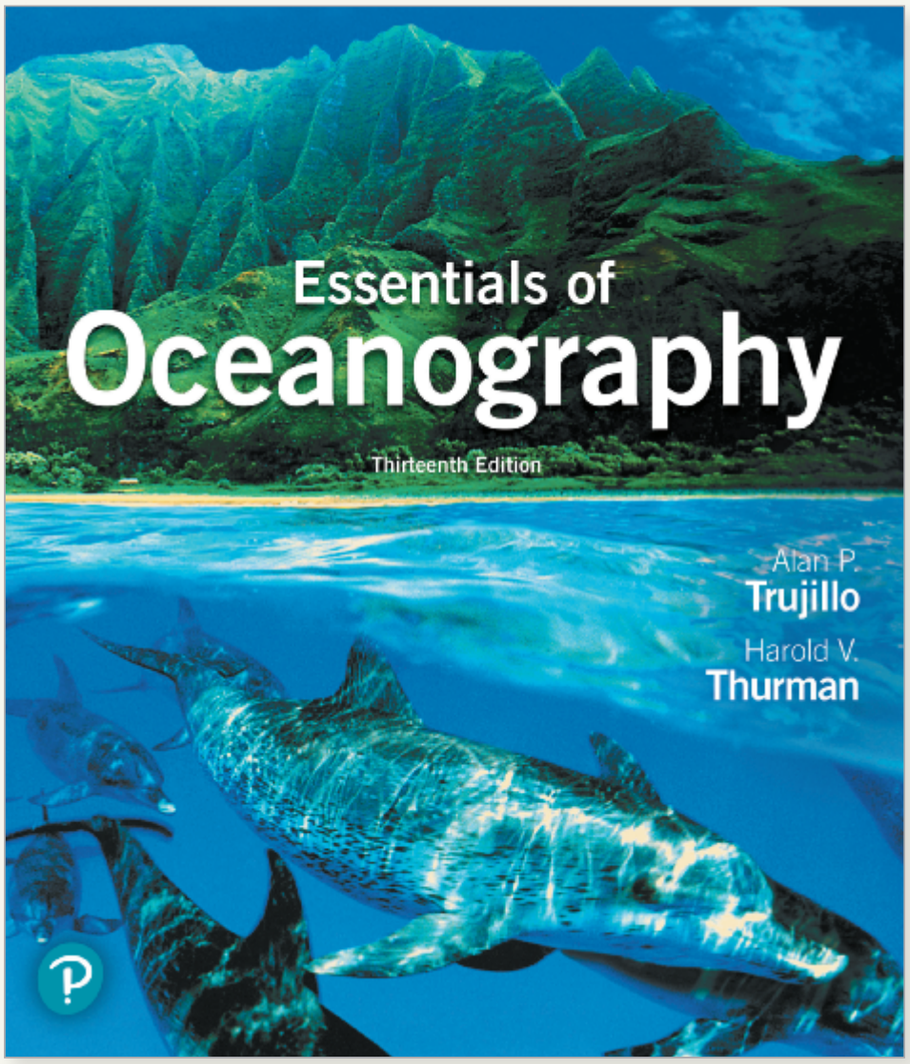
Dive into Oceanography with Trusted Content and Innovative Media



The best-selling brief book in the oceanography market combines dynamic visuals and a student-friendly narrative to bring oceanography to life and inspire students to engage and learn more about the oceans and environments around them. The 13th edition creates an interactive learning experience, providing tightly integrated text and digital offerings that make oceanography approachable and digestible for students. An emphasis on the **process of science** throughout the text provides students with an understanding of how scientists think and work. It also helps students develop the scientific skills of devising experiments and interpreting data.

Pearson

Dive into the Process of Science

GraphIt! Activities are a great way to help your students develop their understanding of graphs and data. These activities use real data to help students build science literacy skills and their understanding of how to analyze and interpret graphs.

NEW Process of Science features develop student understanding of how scientists think and work. Each one highlights an area of oceanographic inquiry and explicitly points out the associated background, method, and conclusion of the inquiry.

NEW Process of Science in Mastering. Each of the new Process of Science features includes an assignable Mastering coaching activity to enable students to be active participants and develop 21st Century Skills.

PROCESS OF SCIENCE 4.1: When The Dinosaurs Died: The Cretaceous–Tertiary (K–T) Event

BACKGROUND

The extinction of the dinosaurs—and about 75% of all plant and animal species on Earth, including many marine species—occurred about 66 million years ago. This extinction marks the boundary between the Cretaceous (K) and Tertiary (T) Periods of geologic time and is known as the **K–T event** or, because of recent changes in the geologic time scale, the *Cretaceous–Paleogene (K–Pg) event*. Did slow climate change lead to the extinction of these organisms, or was it a catastrophic event? Was their demise related to disease, diet, predation, or volcanic activity? Earth scientists have long sought clues to this mystery.

FORMING A HYPOTHESIS

In 1980, geologist Walter Alvarez, his father, Nobel Physics Laureate Luis Alvarez, and two nuclear chemists, Frank Asaro and Helen Michel, reported that marine deposits collected in northern Italy from the K–T boundary contained an unusual clay layer with high proportions of the metallic element iridium (Ir), an element rare in Earth rocks but much more abundant in meteorites. The high concentrations of iridium suggested minerals in the clay had an extraterrestrial origin. In addition, the clay layer contained shocked quartz grains, indicating an event had occurred with enough force to fracture and partially melt pieces of quartz. Other deposits from the K–T boundary revealed similar features, supporting the hypothesis that Earth experienced an extraterrestrial impact at the same time that the dinosaurs died.

One problem with the impact hypothesis, however, is that dust spewing from volcanic eruptions on Earth could create similar clay deposits enriched in iridium and containing shocked quartz. In fact, at about the same time as the dinosaur extinction, large outpourings of basaltic volcanic rock in India (called the Deccan Traps) and other locations had occurred. Also, if there was a catastrophic meteor impact, where was the crater?

In the early 1990s, the 190-kilometer (120-mile)-wide *Chicxulub* (pronounced "SCHICK-sue-lube") *Crater* off the Yucatán coast in the Gulf of Mexico was identified as a likely candidate because of its structure, age, and size. To create a crater this large, a 10-kilometer (6-mile)-wide object composed of rock and/or ice traveling at speeds up to 72,000 kilometers (45,000 miles) per hour must have slammed into Earth (Figure 4B). Such an impact would have created huge waves—estimated to be more than 900 meters (3000 feet) high—that traveled throughout the oceans. In addition, the dust and debris lifted into the atmosphere most likely limited photosynthesis, chilled Earth's surface, and brought about the extinction of the dinosaurs and many other species. Finally, acid rains and global fires may have added to the environmental disaster.

DEVISING AN EXPERIMENT

Supporting evidence for the meteor impact hypothesis was provided in 1997 by recovering cores of sediment from the sea floor. Previous drilling close to the impact site did not reveal any K–T deposits. Evidently, the impact and resulting huge waves had stripped the ocean floor of its sediment. However, at 1600 kilometers (1000 miles) from the impact site, the telltale sediments from the catastrophe, such as the iridium-rich clay layer, were preserved in sea floor sediments.

INTERPRETING THE RESULTS

Convincing evidence of the K–T impact from this and other cores collected in 2016 suggests that Earth has experienced many such extraterrestrial impacts over geologic time. Statistics show that an impact the size of the K–T event should occur on Earth about once every 100 million years, severely affecting life on Earth as it did the dinosaurs. This frequency is consistent with the fossil record, which indicates that in the last 500 million years, Earth has experienced five major extinction events.

THINKING LIKE A SCIENTIST: WHAT'S NEXT?

What kind of evidence would you expect to find in coastal rock sequences that were deposited during the time of the huge waves that were created by the meteor impact?

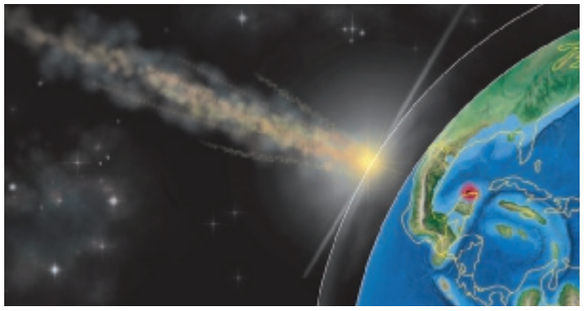
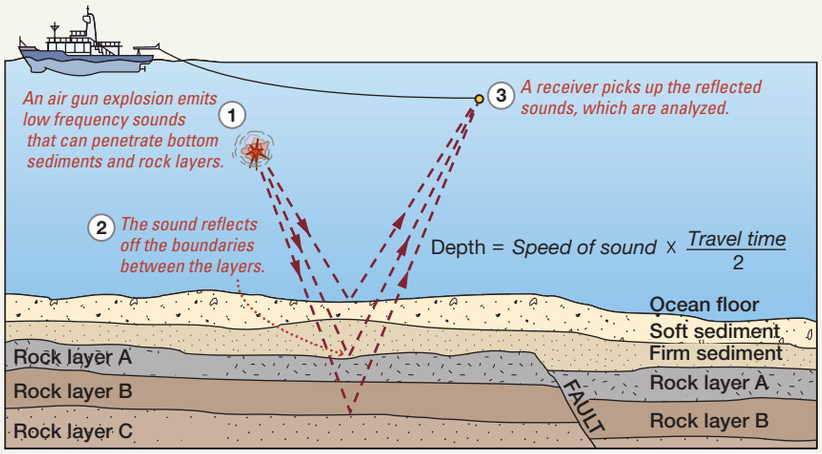


Figure 4B The K–T meteorite impact event.

with Trusted Content and Dynamic Media

EXPLORING DATA ▶ **Using the equation shown in Figure 3.7a, determine the time it takes sound to reach the deepest part of the ocean, the Challenger Deep in the Mariana Trench, which is 11,022 meters (36,161 feet) below sea level. Use the average speed of sound in seawater of 1507 meters (4945 feet) per second.**



(a) A ship conducting seismic profiling. Note that depth can be determined by knowing the speed of sound in seawater and the travel time of the sound.

NEW Exploring Data Activities help students engage with graphs and other data-driven features to enable them to practice their data interpretation skills.

NEW MapMaster 2.0 is GIS inspired, allowing students to layer various thematic maps to analyze spatial patterns and data at regional and global scales. Now, fully mobile, this tool includes zoom and annotation functionality with hundreds of map layers leveraging recent data from sources such as NOAA, NASA, USGS, United Nations, and CIA. Students can also upload their own data. Students are able to access MapMaster 2.0 in the Study Area on their own and instructors can assign auto-graded activities.

Dive into Student Engagement

STUDENTS SOMETIMES ASK . . .

How can I accept a scientific idea if it's just a theory?

When most people use the word "theory" in everyday life, it usually means an idea or a guess (such as the all-too-common "conspiracy theory"), but the word has a much different meaning in science. In science, a theory is not a guess or a hunch. It's a well-substantiated, well-supported, well-documented explanation for observations about the natural world. It's a powerful tool that ties together all the facts about something, providing an explanation that fits all the observations and is used to make predictions (for example, what will happen given a certain set of circumstances). In science, a theory is a well-established explanation of how the natural world works. For a scientific theory to exist, scientists have to be *very* sure about it. So, don't discount a scientific idea because it's "just a theory." As famed astrophysicist Neil deGrasse Tyson has stated about the validity of science, *"The good thing about science is that it's true whether or not you believe in it."*

Students Sometimes Ask features display common and often entertaining questions posed by real students, like "Why do my fingers get wrinkly when they are in the water for a long time?" and pose scientific explanations.

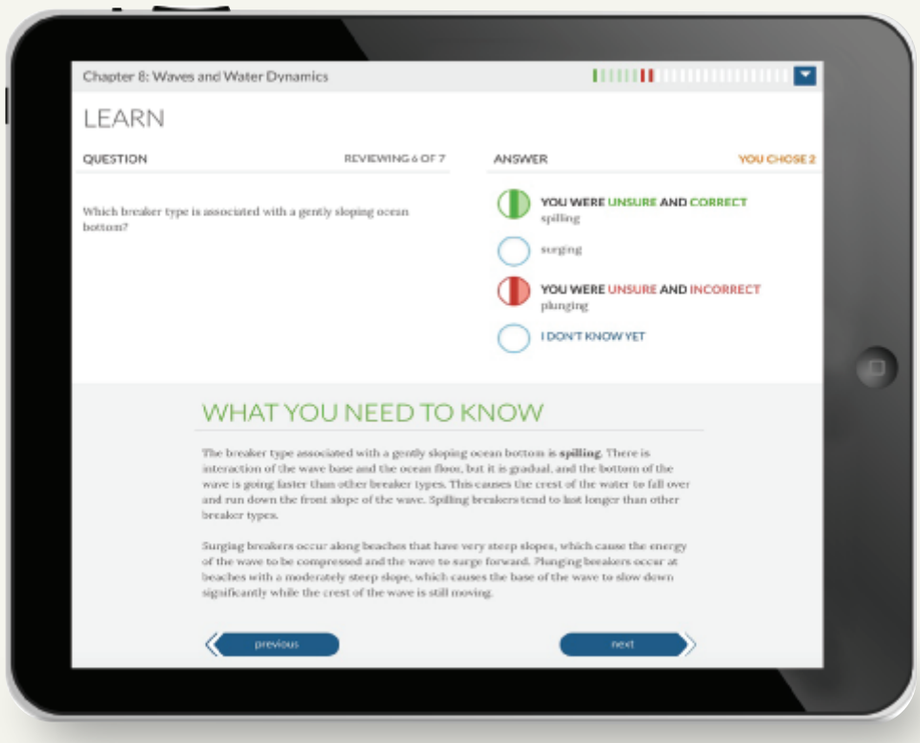
CREATURE FEATURE 2.1

Can you help me find my way home?

The **green sea turtle** (*Chelonia mydas*) is not named for its external color, but for the greenish color of its body fat.

Green sea turtles spend many years living at sea in tropical and subtropical oceans but unerringly return to their place of birth to lay eggs on sandy beaches. How do they navigate so precisely? See **Process of Science 2.1.**

NEW Creature Features draw student interest by introducing compelling facts about marine organisms in an engaging "Who am I?" format.



NEW! Dynamic Study Modules help students study effectively—and at their own pace—by keeping them motivated and engaged. The assignable modules rely on the latest research in cognitive science, using methods—such as adaptivity, gamification, and intermittent rewards—to stimulate learning and improve retention.

with Tools that Enhance Learning

Oceanography Animations captivate students with animations that illustrate key concepts in a visually dynamic and engaging way.

SmartFigures are 3- to 4-minute mini video lessons containing explanations of difficult-to-understand oceanographic concepts and numerical data directed by an oceanography teaching expert and NASA Science Communicator.

The **Student-Centric Approach** enables students to form a path to successful learning. There is a **Recap** feature throughout each chapter, summarizing essential concepts. **Critical Thinking Questions** and **Active Learning Exercises** encourage students to think deeply about and engage with chapter topics.

ESSENTIAL LEARNING CONCEPTS

At the end of this chapter, you should be able to:

- ☐ **3.1** Discuss the techniques that are used to determine ocean bathymetry.
- ☐ **3.2** Describe the sea floor features that exist on continental margins.
- ☐ **3.3** Describe the sea floor features that exist in the deep-ocean basins.
- ☐ **3.4** Describe the sea floor features that exist along the mid-ocean ridge.

RECAP **Sending pings of sound into the ocean (echo sounding) is a commonly used technique for determining ocean bathymetry. More recently, satellites are being used to map sea floor features.**

CONCEPT CHECK 3.1 ▸ Discuss the techniques that are used to determine ocean bathymetry.

1 What is bathymetry? How is it different from topography?

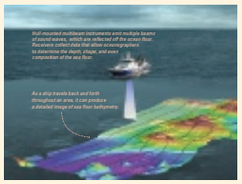
2 Describe how an echo sounder works.

3 Discuss the development of bathymetric techniques, indicating significant advancements in technology.

ESSENTIAL CONCEPTS REVIEW

3.1 ▸ What techniques are used to determine ocean bathymetry?

- *Bathymetry is the measurement of ocean depths and the charting of ocean floor topography.* The varied bathymetry of the ocean floor was first determined using *soundings* to measure water depth. Later, the development of the *echo sounder* gave ocean scientists a more detailed representation of the sea floor.
- Today, much of our knowledge of the ocean floor has been obtained using various *multibeam echo sounders* or *side-scan sonar instruments* (to make detailed bathymetric maps of a small area of the ocean floor), *satellite measurement* of the ocean surface (to produce maps of the world ocean floor), and *seismic reflection profiles* (to examine Earth structure beneath the sea floor).



Selected Key Terms

Use the **glossary** at the end of this book to discover the meanings of these Selected Key Terms: **bathymetry, sounding, echo sounder, sonar, seismic reflection profile.**

Critical Thinking Question

Describe how satellite measurements of the ocean *surface* allow oceanographers to create a map of the sea *floor*.

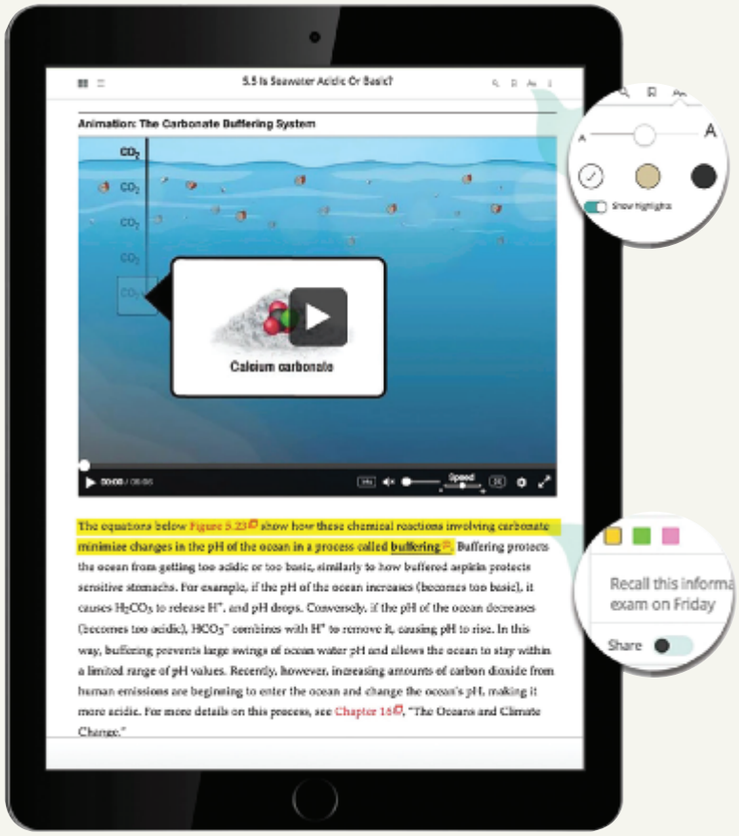
Active Learning Exercise

Use the Internet to research how a "fish finder" works on modern sport-fishing boats. How do these techniques compare to the sonar techniques described in this textchapter?

Dive into a Whole New Learning Experience with Pearson eText

Give students anytime, anywhere access with **Pearson eText**, the simple-to-use, mobile-optimized, and personalized reading experience available within Mastering. It allows students to easily highlight, take notes, and review key vocabulary all in one place—even when offline. Seamlessly integrated videos and other rich media engage students and give them access to the help they need, when they need it.

"I absolutely love the digital book that came with my main paper book, all the audio and video materials made my course so entertaining, and as a result A+ for the semester!"



Pearson eText for Oceanography has hundreds of videos and animations that bring concepts to life. Instructors are able to highlight key concepts within the eText and share with their students to guide them through the reading and help them grasp key concepts.

PREFACE

"The sea, once it casts its spell, holds one in its net of wonder forever."

—Jacques-Yves Cousteau, oceanographer, underwater videographer, and explorer (circa 1963)

To the Student

Welcome! You're about to embark on a journey that is far from ordinary. Over the course of this term, you will discover the central role the oceans play in the vast global system, of which you are a part.

This book's content was carefully developed to provide a foundation in science by examining the vast body of oceanic knowledge. This knowledge includes information from a variety of scientific disciplines—geology, chemistry, physics, and biology—as they relate to the oceans. However, no formal background in any of these disciplines is required to successfully master the subject matter contained within this book. Our desire is to have you take away from your oceanography course much more than just a collection of facts. Instead, we want you to develop a fundamental understanding of how the oceans work and why the oceans behave the way that they do.

This book is intended to help you in your quest to know more about the oceans. Taken as a whole, the components of the ocean—its sea floor, chemical constituents, physical components, and life-forms—comprise one of Earth's largest interacting, interrelated, and interdependent systems. Because human activities impact Earth systems, it is important to understand not only how the oceans operate but also how the oceans interact with Earth's other systems (such as its atmosphere, biosphere, and hydrosphere) as part of a larger picture. Thus, this book uses a systems approach to highlight the interdisciplinary relationships among oceanographic phenomena and how those phenomena affect other Earth systems.

DIVING DEEPER PREFACE.1

A USER'S GUIDE FOR STUDENTS: HOW TO READ A SCIENCE TEXTBOOK

Have you known someone who could scan a reading assignment or sleep with it under their pillow and somehow absorb all the information? Studies have shown that those people haven't really committed anything to long-term memory. For most of us, it takes a focused, concentrated effort to gain knowledge through reading. Interestingly, if you have the proper motivation and reading techniques, you can develop excellent reading comprehension. What is the best way to read a science textbook such as this one that contains many new and unfamiliar terms?

One common mistake is to approach reading a science textbook as one would read a newspaper, magazine, or novel. Instead, many reading instructors suggest using the SQ4R reading technique, which is based on research about how the brain learns. The SQ4R technique includes these steps:

1. **Survey:** Read the title, introduction, major headings, first sentences, concept statements, review questions, summary, and study aids to become familiar with the content in advance.
2. **Question:** Have questions in mind when you read. If you can't think of any good questions, use the chapter questions as a guide.
3. **Read:** Read flexibly through the chapter, using short time periods to accomplish the task one section at a time (not all in one sitting).
4. **Recite:** Answer the chapter questions. Take notes after each section and review your notes before you move on.
5. **(w)Rite:** Write summaries and/or reflections on what you've read. Write answers to the questions in Step 2.
6. **Review:** Review the text using the strategy in the survey step. Take the time to review your end-of-section notes as well as your summaries.

To help you study most effectively, this textbook includes many study aids that are designed to be used with the SQ4R technique. For example, each chapter includes a list of learning objectives that are tied to the Essential Concepts throughout the chapter; review Concept Check questions embedded at the end of each section; and an Essential Concepts Review that includes a chapter summary, study resources, and critical thinking questions.

Here are some additional reading tips that may seem like common sense and are based on brain-based research, but are often overlooked:

- Don't attempt to do your reading when you are tired, distracted, or agitated.
- Break up your reading into manageable sections. Don't save it all until the last minute.
- Take a short break if your concentration begins to fade. Listen to music, call a friend, have a snack, or drink some water. Then return to your reading.

Remember that every person is different, so experiment with new study techniques to discover what works best for you. In addition, being a successful student is hard work; it is not something one does in his/her spare time. With a little effort in applying the SQ4R reading technique, you will begin to see a difference in what you remember from your reading.

To that end—and to help you make the most of your study time—we focused the presentation in this book by organizing the material around three essential components:

1. **CONCEPTS:** General ideas derived or inferred from specific instances or occurrences (for instance, the concept of density can be used to explain why the oceans are layered)
2. **PROCESSES:** Actions or occurrences that bring about a result (for instance, the process of waves breaking at an angle to the shore results in the movement of sediment along the shoreline)
3. **PRINCIPLES:** Rules or laws concerning the functioning of natural phenomena or mechanical processes (for instance, the principle of sea floor spreading suggests that the geographic positions of the continents have changed through time)

Interwoven within these concepts, processes, and principles are hundreds of photographs, illustrations, real-world examples, and applications that make the material relevant and accessible (and maybe sometimes even entertaining) by bringing science to life.

Ultimately, it is our hope that by understanding how the oceans work, you will develop a new awareness and appreciation of all aspects of the marine environment and its role in Earth systems. To this end, the book has been written for you, a student of the oceans. So enjoy and immerse yourself! You're in for an exciting ride.

—Al Trujillo

To the Instructor

This thirteenth edition of *Essentials of Oceanography* is designed to accompany an introductory college-level course in oceanography taught to students who have no formal background in mathematics or science. As in previous editions, the goal of this edition of the textbook is to clearly present the relationships of scientific principles to ocean phenomena in an engaging and meaningful way. In addition, the content of this book is carefully designed to help students engage with and learn oceanographic material.

This edition has greatly benefited from being thoroughly reviewed by hundreds of students who made numerous suggestions for improvement. Comments by former students about the book include, *"I have really enjoyed the oceanography book we've used this semester. It had just the right mix of graphics, text, and user-friendliness that really held my interest;" "I really liked the videos embedded in the daily chapter quizzes, particularly the SmartFigures done by Laura Faye Tenenbaum. I loved her delivery. Her style helped me understand some complex topics and just made it really digestible. She's so bright and her humor came through just in the right way, kept it lively;"* and *"What I really liked about the book is that it's a welcoming textbook—open and airy. You could almost read it at bedtime like a story because of all the interesting pictures."*

This edition has been reviewed in detail by a host of instructors from leading institutions across the country. Reviewers of the twelfth edition described the text as follows: *"Essentials of Oceanography is a great textbook to introduce oceanography to non-science majors, and it has a lot of great supplemental materials for you and your students;" "Students find it easily understandable. The writing and graphics are excellent; easy to comprehend and remember;" "Your book is truly wonderful. Your writing voice is so excellent, and the fact that you have included so many etymological roots of terms is a real memory aid for students. I'm always stressing to them how, among other things, science is a language, and your book is right in groove with that;" and "An excellent introductory oceanography textbook that can be used for courses from two to four credit hours. Easily read, flows well through the chapters and from chapter-to-chapter. Many helpful aids for students as well as ancillaries for instructors. It makes our job easier, and students are happy because they can understand the topics well, leading to higher average grades."*

In 2012, the tenth edition of *Essentials of Oceanography* received a Textbook Excellence Award, called a "Texty," from the Text and Academic Authors Association (TAA). The Texty award recognizes written works for their excellence in the areas of content, presentation, appeal, and teachability. The publisher, Pearson Education, nominated the book for the award, and the textbook was critically reviewed by a panel of expert judges. In 2017, the twelfth edition of *Essentials of Oceanography* received TAA's McGuffey Longevity Award for its long-standing history of publication.

The 16-chapter format of this textbook is designed for easy coverage of the material in a 15- or 16-week semester. For courses taught on a 10-week quarter system, instructors may need to select those chapters that cover the topics and concepts of primary relevance to their course. Chapters are self-contained and can thus be covered in any order. Following the introductory chapter (Chapter 1, which covers the general geography of the oceans; a historical perspective of oceanography; the method behind the process of science; and a discussion of the origin of Earth, the atmosphere, the oceans, and life itself), the four major academic disciplines of oceanography are represented in the following chapters:

- Geological oceanography (Chapters 2–4 and Chapter 10)
- Chemical oceanography (Chapter 5 and Chapter 11)
- Physical oceanography (Chapters 6–9)
- Biological oceanography (Chapters 12–15)
- Interdisciplinary oceanography: Climate change (Chapter 16)

We strongly believe that oceanography is at its best when it links together several scientific disciplines and shows how they are interrelated in the oceans. Therefore, this interdisciplinary approach is a key element of every chapter, particularly Chapter 16, "The Oceans and Climate Change."

What's New in This Edition?

Changes in this edition are designed to increase the readability, relevance, and appeal of this book. Major changes include the following:

- An emphasis on the process of science, including a new "Process of Science" boxed feature in most chapters that illustrates the scientific method by highlighting an area of oceanographic inquiry and explicitly pointing out how the process of science was used in that particular case; each feature also includes a critical thinking assessment question "Thinking Like a Scientist: What's Next?" so that students gain practice approaching problems scientifically and analytically
- New "Exploring Data" questions added to every chapter; this new feature directs students to engage with data and checks their

DIVING DEEPER PREFACE.2

OCEAN LITERACY: WHAT SHOULD PEOPLE KNOW ABOUT THE OCEAN?

The ocean is the defining feature of our planet. Accordingly, there is great interest in developing *ocean literacy*, which means understanding the ocean's influence on humans as well as humans' influence on the ocean. For example, scientists and educators agree that an ocean-literate person:

- Understands the essential principles and fundamental concepts about the functioning of the ocean.
- Can communicate about the ocean in a meaningful way.
- Is able to make informed and responsible decisions regarding the ocean and its resources.

To achieve this goal, ocean educators and experts have developed the **Seven Principles of Ocean Literacy**. The following ideas are what everyone—especially those who successfully pass a college course in oceanography or marine science—should understand about the ocean:

1. Earth has one big ocean with many features.
2. The ocean and life in the ocean shape the features of Earth.
3. The ocean is a major influence on weather and climate.
4. The ocean makes Earth habitable.
5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.
7. The ocean is largely unexplored.

This book is intended to help all people achieve ocean literacy. For more information about the Seven Principles of Ocean Literacy, see **http://oceanliteracy.wp2.coexploration.org/**

understanding by asking data interpretation questions related to data-rich figures, graphs, tables, and maps

- The addition in all chapters of a new "Creature Feature," which uses compelling facts about a marine organism to reinforce the theme of the chapter. Each "Creature Feature's" title is written in an engaging "Who Am I?" format to draw student interest
- Expansion of the discussion of carbon and oxygen in the ocean in Chapter 5, "Water and Seawater," which includes explanation of how the distribution of dissolved gases and pH changes with depth, and their significance
- A thoroughly updated Chapter 16 "The Oceans and Climate Change," introducing a new discussion about the carbon cycle, and describing the most recent findings of the IPCC; the rewrite includes highlights of the 2017 *Climate Science Special Report: Fourth National Climate Assessment*, which was produced at the behest of the U.S. Congress to provide an assessment of the state of science relating to climate change and its physical impacts in the United States; also included in this chapter is a new review of solutions to human-caused greenhouse gas emissions in the atmosphere, and four new or revised "Students Sometimes Ask . . . " questions that address student misconceptions and concerns regarding climate change
- Greater emphasis on the ocean's role in Earth systems
- A stronger learning path that directly links the learning objectives listed at the beginning of each chapter to the end-of-section "Concept Checks," which allow and encourage students to pause and test their knowledge as they proceed through the chapter
- A new active learning pedagogy that divides chapter material into easily digestible chunks, which makes studying easier and assists student learning (cognitive science research shows that the ability to "chunk" information is essential to enhancing learning and memory)
- The inclusion of an array of new SmartFigures and SmartTables, which provide a video explanation of difficult-to-understand oceanographic concepts and numerical data by an oceanography teaching expert
- The addition of one or more "What Did You Learn?" assessment questions to each "Diving Deeper" boxed feature
- Removal of all footnotes; pertinent information from previous footnotes is now contained within the body of the text
- Migration of each chapter's Squidtoons call-out to Mastering Oceanography Study Area as Bonus Web Content
- In all Essential Concept Review (end-of-chapter) materials, the revision of existing "Critical Thinking Questions" and "Active Learning Exercise" questions that can be used for in-class group activities
- The addition of a new "Selected Key Terms" feature in each section's end-of-chapter box that simplifies and replaces the word cloud formerly at the beginning of each chapter and directs students to the glossary at the end of the book to discover the meanings of the most important vocabulary terms that are boldfaced in each section of the text
- Updating of information throughout the text to include technological advances that have resulted in the modernization of oceanographic research and continue to shape the discipline today; for example, space-based oceanographic and atmospheric observations from NASA Earth-observing satellite missions
- Addition of an array of new "Students Sometimes Ask . . . " questions throughout the book
- An enhanced illustration package showcasing new photos, satellite images, and figures to make oceanographic topics more accessible, current, and engaging
- The revision or updating of over half of existing figures and incorporating annotations and labels within key figures that direct student attention and help explain information in storyboard form; this research-proven technique helps students focus on the most relevant information, interpret complex art, and integrate written and visual information

- Standardization of the color scheme and labeling of all figures to make them more appealing and consistent throughout
- Inclusion of more than 70 Web Animations from Pearson's Geoscience Animations Library, which include state-of-the-art computer animations that have been created by Al Trujillo and a panel of geoscience educators
- An enhanced eText, which allows students to review previously learned material with a single click that will place this content side-by-side the page they are currently studying
- Selected Diving Deeper feature boxes have been migrated online to Mastering Oceanography as Bonus Web Content in an effort to reduce the length of the text
- The remaining Diving Deeper features appearing in the book are organized around the following four themes:
  - **HISTORICAL FEATURES**, which focus on historical developments in oceanography that tie into chapter topics
  - **RESEARCH METHODS IN OCEANOGRAPHY**, which highlight how oceanographic knowledge is obtained
  - **OCEANS AND PEOPLE**, which illustrate the interaction of humans and the ocean environment
  - **FOCUS ON THE ENVIRONMENT**, which emphasizes environmental issues that are an increasingly important component of ocean studies
- The former Afterword has been shortened to one page; information about Marine Protected Areas (MPAs) has been moved to Chapter 13 and information about what individuals can do to minimize human impact on the oceans (including former Diving Deeper Aft.1) has been moved to Chapter 16
- All text in the chapters has been thoroughly reviewed and edited by students and oceanography instructors in a continued effort to refine the style and clarity of the writing

Note that a detailed list of specific chapter-by-chapter changes is available at **https://www2.palomar.edu/pages/atrujillo/**

In addition, this edition continues to offer some of the previous edition's most popular features, including the following:

- Scientifically accurate and thorough coverage of oceanography topics
- A series of SmartFigures and SmartTables, which maximize instructional value of the media and help students learn important content
- "Students Sometimes Ask . . . " questions, which present actual student questions along with the authors' answers
- A "Recap" feature that summarizes key points throughout the text, making studying easier
- The continuation of existing "Critical Thinking Questions" and "Active Learning Exercise" questions that can be used for group activities in class in all Essential Concept Review (end-of-chapter) materials
- QR codes embedded in the text that allow students to use their mobile devices to link directly to Mastering Oceanography Animations, SmartFigures and SmartTables, and Web Videos
- QR codes and links to more than 50 hand-picked Web videos that show important oceanographic processes in action
- Use of the international metric system (Système International [SI] units), with comparable English system units in parentheses
- Explanation of word etymons (*etumon* = sense of a word) as new terms are introduced, in an effort to demystify scientific terms by showing what the terms actually mean
- A "Climate Change Connection" icon that alerts students to topics that are related to the overarching theme of global climate change
- Use of **bold print** on key terms, which are defined when they are introduced and are described in the glossary
- A reorganized "Essential Concepts Review" summary at the end of each chapter
- **Mastering Oceanography**, which features chapter-specific Self Study Quizzes, SmartFigures and SmartTables, Oceanography Videos and Animations, Squidtoons, Dynamic Study Modules, and an optional Pearson eText with embedded videos.

For the Student

- **MASTERING OCEANOGRAPHY** delivers engaging, dynamic learning opportunities—focused on course objectives and responsive to each student's progress—that are proven to help students absorb course material and understand difficult concepts. Mastering Oceanography is a customized learning resource that includes:
  - **Student Study Area**, which is designed to be a one-stop resource for students to acquire study help and serve as a launching pad for further exploration. Content for the site was written by author Al Trujillo and is tied, chapter-by-chapter, to the text. The Student Study Area is organized around a four-step learning pathway:
    1. *Review*, which contains **Essential Concepts** as learning objectives
    2. *Read*, which contains the **eText** and **Bonus Web Content**
    3. *Visualize*, which contains Oceanography Animations, Oceanography Videos, and Smart Figures.
    4. *Test Yourself*, which contains a **Chapter Quiz** that is automatically graded for instant feedback.
  - **Study Tools** such as flashcards and a searchable online glossary to help make the most of students' study time
- **THE PEARSON eTEXT** gives students complete access to a digital version of the text whenever and wherever they have access to the Internet.

For the Instructor

- **MASTERING OCEANOGRAPHY: CONTINUOUS LEARNING BEFORE, DURING, AND AFTER CLASS** Mastering Oceanography is an online homework, tutorials, and assessments program designed to improve results by helping students quickly master oceanography concepts. Students will benefit from self-paced tutorials that feature immediate wrong-answer feedback and hints that emulate the office-hour experience to help keep them on track. With a wide range of interactive, engaging, and assignable activities, students will be encouraged to actively learn and retain tough course concepts:

- **New Process of Science Coaching Activities** support the text feature that highlights an area of oceanographic inquiry and explicitly point out the associated background, method, and conclusion.
- **New Exploring Data activities** help students actively engage with graphs and other data-driven features and their data interpretation skills.
- **SmartFigures/SmartTables**, which are three- to four-minute mini-lessons that examine and explain the concepts illustrated by a figure or table. Over 90 SmartFigures/SmartTables are assignable in **Mastering**.
- **Oceanography Animations,** which illuminate the most difficult-to-understand topics in oceanography and were created by an expert team of geoscience educators. The animation activities include audio narration, a text transcript, and assignable multiple-choice questions with specific wrong-answer feedback.
- **Video Field Trips** give students fascinating behind-the-scenes experiences at prescribed fire burns, solar energy, and coal-fired power plants, wastewater treatment facilities, landfills, farms, and more. Each Video Field Trip includes assessment questions for easily assignable homework.
- **Visualizing Oceanography Activities** ask students to label art from the text to ensure they are interpreting and understanding figures.
- **Dynamic Study Modules**, which help students study effectively on their own by continuously assessing their activity and performance in real time. Here's how it works: Students complete a set of questions with a unique answer format that also asks them to indicate their confidence level. Questions repeat until the student can answer them all correctly and confidently. Once completed, Dynamic Study Modules explain the concept using materials from the text. These are available as graded assignments prior to class, and accessible on smartphones, tablets, and computers**.**
- **Learning Catalytics™**, which are an interactive student response tool that uses students' smartphones, tablets, or laptops to engage them in more sophisticated tasks and thinking. Now included with MyLab & Mastering and eText, Learning Catalytics™ enables you to generate classroom discussion, guide your lecture, and promote peer-to-peer learning with real-time analytics.

- **STUDENT PERFORMANCE ANALYTICS** Mastering Oceanography allows an instructor to gain easy access to information about student performance and their ability to meet student learning outcomes. Instructors can quickly add their own learning outcomes, or use publisher-provided ones, to track student performance.
- **INSTRUCTOR MANUAL (DOWNLOAD ONLY)** This resource contains learning objectives, chapter outlines, answers to embedded end-of-section questions, and suggested teaching tips to spice up your lectures.
- **TESTGEN® COMPUTERIZED TEST BANK (DOWNLOAD ONLY)** This resource is a computerized test generator that lets instructors view and edit *Test Bank* questions, transfer questions to tests, and print the test in a variety of customized formats. The *Test Bank* includes over 1200 multiple-choice, matching, and short-answer/essay questions. All questions are tied to the chapter's learning outcomes, include a rating based on Bloom's taxonomy of learning domains (Bloom's 1–6) and contain the section number in which each question's answer can be found.
- **INSTRUCTOR POWERPOINT® PRESENTATIONS (DOWNLOAD ONLY)** Instructor Resource Materials include the following three PowerPoint® files for each chapter so that you can cut down on your preparation time, no matter what your lecture needs:

  1. **EXCLUSIVELY ART:** This file provides all the photos, art, and tables from the text, in order, loaded into PowerPoint® slides.
  2. **LECTURE OUTLINE:** This file averages 50 PowerPoint® slides per chapter and includes customizable lecture outlines with supporting art.
  3. **CLASSROOM RESPONSE SYSTEM (CRS) QUESTIONS:** Authored for use in conjunction with classroom response systems, this PowerPoint® file allows you to electronically poll your class for responses to questions, pop quizzes, attendance, and more.

For more information about these instructor resources, contact your Pearson textbook representative.

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Al Trujillo
Department of Earth, Space, and Environmental Sciences
Palomar College
1140 W. Mission Rd.
San Marcos, CA 92069
atrujillo@palomar.edu
https://www2.palomar.edu/pages/atrujillo/

"If there is magic on this planet, it is contained in water."

—Loren Eiseley, American educator
and natural science writer (1907–1977)

SmartFigures

SmartTables