CONTENTS

Preface xi

Part 1 Int	roduction and the Origins of Resources 1
	Modern Society and Earth Resources: The Complex Network 1 The Changing World 1 Interdependence and Complexity 2 The Earth—Our Only Home 3 Plate Tectonics and the Formation of Earth Resources 3
Chapter 1	Minerals: The Foundations of Society 5 The World's Resource Needs 5 Population Growth: The Force That Drives Resource Consumption 6 Materials We Use 10 Consequences of Resource Exploitation 13 Resources, Reserves, and Ores 16 Where Do Earth Resources Come from? 18 ■ BOX 1.1: CO ₂ and the Greenhouse Effect 12 ■ BOX 1.2: The Lessons of Busang and Bre-X 14
Chapter 2	Plate Tectonics and the Origins of Resources 20 Introduction 21 Plate Tectonics 21 Subsurface Igneous and Metamorphic Processes 23 Surface Processes 32 Shallow Subsurface and Diagenetic Processes 36 Marine Processes 37 Conclusions 39 BOX 2.1: Fluid Inclusions 26 BOX 2.2: Placer Deposits: Panning Gold and Mining Gravel 30 BOX 2.3: Seabed Ownership 33
Part 2 History and Environmental Impact of Resource Usage 41 Historical Changes 41	

Environmental Impact 41

Chapter 3 Earth Resources Through History 44

Introduction 45

Resources of Antiquity 45

From Rome to the Renaissance 47

Global Exploration and Colonialism 48

Humans and Metals 50

Modern Trends in Resource Usage 55

Global Distribution and the International Flow of Resources 59

- BOX 3.1: The California Gold Rush 51
- BOX 3.2: The Industrial Revolution 62

Chapter 4 Environmental Impacts of Resource Exploitation and Use 72

Introduction 73

Environmental Impact of Resource Extraction 75

Environmental Impacts of Resource Usage 95

Environmental Impacts of Waste Disposal or Recycling 108

- BOX 4.1: Acid Rain 80
- BOX 4.2: Radon 102
- BOX 4.3: The Move to Recycle 115

Part 3 Energy 117

Fossil Fuels 118 Nuclear Energy 119 Renewable Energy 120 The Energy Debate 121

Chapter 5 Energy from Fossil Fuels 122

Introduction 123 Energy Units 123 The Changing Use of Energy 125 Fossil Fuels 127

FOSSIL FUEIS 127

Gasoline Usage and Demand—The Example of the United States 159 Future Fossil Fuel Resources 179

- BOX 5.1: The Persian Gulf War 1990–1991: Oil, Politics, Environment 128
- BOX 5.2: The United States Strategic Petroleum Reserve 143
- BOX 5.3: Coal Bed Methane 149
- BOX 5.4: Plastics 171

Chapter 6 Nuclear and Renewable Energy Sources 180

Introduction 181

Nuclear Power—Uranium and Nuclear Fission 182

Renewable Energy Sources 200

The Future 228

- BOX 6.1: United States Nuclear Waste Storage—Yucca Mountain 191
- BOX 6.2: Chernobyl 206
- BOX 6.3: Hydroelectric Power 218

Part 4 Metals 229

History 229 Types and Abundances of Metals 230

Chapter 7 Abundant Metals 232

Metals and Their Properties 233 The Nature of Ore Deposits 233 Iron: The Backbone of Industry 235 Manganese 247 Aluminum, the Metal of the Twenty-first Century 251 Titanium 258 Magnesium 259 Silicon 261 Abundant Metals in the Future 263 ■ BOX 7.1: The Iron Ranges 241

■ BOX 7.2: Recycling Automobiles 253

Chapter 8 The Geochemically Scarce Metals 264

Production of the Geochemically Scarce Metals 265

Distribution of Scarce Metals in the Crust 265

Ore Minerals of the Scarce Metals 268

Classification of the Scarce Metals by Usage 269

The Ferro-Alloy Metals 269

The Base Metals 280

The Precious Metals 297

The Special Metals 311

- BOX 8.1: Metals in Modern Coins 281
- BOX 8.2: Lead in the Environment 291
- BOX 8.3: More Than Zinc from a Zinc Mine 293
- BOX 8.4: Gold Extraction Using Mercury and Cyanide 306

Part 5 Fertilizer, Chemical, Construction, and Industrial Resources 315

Construction and Industrial Minerals 315 Fertilizer and Chemical Minerals 316

Chapter 9 Fertilizer and Chemical Minerals 317

Introduction 318 Minerals for Fertilizers 318 Historical Overview of Fertilizers 319 Nitrogen 322 Phosphorus 324 Potassium 328 Sulfur 329 Minerals for Chemicals 332 Fertilizer and Chemical Minerals in the Future 338

- BOX 9.1: The Early Potash Industry and U.S. Patent Number 1 321
- BOX 9.2: Lake Peigneur, Where Oil and Salt Did Not Mix 338
- BOX 9.3: Minerals in Foods, Medicines, and Cosmetics 340

Chapter 10 Building Materials and Other Industrial Minerals 342

Introduction 342 Untreated Rock Products 343 Treated Rock Products 353 Other Major Industrial Minerals 361 Gemstones 374 The Future for Building Materials and Industrial Minerals 379

- BOX 10.1: Marble for the Masters 348
- BOX 10.2: What Is This Page Made of? 363
- BOX 10.3: Synthetic Diamonds 371

Part 6 Water and Soil for Life Support 381

Water 381 Soil 382

Chapter 11 Water Resources 383

Introduction 384

The Global Distribution of Water 384

Our Use of Water 403

Potential Water Problems 419

Large-Scale Transportation and Diversion Systems 432

BOX 11.1: Restoring a River: The Kissimmee 392

- BOX 11.2: Water for New York City 409
- BOX 11.3: Water in the Middle East 418
- BOX 11.4: The Death of a Lake—The Aral Sea 433

Chapter 12 Soil as a Resource 437

Introduction 438

- Soil Formation and Distribution 438
- Soil Type and Land Use 448

Erosion and Deterioration of Soils 452

Conservation—The Keyword for Soil Science 455

- BOX 12.1: How Fast Does Soil Form? 444
- BOX 12.2: The Dust Bowl 448
- BOX 12.3: Selenium Poisoning in the San Joaquin Valley 453
- BOX 12.4: Deforestation, Soil Erosion, and the Destruction of Environmental Assets 456

Chapter 13 Future Resources 459

- Introduction 460
 - Future Mineral Resources 460

The Environment in the Future 465

Metals for the Future 465

Fertilizers and Chemicals for the Future 466

Building and Industrial Materials for the Future 467

Energy for the Future 467

Renewable Energy for the Future 468

Water and Soil for the Future 469

Technology and Innovation 469

Appendix: Calendar of Earth Resources Events 471 Glossary 479 Index 493