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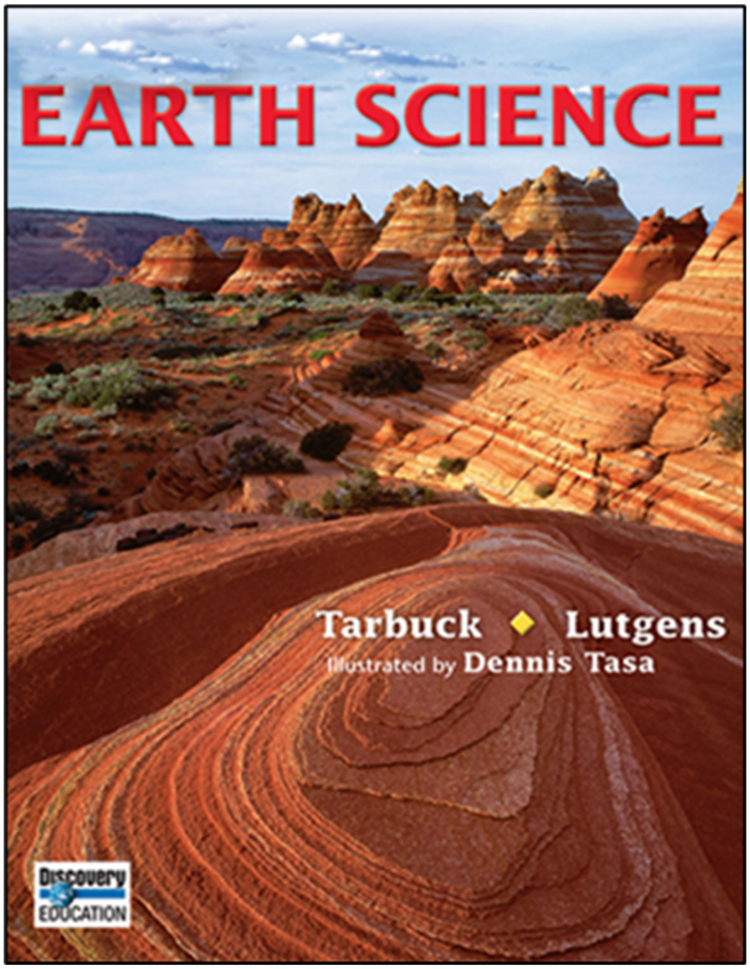

To the

Colorado
Academic Standards for Science 2020
Earth & Space Science, High School

Prepared by Savvas Learning Company, formerly Pearson K12 Learning

A Correlation of Earth Science to the
Colorado 2020 Academic Standards in Science
Earth & Space Science, High School

Introduction

This document demonstrates how ***Earth Science ©2017*** supports the Colorado Academic Standards in Science 2020: Earth and Space Science, High School. Correlation page references are to the Student Edition, Teacher Edition, and Realize™ digital resources.

Engage in a journey of observation, explanation, and participation with ***Earth Science***!

Renowned authors Edward Tarbuck and Frederick Lutgens invite students on a journey of observation, explanation, and participation in the study of Earth's processes. An accessible writing style combined with digital support create a fresh new program that leads your diverse classroom on a path to discovery. Detailed illustrations by Dennis Tasa provide students with a comprehensive and immersive look at the science behind our planet.

This edition of ***Earth Science*** features support for the **Next Generation Science Standards** and STEM activities, as well as enhanced resources for both students and teachers:

21st Century Skills: Each chapter of ***Earth Science*** an activity geared toward developing one or 21st Century skills. All of these activities task students to capture what they are learning in the science classroom and apply their knowledge to solving real-life problems in order to encourage productive, thoughtful members of the 21st century world.

STEM Activities: STEM activities support the implementation of the engineering process in an engaging and hands-on way. Excite students with real-world engineering design problem and hands-on inquiry. These activities promote higher-order critical thinking skills and result in improved student performance. Teachers are provided with point-of-use STEM activities and teaching strategies.

Savvas Realize: On savvasrealize.com, you can go digital with online Student Editions and online Teacher Editions, as well as access to editable worksheets.

In addition, ***Earth Science*** supports the today's diverse classroom with key Spanish resources, including the *Spanish Guided Reading and Study Workbook* and the *Spanish Chapter Tests*.

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High School Earth and Space Science	
Prepared Graduates:	
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Grade Level Expectation:	
1. All stars, including the sun, undergo stellar evolution, and the study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	
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a. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. (HS-ESS1-1)	**SE/TE:** Nuclear Fusion, 689 Star Birth, 707-709 Figure 10, 709 Active Art, Lives of Stars, 709 Figure 11, Stellar Evolution, 710 Burnout and Death, 710-712 **TE ONLY:** Build Science Skills: Use Analogies, 707 Build Science Skills: Use Analogies, 712 Reteach, 714 **Realize™ Digital Resources:** >Lab Manual>Chapter 22: Origin of Modern Astronomy>Investigation 22: Measuring the Angle of the Sun at Noon >Lab Manual>Chapter 24: Studying the Sun>Investigation 24: Measuring the Diameter of the Sun >Reading and Study Workbook>Chapter 24: Studying the Sun>Section 24.3: The Sun >Reading and Study Workbook>Chapter 25: Beyond Our Solar System>Section 25.1: Properties of Stars >Reading and Study Workbook>Chapter 25: Beyond Our Solar System>Section 25.2: Stellar Evolution

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2. Energy and Matter: Energy cannot be created or destroyed — only moved between one place and another place, between objects and/or fields, or between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.	For supporting content, please see: **SE/TE:** Earth's Place in the Universe, 6 Protostar Stage, 708 Main–Sequence Stage, 708 Red–Giant Stage, 709 Figure 11, Stellar Evolution, 710 Burnout and Death, 710 Death of Low–Mass Stars, 710 Death of Medium–Mass Stars, 710 Death of Massive Stars, 711
3. Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems. Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. Science assumes the universe is a vast single system in which basic laws are consistent.	**SE/TE:** Earth's Place in the Universe, 6 The Universe, 715 The Expanding Universe, 718
Prepared Graduates:	
9. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding the universe and Earth's place in it.	
Grade Level Expectation:	
2. Explanations of and predictions about the motions of orbiting objects are described by the laws of physics.	
Evidence Outcomes	
Students Can:	
a. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. (HS-ESS1-4)	**SE/TE:** Earth-Sun Relationships, 481-482 Ancient Greeks, 615-616 Figure 4, Retrograde Motion, 617 Nicolaus Copernicus, 617 Tycho Brahe, 617 Johannes Kepler, 618 Galilea Galilei, 619 Figure 10, Earth's Path Without Gravity, 621 22.1 Assessment, 621 Inquiry—Exploration Lab: Modeling Synodic and Sidereal Months, 636-637 Inquiry—Try It! What is the Shape of a Planetary Orbit?, 643 **Realize™ Digital Resources:** >Lab Manual>Chapter 23: Touring Our Solar System>Investigation 23: Exploring Orbits >Reading and Study Workbook>Chapter 22: Origin of Modern Astronomy>Section 22.1: Early Astronomy >Reading and Study Workbook>Chapter 22: Origin of Modern Astronomy>Section 22.2: The Earth-Moon-Sun System

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Academic Context and Connections	
Colorado Essential Skills and Science and Engineering Practices:	
1. Use mathematical or computational representations of phenomena to describe explanations. (Using Mathematical and Computational Thinking) (Entrepreneurial: Critical thinking/Problem solving)	**SE/TE:** Inquiry—Exploration Lab: Modeling Synodic and Sidereal Months, 636-637 Inquiry—Try It! What is the Shape of a Planetary Orbit?, 643
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Prepared Graduates:	
9. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding the universe and Earth's place in it.	
Grade Level Expectation:	
3. The rock record resulting from tectonic and other geoscience processes as well as objects from the solar system can provide evidence of Earth's early history and the relative ages of major geologic formations.	
Evidence Outcomes	
Students Can:	
a. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. (HS-ESS1-5) (Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges, a result of plate spreading, and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate, a result of past plate interactions.)	**SE/TE:** The Continental Puzzle, 248 Figure 1, A Curious Fit, 248 Matching Fossils, 249 Figure 2, Fossil Evidence, 249 Figure 3, Matching Mountain Ranges, 250 Rock Types, 250 Ancient Climates, 250–251 Figure 4, Glacier Evidence, 251 Active Art, Breakup of Pangaea, 252 9.1 Assessment, 253 Movement of the Ocean Floor, 256 Evidence for Sea-Floor Spreading, 257 Magnetic Strips, 258 Figure 12, Polarity Reversals, 258–259 Earthquake Patterns, 259 The Age of the Ocean Floor, 260 Figure 14, Sea-Floor Ages, 260 9.2 Assessment, 260 Inquiry—Exploration Lab: Paleomagnetism and the Ocean Floor, 272–273 9 Assessment, 276 **TE ONLY:** Integrate History, 256 **Realize™ Digital Resources:** >Lab Manual>Chapter 9: Plate Tectonics>Investigation 9: Modeling a Plate Boundary >Reading and Study Workbook>Chapter 9: Plate Tectonics>Section 9.1: Continental Drift >Reading and Study Workbook>Chapter 9: Plate Tectonics>Section 9.2: Sea-Floor Spreading >Reading and Study Workbook>Chapter 9: Plate Tectonics>Section 9.3: Theory of Plate Tectonics >Reading and Study Workbook>Chapter 9: Plate Tectonics>Section 9.4: Mechanisms of Plate Motions

SE = Student Edition **TE = Teacher Edition**

Digital Resources: The symbol > indicates a click to reach each digital asset on the Realize platform.

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b. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. (HS-ESS1-6) (Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials [obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals], the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.)	**SE/TE:** The Nebular Theory, 4 Figure 3, Formation of the Solar System According to the Nebular Theory, 4 Reading Checkpoint, 5 13.1 Assessment, 368 23.1 Assessment, 648 23.2 Assessment, 653 **TE ONLY:** Use Visuals, 4 Teacher Demo, Separation and Density, 4 Build Reading Literacy, 366 Integrate Biology, 367 Build Science Skills: Apply Concepts, 367 Facts and Figures, 652 **Realize™ Digital Resources:** >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.1: Discovering Earth's History >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.2: Fossils: Evidence of Past Life >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.3: Dating With Radioactivity >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.4: The Geologic Time Scale
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SE = Student Edition **TE = Teacher Edition**
Digital Resources: The symbol > indicates a click to reach each digital asset on the Realize platform.

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Prepared Graduates:	
10. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how and why Earth is constantly changing.	
Grade Level Expectation:	
4. Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes, and these effects occur on different time scales, from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.	
Evidence Outcomes	
Students Can:	
a. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. (HS-ESS2-1) (Clarification Statement: Emphasis is on how the appearance of land features [such as mountains, valleys, and plateaus] and sea-floor features [such as trenches, ridges, and seamounts] are a result of both constructive forces [such as volcanism, tectonic uplift, and orogeny] and destructive mechanisms [such as weathering, mass wasting, and coastal erosion].) (Boundary Statement: Does not include memorization of the details of the formation of specific geographic features of Earth's surface.)	**SE/TE:** Visual Summary, Figure 3, The Rock Cycle, 68 Inquiry—Quick Lab, Observing Some of the Effects of Pressure on Mineral Grains, 83 Inquiry—Try It! What Causes Weathering?, 125 Inquiry—Exploration Lab: Effect of Temperature on Chemical Weathering, 150–151 Figure 9, Mississippi Delta Region, 166 Map It! Activity, 166 Inquiry—Try It! How Does Pressure Affect ice Crystals?, 187 Inquiry—Exploration Lab: Interpreting a Glacial Landscape, 210–211 How Earth Works, 298–299 Inquiry—Try It! Can You Model How Rocks Deform?, 307 Visual Summary, Figure 9, Four Types of Faults, 315 Inquiry—Try It! How Does Particle Size Affect Settling Rates?, 393 **Realize™ Digital Resources:** >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8A: Modeling Liquefaction >Lab Manual>Chapter 9: Plate Tectonics>Investigation 9: Modeling a Plate Boundary

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b. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. (HS-ESS2-2) (Clarification Statement: Examples should include climate feedback, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.)	**SE/TE:** What is a System, 18 Earth as a System, 19–20 People and the Environment, 20–21 Mechanical Weathering, 126–128 Soil Erosion, 140–142 Triggers of Mass Movements, 144–145 Types of Mass Movements, 145–147 Wells 173–174 Figure 17 & Figure 18, 174–175 Folds, 312–313 Continental Accretion, 324–325 Inquiry Quick Lab: Rates of Mountain Building, 323 Earth & Its Systems: Mountain Building Away from Plate Margins, 326–327 Factors That Affect Climate, 588–591 Natural Processes that Change Climate, 600–601 Human Impact on Climate, 602–603 Earth & Space, 691 **Realize™ Digital Resources:** >Lab Manual>Chapter 7: Glaciers, Deserts, and Wind>Investigation 7: Continental Glaciers Change Earth's Topography >Reading and Study Workbook >Chapter 1: Introduction to Earth Science>Section 1.4: Earth System Science >Reading and Study Workbook >Chapter 5: Weathering, Soil, and Mass Movements>Section 5.1: Weathering >Reading and Study Workbook >Chapter 5: Weathering, Soil, and Mass Movements>Section 5.2: Soil >Reading and Study Workbook >Chapter 5: Weathering, Soil, and Mass Movements>Section 5.3: Mass Movements

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c. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. (HS-ESS2-3) (Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field [as constraints on convection in the outer core], and identification of the composition of Earth's layers from high-pressure laboratory experiments.)	**SE/TE:** Theory of Plate Tectonics, 10 The Process of Sea–Floor Spreading, 256 Eruptions Along Mid–Ocean Ridges, 256 Movement of the Ocean Floor, 256 Figure 10, Sea–Floor Spreading and Subduction, 257 9.2 Assessment, 260 What Causes Plate Motions?, 270 Plate Motion Mechanisms, 271 9.4 Assessment, 271 **Realize™ Digital Resources:** >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8A: Modeling Liquefaction >Reading and Study Workbook >Chapter 3: Rocks>Section 3.1: The Rock Cycle >Reading and Study Workbook>Chapter 9: Plate Tectonics>Section 9.2: Sea-Floor Spreading >Reading and Study Workbook>Chapter 9: Plate Tectonics>Section 9.4: Mechanisms of Plate Motions
d. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. (HS-ESS2-4) (Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.) (Boundary Statement: Results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.)	**SE/TE:** Inquiry—Try It! Modeling the Angle of the Sun, 475 Conduction, 483 Convection, 484 Radiation, 485 What Happens to Solar Radiation?, 486 Reflection and Scattering, 486 Absorption, 487 Earth's Atmosphere, 494–495 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Performance–Based Assessment, 500 Global Winds, 540 Rotating Earth Model, 540–541 Influence of Continents, 542 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 **Realize™ Digital Resources:** >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.2: Heating the Atmosphere >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.3: Temperature Controls

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Academic Context and Connections	
Colorado Essential Skills and Science and Engineering Practices:	
1. Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Use a model to provide mechanistic accounts of phenomena. (Developing and Using Models) (Personal: Initiative/Self-direction)	Inquiry—Try It! How Can Buildings Be Made Earthquake–Safe?, 217 Visual Summary, Figure 4, Seismic Waves, 223 Seismic–Safe Design, 232 Inquiry—Try It! Modeling the Angle of the Sun, 475 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Performance–Based Assessment, 500 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 **TE ONLY:** Teacher Demo, Sweet Stress, 219 Teacher Demo, Seismic Waves, 223 Build Science Skills: Use Models, 229
2. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (Analyzing and Interpreting Data) (Entrepreneurial: Critical thinking/Problem solving)	**SE/TE:** Inquiry—Try It! Modeling the Angle of the Sun, 475 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Performance–Based Assessment, 500 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590
3. Connections to Nature of Science: Scientific Knowledge is Based on Empirical Evidence. Science knowledge is based on empirical evidence. Science disciplines share common rules of evidence used to evaluate explanations about natural systems. Science includes the process of coordinating patterns of evidence with current theory.	**SE/TE:** Inquiry—Try It! How Does Pressure Affect ice Crystals?, 187 Inquiry—Exploration Lab: Interpreting a Glacial Landscape, 210–211 How Earth Works, 298–299 Inquiry—Try It! Can You Model How Rocks Deform?, 307 Inquiry—Try It! Modeling the Angle of the Sun, 475 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590

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Elaboration on the GLE:	
1. Students can answer the question: How do Earth's major systems interact?	**SE/TE:** Population Effects on Resources, 21 Environmental Problems, 21–22 Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Figure 15, Change in CO2 Levels, 602 21.3 Assessment, 603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 The Greenhouse Effect, 602 Global Climate Change, 602 The Process of Sea–Floor Spreading, 256 Eruptions Along Mid–Ocean Ridges, 256 Movement of the Ocean Floor, 256 Figure 10, Sea–Floor Spreading and Subduction, 257 9.2 Assessment, 260 What Causes Plate Motions?, 270 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
2. ESS2:A Earth's Materials and Systems: Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior.	**SE/TE:** Earth's Changing Surface, 9 Destructive and Constructive Forces, 9 Earth as a System, 19 Linked Effects, 19 Glaciers, 188 Ancient Climates, 250–251 Figure 4, Glacier Evidence, 251 The Process of Sea–Floor Spreading, 256 Eruptions Along Mid–Ocean Ridges, 256 Movement of the Ocean Floor, 256 Subduction at Deep–Ocean Trenches, 257 Effects of Plate Motion, 261 Types of Plate Boundaries, 262–263 Divergent Boundaries, 264 Oceanic–Continental, 265 Oceanic–Oceanic, 266 Continental–Continental, 266–267 Transform Fault Boundaries, 268 Visual Summary, Figure 3, Three Types of Volcanism, 282–283 How Earth Works, 298–299 Plate Tectonics, 600 **TE ONLY:** Facts and Figures, 20

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Cross Cutting Concepts:	
1. Stability and Change: Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system.	**SE/TE:** Pollution in the Air, 110 Rates of Erosion, 141 Flood-Control Dam, 169 Inquiry—Quick Lab, Rates of Mountain Building, 323 The Greenhouse Effect, 602 Global Climate Change, 602–603 **TE ONLY:** Teacher Demo, The Ability to Erode, 160
2. Energy and Matter: Energy drives the cycling of matter within and between systems.	**SE/TE:** Inquiry—Quick Lab, Rates of Mountain Building, 323 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
3. Cause and Effect: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Inquiry—Try It! Modeling the Angle of the Sun, 475 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Performance–Based Assessment, 500 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 **TE ONLY:** Teacher Demo, Angles and Seasons, 481 Teacher Demo, Heating of Land and Water, 490 Teacher Demo, Heating and Angles, 589 Teacher Demo, Modeling Humid Climates, 596 Teacher Demo, Earth's Motions and Climate, 601

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Prepared Graduates:	
10. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how and why Earth is constantly changing.	
Grade Level Expectation:	
5. Plate tectonics can be viewed as the surface expression of mantle convection, which is driven by heat from radioactive decay within Earth's crust and mantle.	
Evidence Outcomes	
Students Can:	
a. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. (HS-ESS2-1) (Clarification Statement: Emphasis is on how the appearance of land features [such as mountains, valleys, and plateaus] and sea-floor features [such as trenches, ridges, and seamounts] are a result of both constructive forces [such as volcanism, tectonic uplift, and orogeny] and destructive mechanisms [such as weathering, mass wasting, and coastal erosion].) (Boundary Statement: Does not include memorization of the details of the formation of specific geographic features of Earth's surface.)	**SE/TE:** Earth's Major Spheres, 7–9 Earth's Changing Surface, 9–10 The Rock Cycle, 67–69 Formation of Sedimentary Rocks, 76 Formation of Mineral Deposits, 98–100 Landscapes Shaped by Wind, 203–205 Layers Defined by Composition, 233–234 Layers Defined by Physical Properties, 234–235 Evidence for Continental Drift, 249–250 Figure 10 Sea-Floor Spreading and Subduction, 257 Earth's Moving Plates, 261–263 Divergent Boundaries, 264 Convergent Boundaries, 265–267 Transform Fault Boundaries, 268 Earth & Its Systems: Plate Tectonics into the Future, 269 Plate Motion Mechanisms, 271 Inquiry: Exploration Lab? Paleomagnetism and the Ocean Floor, 272–273 Volcanoes and Plate Tectonics, 280–285 Other Volcanic Landforms, 292–293 Intrusive Igneous Activity, 295–297 Principle of Isostasy, 310–311 Uniformitarianism, 336 Relative Dating, 337–341 Precambrian Time, 364–366 Ocean Floor Features, 401–404 Mid-Ocean Ridges, 405–406 Explaining Coral Atolls—Darwin's Hypothesis, 406 **TE ONLY:** Earth Science Refresher, 306C **Realize™ Digital Resources:** >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8A: Modeling Liquefaction >Lab Manual>Chapter 9: Plate Tectonics>Investigation 9: Modeling a Plate Boundary

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b. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. (HS-ESS2-3) (Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments.)	**SE/TE:** Theory of Plate Tectonics, 10 The Process of Sea–Floor Spreading, 256 Eruptions Along Mid–Ocean Ridges, 256 Movement of the Ocean Floor, 256 Figure 10, Sea–Floor Spreading and Subduction, 257 9.2 Assessment, 260 What Causes Plate Motions?, 270 Plate Motion Mechanisms, 271 9.4 Assessment, 271 **Realize™ Digital Resources:** >Lab Manual>Chapter 8: Earthquakes and Earth's Interior>Investigation 8A: Modeling Liquefaction >Reading and Study Workbook >Chapter 3: Rocks>Section 3.1: The Rock Cycle >Reading and Study Workbook>Chapter 9: Plate Tectonics>Section 9.2: Sea-Floor Spreading >Reading and Study Workbook>Chapter 9: Plate Tectonics>Section 9.4: Mechanisms of Plate Motions
Academic Context and Connections	
Colorado Essential Skills and Science and Engineering Practices:	
1. Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (Developing and Using Models) (Civic/Interpersonal: Collaboration/Teamwork)	**SE/TE:** Inquiry—Try It! How Can Buildings Be Made Earthquake–Safe?, 217 Visual Summary, Figure 4, Seismic Waves, 223 Seismic–Safe Design, 232 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Performance–Based Assessment, 500 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 **TE ONLY:** Teacher Demo, Sweet Stress, 219 Teacher Demo, Seismic Waves, 223 Build Science Skills: Use Models, 229

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Elaboration on the GLE:	
1. Students can answer the question: Why do the continents move, and what causes earthquakes and volcanoes?	**SE/TE:** Assessing Earthquake Risk, 231 Subduction at Deep–Ocean Trenches, 257 Earthquake Patterns, 259 Divergent Boundaries, 264 Figure 16, Formation of a Rift Valley, 264 Convergent Boundaries, 265 Oceanic–Continental, 265 Figure 17, Oceanic–Continental Convergent Boundary, 265 Transform Fault Boundaries, 268 What Causes Plate Motions?, 270 Plate Motion Mechanisms, 271 Inquiry—Try It! Where are Volcanoes Located?, 279 Volcanoes and Plate Boundaries, 281 Figure 5, Intraplate Volcanoes, 285 Plate Tectonics, 600
2. ESS2:B Plate Tectonics and Large Scale Interactions: Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection.	**SE/TE:** Destructive and Constructive Forces, 9 The Process of Sea-Floor Spreading, 256 Evidence for Sea-Floor Spreading, 257 Magnetic Strips, 258 Figure 12, Polarity Reversals, 258–259 The Age of the Ocean Floor, 260 Divergent Boundaries, 264 Convergent Boundaries, 265 Oceanic–Continental, 265 Oceanic–Oceanic, 266 Continental–Continental, 266 Plate Tectonics into the Future, 269 Inquiry Lab: Paleomagnetism and the Ocean Floor, 272–273 Volcanoes and Plate Boundaries, 281 Visual Summary, Figure 3, Three Types of Volcanism, 282–283 Convergent Boundary Volcanism, 284 Intraplate Volcanism, 285 Other Volcanic Landforms, 292–293 How Earth Works, 298–299 Forces in Earth's Crust, 308 Folds, Faults, and Mountains, 312 Types of Mountains, 316–317 Plateaus, Domes, and Basins, 318 Convergent Boundary Mountains, 320–322 Divergent Boundary Mountains, 323 Non–Boundary Mountains, 323 Continental Accretion, 324 Figure 18, Accretion in Western North America, 324

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Colorado Academic Standards in Science 2020 High School Earth & Space Science	Earth Science
Cross Cutting Concepts:	
1. Stability and Change: Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	**SE/TE:** Earth's Changing Surface, 9 Destructive and Constructive Forces, 9 Visual Summary, Figure 5, Breakup of Pangaea, 252 Eruptions Along Mid–Ocean Ridges, 256 Movement of the Ocean Floor, 256 Subduction at Deep–Ocean Trenches, 257 Earthquake Patterns, 259 Transform Fault Boundaries, 268 What Causes Plate Motions?, 270 Plate Motion Mechanisms, 271
2. Energy and Matter: Energy drives the cycling of matter within and between systems.	**SE/TE:** Causes of Plate Motion, 261 Types of Plate Boundaries, 263 Divergent Boundaries, 264 Convergent Boundaries, 265–266 Transform Fault Boundaries, 268 Plate Motion Mechanisms, 271
3. Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology. Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	**SE/TE:** For supporting content, please see: Inquiry—Explore it!: Locating an Earthquake, 240-241
4. Influence of Engineering, Technology, and Science on Society and the Natural World: New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	**SE/TE:** For supporting content, please see: Reducing Earthquake Damage, 231-232

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Prepared Graduates:	
10. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how and why Earth is constantly changing.	
Grade Level Expectation:	
6. The planet's dynamics are greatly influenced by water's unique chemical and physical properties.	
Evidence Outcomes	
Students Can:	
Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. (HS-ESS2-5) (Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization [by testing the solubility of different materials] or melt generation (by examining how water lowers the melting temperature of most solids.)	**SE/TE:** Inquiry—Try It! What Causes Weathering?, 125 Inquiry—Exploration Lab: Effect of Temperature on Chemical Weathering, 150–151 Inquiry—Exploration Lab: Investigating the Permeability of Soils, 181 Inquiry—Try It! How Does Pressure Affect Ice Crystals?, 187 Inquiry—Try It! How Does Particle Size Affect Settling Rates?, 393 Inquiry—Try It! How Does Salinity Affect the Density of Water?, 421 Inquiry—Exploration Lab: How Does Temperature Affect Water Density?, 440–441 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 **Realize™ Digital Resources:** >Lab Manual>Chapter 5: Weathering, Soil, and Mass Movements>Investigation 5: Some Factors That Affect Soil Erosion >Lab Manual>Chapter 6: Running Water and Groundwater>Investigation 6A: Rivers Shape the Land >Reading and Study Workbook>Chapter 8: Earthquakes and Earth's Interior>Section 8.2: Measuring Earthquakes >Reading and Study Workbook>Chapter 8: Earthquakes and Earth's Interior>Section 8.3: Earthquake Hazards >Reading and Study Workbook>Chapter 8: Earthquakes and Earth's Interior>Section 8.4: Earth's Layered Structure

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Academic Context and Connections	
Colorado Essential Skills and Science and Engineering Practices:	
1. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (Planning and Carrying Out Investigations) (Entrepreneurial: Inquiry/Analysis)	**SE/TE:** Inquiry—Exploration Lab: Effect of Temperature on Chemical Weathering, 150–151 Inquiry—Try It! How Does Pressure Affect Ice Crystals?, 187 Inquiry—Try It! How Does Salinity Affect the Density of Water?, 421 Inquiry—Exploration Lab: How Does Temperature Affect Water Density?, 440–441 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590
Elaboration on the GLE:	
1. Students can answer the question: How do the properties and movements of water shape Earth's surface and affects its systems?	**SE/TE:** Water, 129 The Water Cycle, 158–159 Erosion, 164 Sediment Transport, 164 Dissolved Load, 164 Suspended Load, 165 Bed Load, 165 Deposition, 166 Glacial Erosion, 192 Glacial Deposition, 194 Water Content, 281 Temperature Variation With Depth, 424 Hydrothermal Vents, 430 Surface Currents, 448–449 Ocean Currents and Climate, 450 Deep Ocean Circulation, 451 Evaporation, 451 Sea Ice, 452 A Conveyor Belt, 453 Figure 8, A Continuous Current, 453 Wave Impact, 461 Abrasion, 462 Longshore Transport, 463 Inquiry—Exploration Lab: Heating Land and Water, 496–497

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2. ESS2:C The Roles of Water in Earth's Surface Processes: The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.	**SE/TE:** Hydrosphere, 8 Frost Wedging, 127 Water, 129 The Water Cycle, 158–159 Erosion, 164 Sediment Transport, 164 Dissolved Load, 164 Suspended Load, 165 Bed Load, 165 Deposition, 166 Glacial Erosion, 192 Glacial Deposition, 194 Water Content, 281 Temperature Variation With Depth, 424 Hydrothermal Vents, 430 Figure 12, Marine Life Zones, 431 How Earth Works, 438–439 Inquiry—Exploration Lab: How Does Temperature Affect Water Density?, 440–441 Surface Currents, 448–449 Ocean Currents and Climate, 450 Deep Ocean Circulation, 451 Evaporation, 451 Sea Ice, 452 A Conveyor Belt, 453 Figure 8, A Continuous Current, 453 Wave Impact, 461 Abrasion, 462 Longshore Transport, 463 Inquiry—Exploration Lab: Heating Land and Water, 496–497
Cross Cutting Concepts:	
1. Structure and Function: The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.	**SE/TE:** Visual Summary, Figure 2, Mechanical Weathering and Surface Data, 127 Inquiry—Try It! How Does Pressure Affect Ice Crystals?, 187 Inquiry—Try It! How Does Salinity Affect the Density of Water?, 421 Inquiry—Exploration Lab: How Does Temperature Affect Water Density?, 440–441 Inquiry—Try It! How Do Ocean Waves Form?, 447 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 Inquiry—Exploration Lab: Measuring Humidity, 524–525

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Prepared Graduates:	
10. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how and why Earth is constantly changing.	
Grade Level Expectation:	
7. The role of radiation from the sun and its interactions with the atmosphere, ocean, and land are the foundation for the global climate system. Global climate models are used to predict future changes, including changes influenced by human behavior and natural factors.	
Evidence Outcomes	
Students Can:	
a. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. (HS-ESS2-2) (Clarification Statement: Examples should include climate feedback, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.)	**SE/TE:** Population Effects on Resources, 21 Environmental Problems, 21–22 Mechanical Weathering, 126–128 Soil Erosion, 140–142 Triggers of Mass Movements, 144–145 Types of Mass Movements, 145–147 Wells 173–174 Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Figure 15, Change in CO_2 Levels, 602 The Greenhouse Effect, 602 Global Climate Change, 602 21.3 Assessment, 603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 **Realize™ Digital Resources:** >Lab Manual>Chapter 21: Climate>Investigation 21: Modeling the Greenhouse Effect >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.3: Temperature Controls >Reading and Study Workbook>Chapter 19: Air Pressure and Wind>Section 19.3: Regional Wind Systems >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes

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b. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. (HS-ESS2-4) (Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.) (Boundary Statement: Results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.)	**SE/TE:** Ocean Currents and Climate, 450 Inquiry—Try It! Modeling the Angle of the Sun, 475 Conduction, 483 Convection, 484 Radiation, 485 What Happens to Solar Radiation?, 486 Reflection and Scattering, 486 Absorption, 487 Earth's Atmosphere, 494–495 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Performance–Based Assessment, 500 Global Winds, 540 Rotating Earth Model, 540–541 Influence of Continents, 542 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Solar Variability and Climate Change, 691 **Realize™ Digital Resources:** >Reading and Study Workbook>Chapter 9: Plate Tectonics>Section 9.1: Continental Drift >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.2: Heating the Atmosphere >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.3: Temperature Controls >Reading and Study Workbook>Chapter 18: Moisture, Clouds, and Precipitation>Section 18.1: Water in the Atmosphere >Reading and Study Workbook>Chapter 19: Air Pressure and Wind>Section 19.2: Pressure Center and Winds

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c. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. (HS-ESS2-6) (Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere [including humans], providing the foundation for living organisms.)	**SE/TE:** Isotopes, 38 Carbonates, 48 Biochemical Sedimentary Rocks, 78 The Carbon Cycle, 85 Coal, 95–96 Petroleum and Natural Gas, 96 Tar Sands, 97 Oil Shales, 97 Earth's Blanket of Air, 110 Pollution in the Air, 110 **Realize™ Digital Resources:** >Lab Manual>Chapter 17: Earth's Atmosphere> Investigation 17B: Investigating Factors That Control Temperature >Lab Manual>Chapter 21: Climate>Investigation 21: Modeling the Greenhouse Effect >Reading and Study Workbook >Chapter 3: Rocks>Section 3.4: Metamorphic Rocks >Reading and Study Workbook>Chapter 14: The Ocean Floor>Section 14.3: Seafloor Sediments >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.1: Atmosphere Characteristics >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
d. Construct an argument based on evidence about the simultaneous co-evolution of Earth's systems and life on Earth. (HS-ESS2-7) (Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.) (Boundary Statement: Does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.)	**SE/TE:** People and the Environment, 20–21 Soil Formation, 135–137 Discovering Earth's History, 336–341 Types of Fossils, 342–343 The Fossil Record, 344–346 Inquiry-Fossil Occurrence and the Age of Rocks, 356–357 How Earth Works, 438–439 World Soils, 755–757 **Realize™ Digital Resources:** >Lab Manual>Chapter 13: Earth's History>Investigation 13: Determining Geologic Ages >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.1: Discovering Earth's History >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.2: Fossils: Evidence of Past Life >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.3: Dating With Radioactivity >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.4: The Geologic Time Scale

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Academic Context and Connections	
Colorado Essential Skills and Science and Engineering Practices:	
1. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (Analyzing and Interpreting Data) (Entrepreneurial: Critical thinking/Problem solving)	**SE/TE:** Visual Summary, Figure 3, The Rock Cycle, 68 Inquiry—Try It! What Causes Weathering?, 125 Inquiry—Exploration Lab: Effect of Temperature on Inquiry—Exploration Lab: Interpreting a Glacial Landscape, 210–211 9.1 Assessment, 253 9.2 Assessment, 260 9.3 Assessment, 268 9.4 Assessment, 271 Inquiry—Exploration Lab: Paleomagnetism and the Ocean Floor, 272-273 Inquiry—Try It! Can You Model How Rocks Deform?, 307
2. Use a model to provide mechanistic accounts of phenomena and develop a model based on evidence to illustrate the relationships between systems or between components of a system. (Developing and Using Models) (Personal: Initiative/Self-direction)	**SE/TE:** The Carbon Cycle, 85 Inquiry—Try It! What Are Fossils?, 363 Inquiry—Try It! Modeling the Angle of the Sun, 475 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Performance–Based Assessment, 500 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 560 Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Global Climate Change, 602–603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
3. Construct an oral and written argument or counter-arguments based on data and evidence. (Engaging in Argument from Evidence) (Civic/Interpersonal: Collaboration/Teamwork)	**SE/TE:** Performance–Based Assessment, 500
4. Connections to Nature of Science: Scientific Knowledge is Based on Empirical Evidence. Science arguments are strengthened by multiple lines of evidence supporting a single explanation.	**SE/TE:** Performance–Based Assessment, 500 Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607

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Elaboration on the GLE:	
1. Students can answer the question: What regulates weather and climate?	**SE/TE:** Inquiry—Try It! Modeling the Angle of the Sun, 475 Conduction, 483 Convection, 484 Radiation, 485 What Happens to Solar Radiation?, 486 Reflection and Scattering, 486 Absorption, 487 Earth's Atmosphere, 494–495 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Performance–Based Assessment, 500 Global Winds, 540 Rotating Earth Model, 540–541 Influence of Continents, 542 Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 The Greenhouse Effect, 602 Figure 15, Change in CO2 Levels, 602 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
2. ESS2:D Weather and Climate: The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere.	**SE/TE:** The Carbon Cycle, 85 Dating with Tree Rings, 352 The Atmosphere Evolves, 365 Photosynthetic Organisms, 367 Silurian Life, 372 Devonian Period, 372 Seafloor Sediment and Climate Data, 409 Reflection and Scattering, 486 Absorption, 487 Land and Water, 489 Cloud Cover and Albedo, 492 Factors That Affect Climate, 588 Latitude, 589 Elevation, 589 Topography, 590 Bodies of Water, 590 Circulation in the Atmosphere, 591 Vegetation, 591 Ocean Circulation, 601 Solar Activity, 601 Volcanic Eruptions, 601 Figure 15, Change in CO_2 Levels, 602 The Greenhouse Effect, 602 Global Climate Change, 602–603

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Continued:	Continued: **TE ONLY:** Teacher Demo, Heating and Angles, 589 Address Misconceptions, 600 Teacher Demo, Earth's Motions and Climate, 601 Facts and Figures, 602 Integrate Biology, 367
Cross Cutting Concepts:	
1. Stability and Change: Feedback (negative or positive) can stabilize or destabilize a system. Much of science deals with constructing explanations of how things change and how they remain stable.	**SE/TE:** Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Figure 15, Change in CO_2 Levels, 602 Global Climate Change, 602–603
2. Cause and Effect: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Inquiry—Try It! Modeling the Angle of the Sun, 475 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 Performance–Based Assessment, 500 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 **TE ONLY:** Teacher Demo, Angles and Seasons, 481 Teacher Demo, Heating of Land and Water, 490 Teacher Demo, Heating and Angles, 589 Teacher Demo, Modeling Humid Climates, 596 Teacher Demo, Earth's Motions and Climate, 601
3. Energy and Matter: The total amount of energy and matter in closed systems is conserved.	**SE/TE:** Conduction, 483 Convection, 484 Radiation, 485 What Happens to Solar Radiation?, 486 Reflection and Scattering, 486 Absorption, 487 Earth's Atmosphere, 494–495 Inquiry—Exploration Lab: Heating Land and Water, 496–497 Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Inquiry—Quick Lab, Observing How Land and Water Absorb and Release Energy, 590 The Greenhouse Effect, 602 Figure 15, Change in CO2 Levels, 602 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607

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Prepared Graduates:	
10. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how and why Earth is constantly changing.	
Grade Level Expectation:	
8. The biosphere and Earth's other systems have many interconnections that cause a continual co-evolution of Earth's surface and life on it.	
Evidence Outcomes	
Students Can:	
a. Construct an argument based on evidence about the simultaneous co-evolution of Earth's systems and life on Earth. (HS-ESS2-7) (Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.)	**SE/TE:** Inquiry—Try It! What Are Fossils?, 363 The Atmosphere Evolves, 365 Photosynthetic Organisms, 367 Precambrian Life, 367 The Earliest Life, 367 Photosynthetic Organisms, 367 13.1 Assessment, 368 Figure 6, Paleozoic Era, 369 Reading Strategy, 369 Figure 17, Mesozoic Era, 377 Figure 24, Cenozoic Era, 382 Quaternary Earth, 384 Quaternary Life, 384 Quaternary Extinction, 385 **Realize™ Digital Resources:** >Lab Manual>Chapter 13: Earth's History>Investigation 13: Determining Geologic Ages >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.1: Discovering Earth's History >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.2: Fossils: Evidence of Past Life >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.3: Dating With Radioactivity >Reading and Study Workbook>Chapter 12: Geologic Time>Section 12.4: The Geologic Time Scale

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Colorado Academic Standards in Science 2020 High School Earth & Space Science	Earth Science
Academic Context and Connections	
Colorado Essential Skills and Science and Engineering Practices:	
1. Construct an oral and written argument or counter-arguments based on data and evidence. (Engaging in Argument from Evidence) (Professional: Information and Communications Technologies)	**SE/TE:** 13.1 Assessment, 368 Reading Strategy, 369 13.2 Assessment, 376 Reading Strategy, 377 13.3 Assessment, 381 Reading Strategy, 382 Figure 26, Ice Age Cycles, 384 13,4 Assessment, 385 13 Assessment, 389–390 Performance–Based Assessment, 360 **TE ONLY:** Build Science Skills: Use Analogies, 336 Use Community Resources, 337 Build Science Skills: Use Models, 344 Build Reading Literacy, 365 Build Reading Literacy, 372 Build Science Skills: Use Models, 375 21st Century Learning, 388
Elaboration on the GLE:	
1. Students can answer the question: How do living organisms alter Earth's processes and structures?	**SE/TE:** The Earliest Life, 367 Photosynthetic Organisms, 367 Prokaryotes and Eukaryotes, 368 Multicellular Life, 368 The Paleozoic Era, 369 Cambrian Earth, 370 Cambrian Period, 370 Ordovician Earth, 371 Ordovician Life, 371 Silurian Earth, 372 Silurian Life, 372 Devonian Earth, 372 Devonian Life, 373 Carboniferous Earth, 374 Carboniferous Life, 374 Permian Earth, 375 Permian Life, 375 Triassic Earth, 378 Triassic Life, 378 Jurassic Earth, 379 Jurassic Life, 379 Cretaceous Earth, 380 Cretaceous Life, 380 Figure 6, Cenozoic Era, 382 Tertiary Earth, 383 Tertiary Life, 383 Quaternary Life, 384

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2. ESS2:E Biogeology: The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.	**SE/TE:** The Atmosphere Evolves, 365 Precambrian Life, 367 The Earliest Life, 367 Photosynthetic Organisms, 367 Prokaryotes and Eukaryotes, 368 Multicellular Life, 368 The Paleozoic Era, 369 Figure 6, Paleozoic Era, 369 Cambrian Earth, 370 Cambrian Period, 370 Ordovician Earth, 371 Ordovician Life, 371 Silurian Earth, 372 Silurian Life, 372 Devonian Earth, 372 Devonian Life, 373 Carboniferous Earth, 374 Carboniferous Life, 374 Permian Earth, 375 Permian Life, 375 The Permian Extinction, 376 Figure 6, Mesozoic Era, 377 Triassic Earth, 378 Triassic Life, 378 Jurassic Earth, 379 Jurassic Life, 379 Evolution of Birds, 380 Cretaceous Earth, 380 Cretaceous Life, 380 The Cretaceous Extinction, 381 Figure 6, Cenozoic Era, 382 Tertiary Earth, 383 Tertiary Life, 383 Quaternary Earth, 384 Quaternary Life, 384 Quaternary Extinction, 385
Cross Cutting Concepts:	
1. Stability and Change: Much of science deals with constructing explanations of how things change and how they remain stable.	**SE/TE:** Inquiry—Exploration Lab: Modeling the Geologic Time Scale, 386-387

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Prepared Graduates:	
11. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how human activities and the Earth's surface processes interact.	
Grade Level Expectation:	
9. Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.	
Evidence Outcomes	
Students Can:	
a. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. (HS-ESS3-1) (Clarification Statement: Examples of key natural resources include access to fresh water [such as rivers, lakes, and groundwater], regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes [such as volcanic eruptions and earthquakes], surface processes [such as tsunamis, mass wasting, and soil erosion], and severe weather [such as hurricanes, floods, and droughts]. Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.)	**SE/TE:** 1.4 Assessment, 22 Figure 5, Distribution of Oil Shale in the Green River Formation, 98 4.1 Assessment, 101 Figure 10, Photovoltaic Cells, 103 Figure 11, Diablo Canyon Nuclear Power Plant Near San Luis Obispo, California, 103 4.2 Assessment, 107 4.3 Assessment, 112 Reading Checkpoint, 141 5.2 Assessment, 142 Figure 21, Mudflow, 144 Reading Checkpoint, 144 5.3 Assessment, 147 Inquiry—Try It! How Do Local Bodies of Water Affect Your Community?, 157 6.1 Assessment, 163 6.2 Assessment, 170 The Ogallala Aquifer—How Long Will the Water Last?, 180 6 Assessment, 184 8.3 Assessment, 232 20 Assessment, 584 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 **Realize™ Digital Resources:** >Lab Manual>Chapter 21: Climate>Investigation 21: Modeling the Greenhouse Effect >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.3: Temperature Controls >Reading and Study Workbook>Chapter 19: Air Pressure and Wind>Section 19.3: Regional Wind Systems >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes

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b. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. (HS-ESS3-2) (Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources [such as minerals and metals] where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining [for coal, tar sands, and oil shales] and pumping [for petroleum and natural gas]. Science knowledge indicates what can happen in natural systems — not what should happen.)	**SE/TE:** Inquiry—Try It! How Can You Determine the Resources You Use?, 93 Coal, 96 Tar Sands, 97 Oil Shale, 97–98 Solar Energy, 103 Nuclear Energy, 104 Wind Energy, 104 Hydroelectric Power, 105 Bingham Canyon, Utah: The Largest Open-–Pit Mine, 117 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 4 Assessment, 122 Earth and Human Activity: Science and Engineering Practices: Designing Solutions: Design to Reduce Waste, 729 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4A: Recovering Oil >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.1: Energy and Mineral Resources >Reading and Study Workbook >Chapter 4: Earth's Resources>Section 4.3: Water, Air, and Land Resources
Academic Context and Connections	
Colorado Essential Skills and Science and Engineering Practices:	
1. Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (Constructing Explanations and Designing Solutions) (Civic/Interpersonal: Civic engagement)	**SE/TE:** Inquiry—Try It! How Can You Determine the Resources You Use?, 93 4.2 Assessment, 107 6.1 Assessment, 163 6.2 Assessment, 170 8.2 Assessment, 227 8.3 Assessment, 232 Figure 15, Assessing Resources, 410 14.4 Assessment, 413 How Earth Works, 578–579 Bingham Canyon, Utah: The Largest Open-–Pit Mine, 117 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 4 Assessment, 122 Earth and Human Activity: Science and Engineering Practices: Designing Solutions: Design to Reduce Waste, 729

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2. Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations). (Engaging in Argument from Evidence) (Personal: Initiative/Self-direction)	**SE/TE:** Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Keeping Water Clean and Safe, 114 Farming, 115 Design to Reduce Waste, 729 Design Solutions, 729
Elaboration on the GLE:	
1. Students can answer the question: How do humans depend on Earth's resources?	**SE/TE:** Coal, 96 Tar Sands, 97 Oil Shale, 97–98 Nonmetallic Mineral Resources, 100 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Solar Energy, 102–103 Nuclear Energy, 103–104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Figure 15, Tidal Dam, 107 Freshwater Pollution, 108–109 Pollution in the Air, 110 Damage to Land Resources, 111–112 Protecting Resources, 113 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Farming, 115 Forests, 115 Disposal of Waste, 116 Recycling, 116 Oil and Gas, 410 Figure 15, Accessing Resources, 410 Gas Hydrates, 411 Evaporative Salts, 412 Sand and Gravel, 412 Design to Reduce Waste, 729 Design Solutions, 729

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2. ESS3:A Natural Resources: Resource availability has guided the development of human society. All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.	**SE/TE:** Coal, 96 Tar Sands, 97 Oil Shale, 97–98 Figure 5, Distribution of Oil Shale in the Green River Formation, 98 Nonmetallic Mineral Resources, 100 4.2 Alternative Energy Sources, 102 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Solar Energy, 102–103 Figure 11, Diablo Canyon Nuclear Power Plant Near San Luis Obispo, California, 103 Nuclear Energy, 103–104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Figure 15, Tidal Dam, 107 Freshwater Pollution, 108–109 Pollution in the Air, 110 Damage to Land Resources, 111–112 Protecting Resources, 113 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Farming, 115 Forests, 115 Disposal of Waste, 116 Recycling, 116 Bingham Canyon, Utah: The Largest Open–Pit Mine, 117 Oil and Gas, 410 Figure 15, Accessing Resources, 410 Gas Hydrates, 411 Evaporative Salts, 412 Sand and Gravel, 412 Design to Reduce Waste, 729 Design Solutions, 729 **TE ONLY:** Integrate Economics, 94 Differentiated Instruction, 95 Build Reading Literacy, 97 Facts and Figures, 97 Build Science Skills: Apply Concepts, 109 Build Reading Literacy, 115 Facts and Figures, 115

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Cross Cutting Concepts:	
1. Cause and Effect: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Inquiry—Try It! How Can You Determine the Resources You Use?, 93 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119
2. Connections to Nature of Science: Science Addresses Questions About the Natural and Material World. Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.	**SE/TE:** Alternative Energy Sources, 102 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Solar Energy, 102–103 Figure 11, Diablo Canyon Nuclear Power Plant Near San Luis Obispo, California, 103 Nuclear Energy, 103–104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 Figure 15, Tidal Dam, 107 Freshwater Pollution, 108–109 Pollution in the Air, 110 Damage to Land Resources, 111–112 Protecting Resources, 113 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Figure 15, Accessing Resources, 410 Design to Reduce Waste, 729

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Prepared Graduates:	
11. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how human activities and the Earth's surface processes interact.	
Grade Level Expectation:	
10. Natural hazards and other geological events have shaped the course of human history at local, regional, and global scales.	
Students Can:	
a. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. (HS-ESS3-1) (Clarification Statement: Examples of key natural resources include access to fresh water [such as rivers, lakes, and groundwater], regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes [such as volcanic eruptions and earthquakes], surface processes [such as tsunamis, mass wasting, and soil erosion], and severe weather [such as hurricanes, floods, and droughts]. Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.)	**SE/TE:** Environmental Problems, 21–22 Freshwater Pollution, 108–109 Land Resources, 111–112 Protecting Resources, 113–116 Inquiry—Try It! How Do Local Bodies of Water Affect Your Community?, 157 Environmental Problems Associated With Groundwater, 174–176 The Ogallala Aquifer—How Long Will the Water Last?, 180 Inquiry—Try It! How Can Buildings Be Made Earthquake–Safe?, 217 Earthquake Hazards, 228–232 Tsunamis, 230 Tornado Warnings, 574 How Earth Works, 578–579 Critical Thinking, 584 Concepts in Action, 584 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 **Realize™ Digital Resources:** >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
Academic Context and Connections	
Colorado Essential Skills and Science and Engineering Practices:	
1. Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (Constructing Explanations and Designing Solutions) (Entrepreneurial: Critical thinking/Problem solving)	**SE/TE:** Hubble's Law, 719 The Big Bang, 720 Reading Checkpoint, 720 25.3 Assessment, 721 **TE ONLY:** 21st Century Learning, 724

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Elaboration on the GLE:	
1. Students can answer the question: How do natural hazards affect individuals and societies?	**SE/TE:** Damage to Land Resources, 111–112 Figure 21, Mudflow, 144 Flood–Control Dam, 169 Figure 24, Sinkhole, 179 Photograph, 216–217 Figure 9, Earthquake Damage, 228 Figure 10, Liquefaction and Landslides, 229 Landslides and Mudflows, 229 Figure 11, Indian Ocean Tsunami, 2004, 230 Tsunamis, 230 Volcanic Hazards, 294
2. ESS3:B Natural Hazards: Natural hazards and other geologic events have shaped the course of human history, and have significantly altered the sizes of human populations and have driven human migrations.	**SE/TE:** Damage to Land Resources, 111–112 Figure 21, Mudflow, 144 Removal of Vegetation, 145 Map It! Activity, 166 Map It! Activity, 168 Floods and Flood Control, 168–169 Artificial Levees, 169 Flood–Control Dam, 169 Limiting Development, 169 Figure 24, Sinkhole, 179 Photograph, 216–217 Figure 7, Modified Mercalli Scale, 226 Figure 9, Earthquake Damage, 228 Figure 10, Liquefaction and Landslides, 229 Liquefaction, 229 Landslides and Mudflows, 229 Figure 11, Indian Ocean Tsunami, 2004, 230 Tsunamis, 230 Volcanic Hazards, 294 How Earth Works, 298–299
Cross Cutting Concepts:	
1. Cause and Effect: Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	**SE/TE:** Inquiry—Try It! How Can Buildings Be Made Earthquake–Safe?, 217 Inquiry—Quick Lab, Why Are Some Volcanoes Explosive?, 287

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Prepared Graduates:	
11. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how human activities and the Earth's surface processes interact.	
Grade Level Expectation:	
11. Sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources, including the development of technologies.	
Evidence Outcomes	
Students Can:	
a. Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity. (HS-ESS3-3) (Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.) (Boundary Statement: Computational simulation is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.)	**SE/TE:** Population Effect on Resources, 21 Environmental Problems, 21–22 Renewable and Nonrenewable Resources, 94–95 Coal, 95–96 Petroleum and Natural Gas, 96–97 Tar Sands, 97 Oil Shale, 97–98 Mineral Resources and igneous Processes, 98 Hydrothermal Solutions, 99 Placer Deposits, 99–100 Nonmetallic Mineral Resources, 100–101 Solar Energy, 102–103 Nuclear Energy, 104 Wind Energy, 104 Hydroelectric Power, 105 Geothermal Energy, 105–106 Tidal Power, 106–107 The Water Planet, 108 Freshwater Pollution, 108–109 Pollution in the Air, 110 Damage to Land Resources, 111–112 Protecting Resources, 113 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Farming, 115 Forests, 115 Disposal of Waste, 116 Recycling, 116 **Realize™ Digital Resources:** >Lab Manual>Chapter 4: Earth's Resources>Investigation 4A: Recovering Oil >Lab Manual>Chapter 5: Weathering, Soil, and Mass Movements>Investigation 5: Some Factors That Affect Soil Erosion

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b. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. (HS-ESS3-4) (Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use [such as for urban development, agriculture, and livestock, or surface mining]. Examples for limiting future impacts could range from local efforts [such as reducing, reusing, and recycling resources] to large-scale geoengineering design solutions [such as altering global temperatures by making large changes to the atmosphere or ocean].	**SE/TE:** Protecting Resources, 113 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Caring for Land Resources, 115–116 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 Performance–Based Assessment, 122 Controlling Erosion, 142 Artificial Levees, 169 Flood–Control Dam, 169 Limiting Development, 169 Performance–Based Assessment, 154 Performance–Based Assessment, 418 **Realize™ Digital Resources:** >Lab Manual>Chapter 17: Earth's Atmosphere> Investigation 17B: Investigating Factors That Control Temperature >Reading and Study Workbook>Chapter 21: Climate>Section 21.1: Factors That Affect Climate >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
Academic Context and Connections	
Colorado Essential Skills and Science and Engineering Practices:	
1. Create a computational model or simulation of a phenomenon, designed device, process, or system. (Using Mathematics and Computational Thinking) (Entrepreneurial: Critical thinking/Problem solving)	**SE/TE:** Use Mathematical and Computational Thinking, 728
2. Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations. (Constructing Explanations and Designing Solutions) (Civic/Interpersonal: Global/Cultural awareness)	**SE/TE:** Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 Design to Reduce Waste, 729 Build Science Skills: Use Models, 103
Elaboration on the GLE:	
1. Students can answer the question: How do humans change the planet?	**SE/TE:** Protecting Resources, 113 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Caring for Land Resources, 115–116 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 Figure 15, Change in CO_2 Levels, 602 21.3 Assessment, 603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607

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2. ESS3:C Human Impacts on Earth's Systems: The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.	**SE/TE:** Environmental Problems, 21 1.4 Assessment, 22 Coal, 96 Oil Shale, 97 Nonmetallic Mineral Resources, 100 Alternative Energy Sources, 102 Solar Energy, 103 Nuclear Energy, 104 Wind Energy, 104 Hydroelectric Power, 105 Table 2, Major Types of Water Pollution, 109 Pollution in the Air, 110 Damage to Land Resources, 111–112 4.3 Assessment, 112 How Earth Works, 494–495
Cross Cutting Concepts:	
1. Stability and Change: Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system.	**SE/TE:** Environmental Problems, 21 Table 2, Major Types of Water Pollution, 109 Pollution in the Air, 110 Damage to Land Resources, 111–112
2. Connections to Nature of Science: Science is a Human Endeavor. Science is a result of human endeavors, imagination, and creativity.	**SE/TE:** Protecting Resources, 113 Keeping Water Clean and Safe, 114 Protecting the Air, 114–115 Caring for Land Resources, 115–116 Inquiry—Exploration Lab: Finding the Product that Best Conserves Resources, 118–119 Controlling Erosion, 142 Limiting Development, 169

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Prepared Graduates:	
11. Students can use the full range of science and engineering practices to make sense of natural phenomena and solve problems that require understanding how human activities and the Earth's surface processes interact.	
Grade Level Expectation:	
12. Global climate models used to predict future climate change continue to improve our understanding of the impact of human activities on the global climate system.	
Evidence Outcomes	
Students Can:	
a. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems. (HS-ESS3-5) (Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes [such as precipitation and temperature] and their associated impacts [such as on sea level, glacial ice volumes, or atmosphere and ocean composition].) (Boundary Statement: Limited to one example of a climate change and its associated impacts.)	**SE/TE:** Figure 15, Change in CO_2 Levels, 602 21.3 Assessment, 603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 21 Assessment, 610 **Realize™ Digital Resources:** >Lab Manual>Chapter 17: Earth's Atmosphere> Investigation 17B: Investigating Factors That Control Temperature >Lab Manual>Chapter 21: Climate>Investigation 21: Modeling the Greenhouse Effect >Reading and Study Workbook>Chapter 21: Climate>Section 21.1: Factors That Affect Climate >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes
b. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. (HS-ESS3-6) (Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.) (Boundary Statement: Does not include running computational representations but is limited to using the published results of scientific computational models.)	**SE/TE:** How Earth Works, 494–495 Climate Changes, 600 Figure 15, Change in CO_2 Levels, 602 Human Impact on Climate, 602 Global Climate Change, 602–603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607 **Realize™ Digital Resources:** >Lab Manual>Chapter 17: Earth's Atmosphere> Investigation 17B: Investigating Factors That Control Temperature >Reading and Study Workbook>Chapter 17: Earth's Atmosphere> Section 17.3: Temperature Controls >Reading and Study Workbook>Chapter 21: Climate>Section 21.1: Factors That Affect Climate >Reading and Study Workbook>Chapter 21: Climate>Section 21.3: Climate Changes

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Academic Context and Connections	
Colorado Essential Skills and Science and Engineering Practices:	
1. Analyze data using computational models in order to make valid and reliable scientific claims. (Analyzing and Interpreting Data) (Entrepreneurial: Critical thinking/Problem solving)	**SE/TE:** Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 The Greenhouse Effect, 602 Figure 15, Change in CO_2 Levels, 602 Global Climate Change, 602–603 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
2. Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (Using Mathematics and Computational Thinking) (Professional: Information and Communications Technologies)	**SE/TE:** For supporting content, please see: Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
3. Connections to Nature of Science: Scientific Investigations Use a Variety of Methods. Science investigations use diverse methods and do not always use the same set of procedures to obtain data. New technologies advance scientific knowledge.	**SE/TE:** Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607
4. Scientific Knowledge is Based on Empirical Evidence: Science arguments are strengthened by multiple lines of evidence supporting a single explanation.	**SE/TE:** Inquiry—Try It! Global Climate Change: What Is Causing It?, 587
Elaboration on the GLE:	
1. Students can answer the question: How do people model and predict the effects of human activities on Earth's climate?	**SE/TE:** How Earth Works, 494–495 Climate Changes, 600 Human Impact on Climate, 602 Figure 15, Change in CO2 Levels, 602 Global Climate Change, 602–603 21.3 Assessment, 603 21 Assessment, 610 Inquiry—Exploration Lab: Human Impact on Climate and Weather, 606–607

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2. ESS3:D Global Climate Change: Though the magnitudes of humans' impacts are greater than they have ever been, so too are humans' abilities to model, predict, and manage current and future impacts. Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities, as well as to changes in human activities.	**SE/TE:** The Carbon Cycle, 85 Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Plate Tectonics, 600 Earth's Orbital Motions, 601 Ocean Circulation, 601 Solar Activity, 601 Volcanic Eruptions, 601 Figure 15, Change in CO_2 Levels, 602 The Greenhouse Effect, 602 Global Climate Change, 602–603 **TE ONLY:** 21st Century Learning, 608
Cross Cutting Concepts:	
1. Stability and Change: Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	**SE/TE:** Inquiry—Try It! Global Climate Change: What Is Causing It?, 587 Figure 15, Change in CO_2 Levels, 602 Global Climate Change, 602–603
2. Systems and System Models: When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.	**SE/TE:** Inquiry—Try It! Global Climate Change: What Is Causing It?, 587