINSON, JESSIE SHIPP, AND LYNDA WILLIAMS | |
| 15 | New Perspectives on Abiotic Organic Synthesis and Processing during Hydrothermal Alteration of the Oceanic Lithosphere | 447 |
| | MURIEL ANDREANI AND BÉNÉDICTE MÉNEZ | |
| 16 | Carbon in the Deep Biosphere: Forms, Fates, and Biogeochemical Cycling | 480 |
| | SUSAN Q. LANG, MAGDALENA R. OSBURN, AND ANDREW D. STEEN | |
| 17 | Biogeography, Ecology, and Evolution of Deep Life | 524 |
| | CARA MAGNABOSCO, JENNIFER F. BIDDLE, CHARLES S. COCKELL, SEAN P. JUNGBLUTH, AND KATRINA I. TWING | |

- 18 The Genetics, Biochemistry, and Biophysics of Carbon Cycling by Deep Life 556
KAREN G. LLOYD, CODY S. SHEIK, BERTRAND GARCÍA-MORENO, AND
CATHERINE A. ROYER
- 19 Energy Limits for Life in the Subsurface 585
DOUG LAROWE AND JAN AMEND
- 20 Deep Carbon through Deep Time: Data-Driven Insights 620
ROBERT M. HAZEN, YANA BROMBERG, ROBERT T. DOWNS, AHMED ELEISH,
PAUL G. FALKOWSKI, PETER FOX, DONATO GIOVANNELLI, DANIEL R. HUMMER,
GRETHE HYSTAD, JOSHUA J. GOLDEN, ANDREW H. KNOLL, CONGRUI LI,
CHAO LIU, ELI K. MOORE, SHAUNNA M. MORRISON, A.D. MUSCENTE,
ANIRUDH PRABHU, JOLYON RALPH, MICHELLE Y. RUCKER, SIMONE E. RUNYON,
LISA A. WARDEN, AND HAO ZHONG

Index 653

Online Resources (available at www.cambridge.org/deepcarbon)

Compilations of global volcanic CO₂ emissions (Supplemental Tables 8.1 to 8.4 to accompany Chapter 8)

Movie of molecular dynamics in magma melts (to accompany Chapter 7)