**Unit Essential Question:** *How have natural processes and human activities created the ecosystems we see today?*

**Introduction**

In Task 1, students learned about how plate motions have led to the geological world they experience. In this task, students learn that some of these same processes also lead to the natural resources that are available in different regions. The question of how natural resources are made and distributed is a very important one for humans because we rely so heavily on them every day. In this task, students explore both the geoscience processes and the human actions that result in an uneven distribution of resources—which is a cause for major conflict around the globe. In their culminating project, this knowledge will help them to justify the resources they present in their arena.

**Alignment Table**

|  |  |  |  |
| --- | --- | --- | --- |
| **Performance Expectations** | **Science and Engineering Practices** | **Disciplinary Core Ideas** | **Crosscutting Concepts** |
| **MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes.** [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).] | **Constructing Explanations**   * Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) 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. | **ESS3.A: Natural Resources**   * Humans depend on Earth’s land, ocean, atmosphere, and biosphere for many different resources. Minerals, freshwater, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. | **Cause and Effect**   * Cause and effect relationships may be used to predict phenomena in natural or designed systems. |
| **Supplementary Science and Engineering Practices**   * Developing and Using Models   + Develop and/or use a model to predict and/or describe phenomena. | | | |
| **Equity and Groupwork**   * Pairs participate in group roles to model plate tectonics. * Share ideas about various resources. | | | |
| **Language**   * Read and discuss information on resources. * Write a CER report. | | | |

**Learning Goals:**

This learning task asks students to explain how Earth’s resources are unevenly distributed on Earth because of past and current geoscience processes. More specifically, students will:

* Activate prior knowledge about natural resources in the world via news headlines.
* Model how plate tectonics create geologic features.
* Analyze research to learn how geoscience processes form oil and natural gas.
* Apply understanding of one resource to predict distribution of another resource.
* Apply knowledge of uneven distribution of resources to their own imitation arena.

**Content Background for Teachers**

Uneven distribution of resources is one of the foremost politically charged environmental issues of today, as evidenced by the newspaper headlines provided in the Engage portion of this task. Both past and current geoscience processes as well as current human removal practices cause the uneven distribution of natural resources.

In the last task, students learned about plate motions leading to the geological world they currently experience. This task asks students to delve deeper into this concept by thinking about why many natural resources are limited and unevenly distributed. To do this, they first model plate tectonics and the different plate interactions that can occur. Tectonic plates move. Thus, at their boundaries, they can bang into, dive under, split further apart, or slide along each other. The driving force behind plate tectonics is convection in the mantle, causing plate movement.

* When two plates spread apart, this creates a divergent boundary, and this is where seafloor-spreading ridges or continental rift zones can occur.
* When two plates slide along each other, this forms a transform boundary, and can often result in earthquakes.
* When two plates come together, this is known as a convergent boundary, and one of two things can happen. If both plates uplift, this can create mountain ranges. If one plate subducts under another, this can create ocean trenches (also known as ocean basins) or volcanoes.

This relates to natural resources because plate tectonics are heavily involved in the creation of some of these nonrenewable resources. The examples specifically discussed in this task are oil and natural gas. As noted in the student resource card, oil and gas are formed mostly from the rapid burial of dead microorganisms in environments where oxygen is so limited that they do not decompose. These were most likely in swamps, river deltas, and mild climates. Ocean basins developed by plate subduction provide just the right conditions for rapid burial of the dead microorganisms that will one day become oil. The movement of plates also shifts these deposits around the world and is why we see some of the largest oil and gas reservoirs in deserts and arctic areas. Lastly, collisions between tectonic plates can free the mature oil and gas from deep within ocean basins and then trap oil and gas in reservoirs before they escape to the Earth’s surface. We know these reservoirs as oil and gas fields.

This task also explores another natural resource that was already introduced in Task 1—coal. Coal is another important energy resource and is created in a similar process to oil formation. Tropical swamp forests of Europe and North America provided much of the organic material that was buried and compressed in sediments to form coal. Thus, locations, such as today’s Appalachian Mountain region, that supported these Carboniferous swamp forests have more of the unevenly distributed coal.

These are only three examples of natural resources that are unevenly distributed throughout the world. In Unit 2, students will return to this Performance Expectation and explore more examples. Students will later be introduced to mineral resources, such as gold, copper, and other metal ores, which are brought to the surface by similar volcanic and uplift processes. For example, a prospector’s shout that “there’s gold in them thar hills” directly connects gold distribution with the plate tectonics that created “them thar hills.” Groundwater is another unevenly distributed resource, determined by the amount of precipitation in that area and the permeability of the soil and rocks in that region. For more information on any of these topics, please reference the resource cards from Unit 1, Task 2 and Unit 2, Task 2.

**Academic Vocabulary**

* Natural Resource
* Tectonic Plates
* Oil
* Natural Gas
* Nonrenewable
* Reservoir
* Deposit
* Divergent
* Convergent
* Subduction
* Transform
* Coal
* Geoscience Process

**Time Needed (Based on 45-Minute Periods)**

4 Days

* Engage: 0.5 periods
* Explore: 1.5 periods
* Explain: 0.5 period
* Elaborate: 0.5 period
* Evaluate and Reflection: 1 period

**Materials**

* Unit 1, Task 2 Student Version

Explore (per group or pair)

* Resource Cards in sheet protectors
* 4 Graham Crackers
* Cake Frosting
* Wax Paper
* Plastic Knife
* Cup of Water
* Computer

Evaluate

* Project Organizer Handout

**Instructions**

**Engage**

1. Introduce Task 2: In Task 1, you learned about how plate motions lead to the geological world you currently experience. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
   * Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.
2. Transition to Task 2: But how does this also affect which resources are available in a region? This question is very important to us, as humans, because we take many different substances from the Earth—such as water, minerals, timber, and oil—and put them to our own uses.

* Now pass out their Task 1 student guide.

1. Because we use natural resources so much, we will often see them written about in the news. In this activity, students analyze a few real news headlines from different time periods, shown in their student guide.

* We recommend projecting the news headlines on the board and popcorn reading them aloud, but students may also consider them silently.

1. We also recommend taking students through the discussion questions as a whole-class facilitated discussion. First have students discuss the question in pairs and then share out as a class. Make sure to provide wait time for students to write and collect their thoughts.

* When calling on students, it is recommended that you give pairs of students time to discuss questions and then call on pairs using equity sticks. This encourages more equitable participation in class-wide discussions (See “How to Use This Curriculum” for more details).

1. Below are some sample responses to the four discussion questions:
   * Question 1: This question is intended to elicit prior knowledge of natural resources and collectively come up with a definition. Students should eventually arise at a definition similar to the following: Natural resources are substances that come from nature and that humans use.
   * Question 2: This question links this task to the last task. Students may remember that the last task used coal distribution as evidence of past plate motions, and coal is a natural resource. Some may already know that many natural resources come from plate tectonic processes.
   * Question 3: Possible responses are gold, oil, diamonds, and water. If students are struggling, you can point their attention back to the headlines and ask them to identify the resources in the headlines.
   * Question 4: Students may use the headlines as evidence that certain resources are in certain places, so America may not have all of the resources within their own land. When there is a limited amount of something that everyone needs, this often causes conflict. Students can use their own experiences of this phenomenon to explain this (ie. When there are only a few cookies left, but lots of kids want them).
2. Optional: The following video is another great way to give students background on what natural resources are and how much we rely on them in our daily lives - <https://www.youtube.com/watch?v=8LfD_EKze2M>.

**Explore**

1. In the last task, students learned that plate motions have led to the geological world around them. However, the news headlines in the Engage showed them that these processes occur in different places in the world and lead to different results. How does the Earth actually make these resources? In this activity, students will explore what plate movements have to do with all of this.
2. Give students a brief overview of tectonic plates (provided in student guide), which they have likely learned about in earlier grades. This provides the foundation for them to think about the events that occur at plate boundaries, which they will model in this activity.
3. Distribute materials to pairs of students for the Graham Cracker Plate Modeling Activity. We recommend assigning roles to each group. You may use whatever roles you prefer. We recommend the use of the Materials Manager, Facilitator, Harmonizer, and Recorder.
   * Ask the Materials Manager to handle any resources needed to complete the task.
   * Ask the Facilitator to read the directions, make sure everyone understands the task, and facilitate discussion.
   * Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
   * Ask the Recorder to make sure the group is drawing their diagrams and recording observations in their student guides.
4. This activity emphasizes the crosscutting concept of **Cause and Effect** as students use the cause-and-effect relationship between geoscience processes and geologic features to make predictions about resource formation. It also utilizes the science and engineering practice of **Developing and Using Models**, as students make a model with graham crackers to describe the phenomenon of plate tectonics forming resources over time.
   * Options: Have students use the resource card to do this activity in groups OR guide them through each step of the modeling process as a class, reading directions aloud.
   * After each model, students should diagram what they made and explain what potential results there might be.
5. Once students finish the modeling activity, emphasize to students that not only are geologic features created, but also natural resources are formed that humans then extract from the Earth.

* Distribute the “How Is Oil Made?” resource card to each group or pair of students and have them read about oil formation in order to apply it to one or a few of their models.
* Students should fill in the flowchart in their student guides to explain the oil formation process and then identify which type(s) of plate interactions help to make oil. Again, students are using the same **Cause and Effect** relationship to predict and explain how oil is made around the world.
* You may need to describe for students what a “flowchart” is and model a simple one as an example:

Seed grows

Water the seed

Plant a seed

* + The last question in this section asks students to use their prior knowledge as well as evidence from the *Engage* and the article to consider how humans are also affecting distribution of resources. This asks students to push past just the geoscience processes and consider how humans’ mass removal of these nonrenewable resources is also having a large effect.

**Explain**

1. This section of the task puts all the information together so students can come to a generalized conclusion. It focuses on the crosscutting concept of **Cause and Effect**, using the relationship between plate tectonics and oil to predict how geologic processes and human activity distribute most resources around the world.
   * Students summarize their understanding by writing a CER report that answers the question: Are all resources distributed evenly throughout the world? Why or why not? They should use evidence from the *Engage and Explore* to justify their response, thus explicitly practicing the skill of **Constructing Explanations.**

Optional Sentence Stems to Provide

|  |  |
| --- | --- |
| **Claim** | Resources are/are not (pick one) distributed evenly throughout the world because…  Humans are also… |
| **Evidence** | * There are areas in the world… * For example… |
| **Reasoning** | * A long time ago, organisms\_\_\_\_\_\_\_. * The plate movement leads to … * ….., which causes \_\_\_\_\_\_. |

Sample Student Response

|  |  |
| --- | --- |
| **Claim** | Resources are not evenly distributed throughout the world because the geoscience processes that have created these resources happen in different parts of the world. Humans are also extracting them at different rates in different areas. |
| **Evidence** | There are areas in the world where you can get a lot of oil and gas and other areas where there is none. |
| **Reasoning** | This is because there are certain areas where fossils ended up deep down in the earth. Then plate movement ended up moving these fossils to different places around the world. Humans also remove them at different rates. |

1. This CER paragraph can be a good option for formative assessment. Collect student work to identify trends in students’ ability to use evidence to support an explanation. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

**Elaborate**

1. At this point, students have identified a pattern that certain geoscience processes lead to certain resources. They have also seen in the cases of oil and natural gas that these geoscience processes happen in specific places and thus oil and gas are specific to these locations.
   * This section of the task asks students to use this knowledge and their understanding of the crosscutting concept of **Cause and Effect** to make a prediction about coal distribution.
   * Students read the description of how coal is created and decide whether they think coal is evenly or unevenly distributed throughout the world. It is important that they explain why within the context of the cause-and-effect relationship they have identified from the rest of the task.
2. Return to the whole-class concept map from the Lift-Off Task.

* In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).
  + Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
  + Draw circles around each question and boxes around each concept.
  + Write connector words to describe connections between the concept boxes.
  + For this task, students may begin to connect some of their previous question circles to concept boxes about the following: how geologic processes and human activity lead to the uneven distribution of natural resources.
* Have students analyze the additions to the class concept map for as many examples of this task’s crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
  + **Cause and Effect**. These could be phrases such as, “which results in,” “which causes,” “that explains why,” “is due to,” etc.
* Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

**Evaluate: Connecting to the Culminating Project**

1. Students independently complete the Task 2 section of the Unit 1 Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
2. Students have been tasked with creating an arena that mimics an environment they may see on Earth. The student prompt is as follows: Every arena needs certain resources to function. Now that you have discovered how resources have been distributed on our own Earth, decide which resources your arena will have.
   * What natural resources will your arena have the most and least of?
   * What geoscience processes will have caused these resources to be available in your arena?
   * What evidence is there for why these resources are unevenly distributed?

**Reflection**

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:

* At the beginning of this task, you looked at different news headlines and hypothesized as to why certain resources are associated with specific regions. Look back at your responses: after learning everything you have about resources, how can you add to your answers? Use information from the task to better explain why America can’t just get all of its resources within its own borders.
* In this task, we focused on the crosscutting concept of **Cause and Effect**: cause and effect relationships may be used to predict phenomena. Where did you see examples of **Cause and Effect** in this task?
* Now that you have learned more about how natural resources are distributed, what questions do you still have?

1. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

**Assessment**

1. You may collect students’ Project Organizer and assess using:

* *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
* This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

1. You may also give students time to make revisions with one of the two options:

* Students may make changes to their Project Organizer according to your comments OR
* Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.