Amplify Science
CALIFORNIA

UNIT GUIDE

Plate Motion

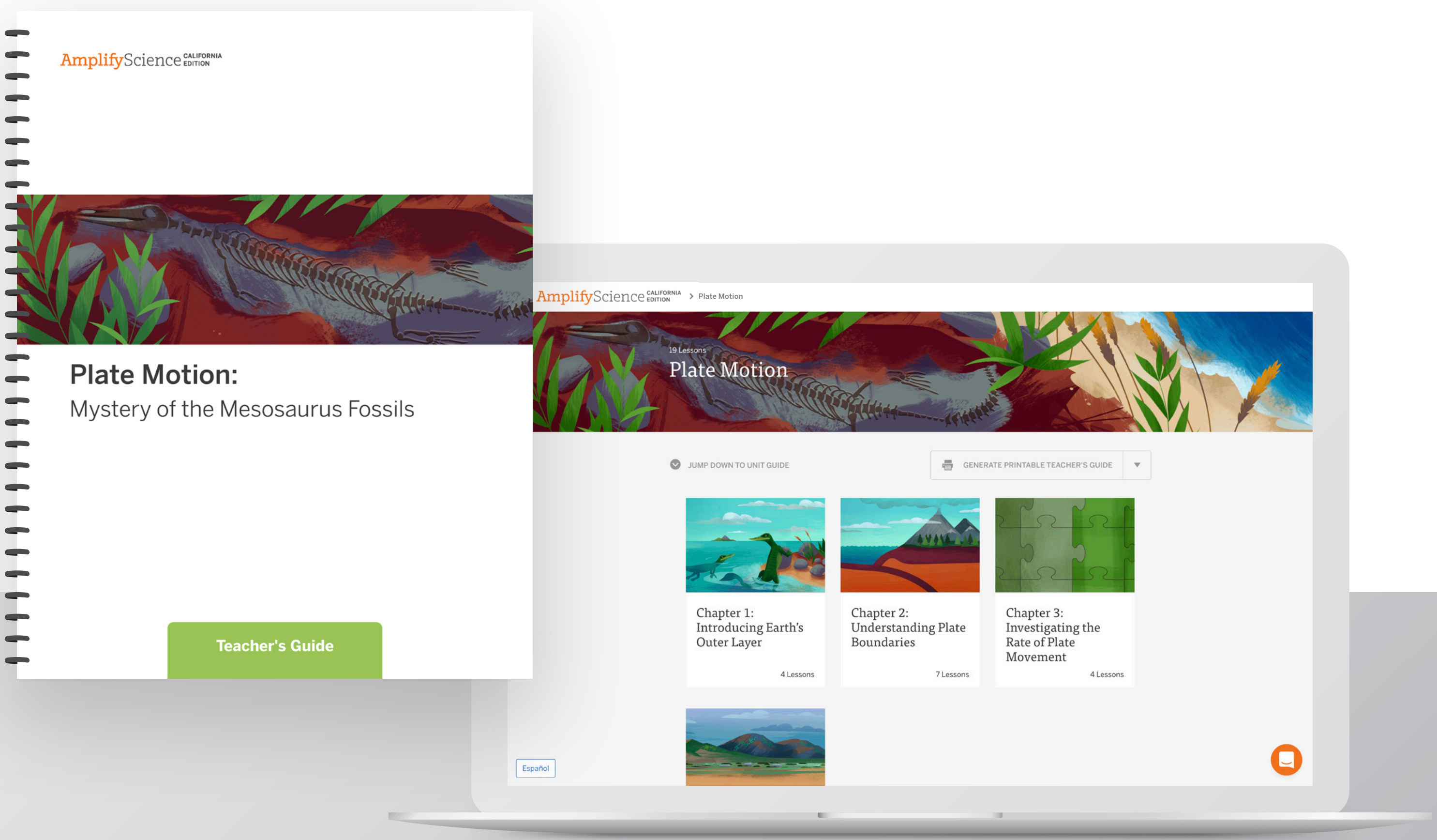


Table of contents

Welcome to Plate Motion 4

Chapter 1: The storyline begins 6

Chapter 2: The storyline builds 8

Chapter 3: The storyline goes deeper 10

Chapter 4: Application to a new storyline 12

All students. All standards. 14

3-D Statements 16

Welcome to Plate Motion

The foundational work for the theory of plate tectonics originated in work done by climatologists who were curious about why the fossil record revealed evidence of organisms. With the emergence of new tools, such as GPS, geologists continue to refine their understanding of Earth and the dynamic tectonic processes that still shape it today. By grounding learning about plate motion in the context of solving a fossil mystery, Amplify Science California provides students an authentic reason to dive deeply into examining ancient evidence of plate movement.

> Unlike a typical curriculum, Amplify Science California anchors learning by inviting students to take on the role of scientists and engineers.

In this unit, students take on the role of geologists. Their job is to help the fictional Museum of West Namibia investigate a fossil mystery: why are fossils of *Mesosaurus*, a population of extinct reptile that once lived all together, now found separated by thousands of kilometers of ocean? Working together, they figure out what happens at plate boundaries, at what rate changes happen on a geologic scale, and whether the fossils were separated suddenly as a result of one geologic event, or slowly over millions of years. The unit concludes with a Science Seminar in which students use what they have learned about plates and plate boundaries to help explain what is causing volcanic activity and earthquakes in the Jalisco area.

Unit Type: Core

Student Role: Geologists

Phenomenon: *Mesosaurus* fossils have been found on continents separated by thousands of kilometers of ocean, even though the *Mesosaurus* species once lived all together.

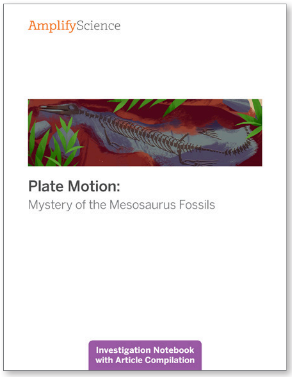
Core Concept: Understanding how plate motion can explain significant changes in Earth's history over geologic time

Target Performance Expectations:

- ESS2-2: Geoscience Processes
- ESS2-3: Evidence for Plate Motion

Students figure out the unit phenomenon through the use of a variety of resources.

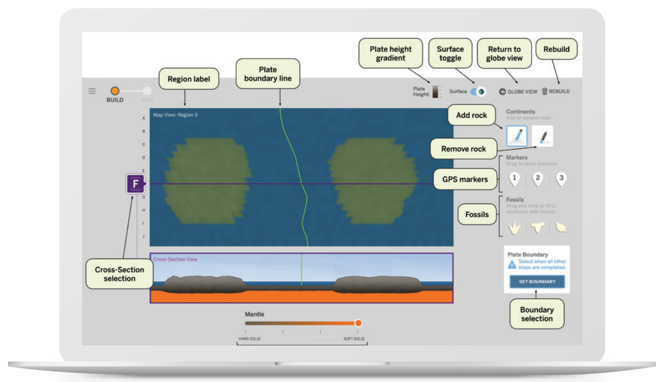
Student Investigation Notebook



Hands-On Kit

Videos

Digital Tools



About technology in this unit:
All Amplify Science California lessons were designed with device sharing in mind, and never assume that every student has a separate device.

In this grade, student-facing technology includes Practice Tools and digital Simulations. When the use of a digital tool is called for in a lesson, teachers have several implementation options:

If limited student devices are available—teachers can have students do activities in pairs or small groups.

If no student devices are available—teachers can project the digital tool to the class and either "drive" the digital tool themself or invite students to "drive" by using their device.

If internet access is unavailable—teachers can "pre-load" the digital tool on their device for use offline.

Chapter 1:
The storyline begins

What students investigate:

What is the land like where *Mesosaurus* fossils are found?

What they figure out:

The *Mesosaurus* fossils are found in hard, solid rock on two different plates of Earth's surface: the South American and African plates. Earth's outer layer is made of hard, solid rock, and divided into sections called plates. Geologists look for patterns in landforms and in geologic events in order to better understand Earth. The plates of Earth's outer layer move.

How they figure it out:

- Reading an article about the *Mesosaurus* and what can it tell us about life on Earth millions of years ago
- Exploring plate motion using the Sim
- Interpreting evidence in cross sections and maps, including earthquakes maps
- Testing the relationship between earthquakes and plate motion using the Sim
- Creating visual models

KEY

- CLASS
- HANDS-ON
- HOMEWORK
- MODELING
- READING
- SIM
- STUDENT-TO-STUDENT DISCUSSION
- TEACHER
- TEACHER-LED DISCUSSION
- WARM-UP
- WRITING

DAY 1 | LESSON 1.1

Pre-Unit Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

Pre-Unit Assessment

DAY 2 | LESSON 1.2

Using Fossils to Understand Earth

- Warm-Up (5 min)
- Why Geologists Value Fossils (8 min)
- Introducing Mesosaurus (12 min)
- Exploring Cross Sections (20 min)
- Homework

DAY 3 | LESSON 1.3

Exploring Earth's Plates

- Warm-Up (5 min)
- Revealing Earth's Outer Layer (5 min)
- Exploring Earth's Outer Layer (15 min)
- Analyzing Maps (20 min)
- Homework

On-the-Fly Assessment

DAY 4 | LESSON 1.4

Analyzing Patterns at Plate Boundaries

- Warm-Up (5 min)
- Simulating Earthquakes (17 min)
- Modeling a Plate Boundary (15 min)
- Considering the Mesosaurus Exhibit (8 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

Chapter 2: The storyline builds

What students investigate:

How did the South American Plate and African Plate move?

What they figure out:

The South American and African plates moved apart as a divergent boundary formed between them and an ocean basin formed and spread. Earth's plates move on top of a soft, solid layer of rock called the mantle. At divergent plate boundaries, rock rises from the mantle and hardens, adding new solid rock to the edges of both plates. At convergent plate boundaries, one plate moves underneath the other plate and sinks into the mantle.

How they figure it out:

- Examining the properties of soft and hard materials to understand how the soft, solid mantle can allow plates to move over it
- Conducting further plate motion investigations using the Sim and physical models
- Reading an article about Dr. Bob Dziak's work at the National Oceanic and Atmospheric Administration (NOAA) to study the ocean using sound, and his unexpected discovery of the sounds made by earthquakes and volcanoes at different kinds of plate boundaries
- Creating visual models of plate motion
- Reading an article about Iceland, how the plates that the island sits on caused Iceland to form, and why one part of Iceland is experiencing more geologic activity than usual

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- WARM-UP
- WRITING

DAY 5 | LESSON 2.1

Considering What's Underneath Earth's Plates

- Warm-Up (5 min)
- Considering the Mantle (10 min)
- Exploring Characteristics of the Mantle (10 min)
- Word Relationships (20 min)
- Homework

DAY 6 | LESSON 2.2

"Listening to Earth"

- Warm-Up (5 min)
- Reading "Listening to Earth" (25 min)
- Discussing Annotations (15 min)
- Homework

On-the-Fly Assessment

DAY 7 | LESSON 2.3

Explaining Plate-Mantle Interactions

- Warm-Up (5 min)
- Rereading "Listening to Earth" (20 min)
- Creating Physical Models of Plate Motion (20 min)

DAY 8 | LESSON 2.4

Modeling Plate-Mantle Interactions

- Warm-Up (5 min)
- Explaining What Happens at Plate Boundaries (10 min)
- Exploring Plate Boundaries in the Sim (20 min)
- Revising Models of Plate Boundaries (10 min)

On-the-Fly Assessment

Optional Flextension: *Mountain Formation*

DAY 9 | LESSON 2.5

Identifying Plate Motion at a Plate Boundary

- Warm-Up (8 min)
- Interpreting Plate Boundary Evidence (17 min)
- Modeling Plate Motion (20 min)
- Homework
- Family Homework Experience (Optional)

On-the-Fly Assessment

DAY 10 | LESSON 2.6

Critical Juncture Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

Critical Juncture Assessment

DAY 11 | LESSON 2.7

Exploring Iceland's Plate Boundary

- Warm-Up (8 min)
- Preparing for the Activities (10 min)
- Learning About Iceland (25 min)
- Introducing the Homework (2 min)
- Homework
- Self-Assessment (Optional)

Self-Assessment

Chapter 3: The storyline goes deeper

What students investigate:

How did the *Mesosaurus* fossils on the South American Plate and African Plate get so far apart?

What they figure out:

The *Mesosaurus* fossils moved apart gradually over tens of millions of years. Earth's plates travel at a rate too slow to be experienced by humans. It takes a long time for Earth's plates to travel great distances.

How they figure it out:

- Analyzing GPS data and testing the rate of plate motion using the Sim
- Reading an article about Alfred Wegener's investigation of fossils and how he developed the first continental drift hypothesis
- Using a physical model of moving continents
- Reexamining evidence from across the unit and writing a final explanation about the *Mesosaurus* fossils

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- TEACHER-LED DISCUSSION
- WARM-UP
- WRITING

DAY 12 | LESSON 3.1

Considering Rates of Plate Movement

- Warm-Up (5 min)
- Video: Plate Motion and GPS (10 min)
- Observing How Plates Move (15 min)
- Word Relationships (15 min)
- Homework

On-the-Fly Assessment

DAY 13 | LESSON 3.2

"A Continental Puzzle"

- Warm-Up (5 min)
- The Value of Fossil Evidence (10 min)
- Reading "A Continental Puzzle" (20 min)
- Discussing Annotations (10 min)
- Homework

On-the-Fly Assessment

DAY 14 | LESSON 3.3

Reconstructing Gondwanaland

- Warm-Up (5 min)
- Rereading "A Continental Puzzle" (15 min)
- Reconstructing Gondwanaland (25 min)
- Homework

On-the-Fly Assessment

Optional Flextension: *Modeling Plate Boundaries*

DAY 15 | LESSON 3.4

Writing About Mesosaurus

- Warm-Up (10 min)
- Examining Evidence About Plate Motion (10 min)
- Reasoning About Plate Motion (15 min)
- Video: Indian Plate Motion (5 min)
- Explaining the Homework Assignment (5 min)
- Homework
- Self-Assessment (Optional)

Self-Assessment

Chapter 4: Application to a new storyline

What students investigate:

There's been a pattern of volcanic activity and earthquakes in the Jalisco area, and Dr. Moraga's colleague is tasked with communicating what's happening to the local residents. Is the recent geologic activity due to divergent or convergent plate movement?

What they figure out:

Scientists must communicate how their claims and evidence are supported with reasoning in a convincing scientific argument. A written scientific argument needs to state a claim, describe specific evidence, and explain how the evidence supports the claim to convince its reader. A claim can sometimes be supported more effectively if you consider the combination of several different pieces of evidence.

How they figure it out:

- Reviewing available evidence to make an argument
- Engaging in oral argumentation in a student-led discourse routine called a Science Seminar
- Writing final arguments

KEY

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- TEACHER-LED DISCUSSION
- WARM-UP
- WRITING

DAY 16 | LESSON 4.1

Plate Motion Near Jalisco, Mexico

- Warm-Up (5 min)
- Introducing the Jalisco Block (5 min)
- Analyzing Evidence (25 min)
- Sorting Evidence (10 min)
- Homework

DAY 17 | LESSON 4.2

Science Seminar

- Warm-Up (5 min)
- Preparing for the Science Seminar (10 min)
- Introducing the Science Seminar (5 min)
- Participating in the Science Seminar (25 min)
- Homework

On-the-Fly Assessment

DAY 18 | LESSON 4.3

Writing a Scientific Argument

- Warm-Up (5 min)
- Using the Reasoning Tool (15 min)
- Organizing Ideas in the Reasoning Tool (10 min)
- Writing a Scientific Argument (15 min)
- Homework
- Self-Assessment (Optional)

On-the-Fly Assessment
Self-Assessment

DAY 19 | LESSON 4.4

End-of-Unit Assessment

- Multiple-Choice Questions (25 min)
- Written-Response Question #1 (10 min)
- Written-Response Question #2 (10 min)

End-of-Unit Assessment

All students. All standards.

Rather than treating the standards simply as a list of topics to cover, we designed Amplify Science California to allow for truly in-depth and integrated coverage of the disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). Unlike other programs, however, ours makes the NGSS' vision of "all students, all standards" a reality by creating a unit-specific learning progression for every unit called a Progress Build.

Each Progress Build defines several levels of understanding of the unit's anchoring phenomenon, with each level integrating and building upon the knowledge and skills from lower levels. In this way, each Progress Build provides a clear roadmap for how students' understanding of the phenomenon is expected to deepen and develop with each successive chapter and lesson.

What's more, the program's system of assessments is also tied to these Progress Builds. This carefully crafted integration provides teachers with credible, actionable, and timely diagnostic information about student progress toward the unit's learning goals and grade-level performance expectations. Armed with this powerful data, teachers have the ultimate flexibility to decide when to move on and when to slow down and dive deeper.

Plate Motion Progress Build

The Progress Build in this unit consists of three levels of understanding. At each level, students add new ideas and integrate them into a progressively deeper understanding of how plate motion can explain significant changes in Earth's history over geologic time.

Progress Build Level 3:
Plates travel at a rate too slow to be experienced by humans but can travel great distances over time.

Progress Build Level 2:
The plates move on top of a soft, solid layer of rock called the mantle. At plate boundaries where the plates are moving away from each other, rock rises from the mantle and hardens, adding new solid rock to the edges of the plates. At plate boundaries where plates are moving toward each other, one plate moves underneath the other and sinks into the mantle.

Progress Build Level 1:
The Earth's entire outer layer (below the water and soil that we see) is made of solid rock that is divided into plates. Earth's plates can move.

Examples of differentiation in this unit

In addition to providing unit-specific Progress Builds that break learning goals into smaller, more achievable levels of understanding, Amplify Science California makes learning accessible for all students through a variety of scaffolds, supports, and differentiation strategies for every lesson. **For a complete list of strategies, see the Differentiation section of every Lesson Brief**.

Below are a few examples of strategies embedded in this unit.

For English learners:

Reading and extracting important information (Example from Lesson 4.1)
Students who struggle with reading and extracting the most essential information after they read may need more support in interpreting the information in the Science Seminar Evidence Cards. If you think your students will benefit from additional support for analyzing the evidence in this lesson, go over each piece of evidence as a class before students sort the cards. Prompt the class to look at a specific piece of evidence. Ask students to first summarize the information provided on the evidence card and share any questions about the information. Then, ask them how it relates to the claims or key concepts they have learned. After they understand what is presented on each card, they can begin sorting the evidence. You can also adjust the activity so that partners work with only 1–2 Science Seminar Evidence Cards at a time and then share and discuss as a class. In addition, you may want to add examples of occasions when summarizing before moving on would be helpful. For example, it might be helpful to summarize the two claims before moving onto the evidence cards.

For students needing more support:

Frequent, embedded summaries (Example from Lesson 2.4)
Some students might benefit from pausing after each part of the Sim activity to examine the data closely and come up with a one- or two-sentence summary (oral or written) of what the data shows. Providing a minute or two for students to summarize what they observed in and concluded from the Sim activity supports students' analysis of the data. It also offers students an opportunity to use words that are important for understanding the relevant science concepts in a focused and specific way. Taking time to summarize also enables students to stop and assess their own learning before moving on to the next activity.

For students ready for a challenge:

Additional research on fossil evidence (Example from Lesson 3.3)
In addition to locations where *Mesosaurus* fossils have been found, the Gondwanaland Puzzle student sheet shows locations where fossils of the Triassic reptiles, Cynognathus and Lystrosaurus, and the fern Glossopteris have been found. Students who need more challenge can do research on Cynognathus, Lystrosaurus, or Glossopteris. Some topics you might consider encouraging students to research are the approximate dates that these species existed on Earth, the characteristics of the species that can be learned about from their fossils, or how these organisms might have ended up on different continents.

3-D Statements

In order to help teachers recognize the three-dimensional structure of every unit, chapter, and lesson, each unit contains a 3-D Statement document that makes the integration clear.

Making the 3-D statement document all the more effective, the three dimensions are color-coded for easy recognition.

Plate Motion 3-D Coverage

SEPs	DCIs	CCCs
Science and Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts

Unit Level

Students analyze data about plates, plate boundaries, and the patterns of geologic activity characteristic of plate boundaries (patterns)—through the use of physical and digital models and articles and videos featuring real-life scientists—in order to construct explanations about how the fossils of *Mesosaurus* (a population of extinct reptile that once lived all together) were separated by thousands of kilometers of ocean as a result of slow plate movement over millions of years (scale, proportion, and quantity).

Chapter Level

Chapter 1: Introducing Earth's Outer Layer

Students use a digital model of plate motion and analyze evidence, including patterns of geologic activity and images of core samples, in order to learn that Earth's outer layer is made of hard solid rock divided into moving plates (patterns).

Chapter 2: Understanding Plate Boundaries

Students analyze data about patterns of plate-mantle interactions at convergent and divergent plate boundaries (patterns) and gather information about geologic activity and the processes that create landforms as a result of the interactions (cause and effect).

Chapter 3: Investigating the Rate of Plate Movement

Students analyze and interpret data to determine current rates of plate motion (scale, proportion, and quantity) and evaluate evidence about the distribution of fossils (patterns) in order to construct explanations that the *Mesosaurus* fossils were separated by slow divergent plate motion over hundreds of millions of years.

Chapter 4: Science Seminar

Students analyze evidence and make oral and written arguments, using what they have learned about plate motion, to determine whether convergent plate motion or divergent plate motion best explains patterns of geologic activity (patterns) near Jalisco, Mexico.

To review the 3-D Statements at the lesson level, see the Lesson Brief section of every lesson.

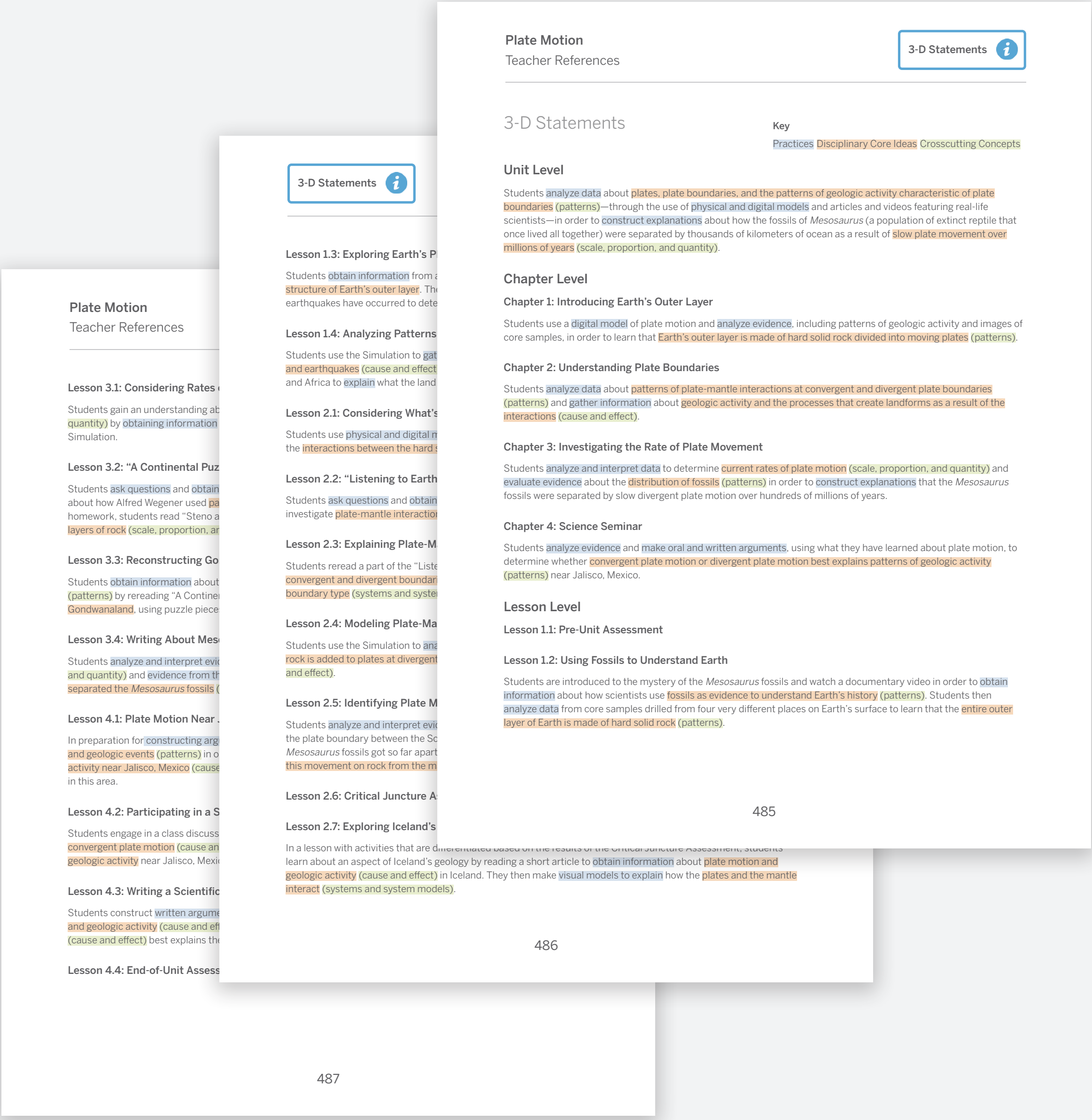

Plate Motion
Teacher References

3-D Statements

3-D Statements

Key

Practices Disciplinary Core Ideas Crosscutting Concepts

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Chapter 4: Science Seminar

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Lesson Level

Lesson 1.1: Pre-Unit Assessment

Lesson 1.2: Using Fossils to Understand Earth

Students are introduced to the mystery of the *Mesosaurus* fossils and watch a documentary video in order to obtain information about how scientists use fossils as evidence to understand Earth's history (patterns). Students then analyze data from core samples drilled from four very different places on Earth's surface to learn that the entire outer layer of Earth is made of hard solid rock (patterns).

485

Notes

Notes

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amplify.com/science/california.

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