



Student Work Annotations Based upon the Science ERQ Rubric

Evolution of The Andes

Grade Level:
Middle School

Designed and revised by Kentucky Department of Education staff
in collaboration with teachers from Kentucky schools and districts.



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Background Information about the Task

Task Overview

Students will **construct an argument** to support a claim about one way that the **Andes Mountains** **have influenced** the sloths living in the Amazon rainforest. This argument should use evidence from the model to support your claim.

Dimensions

Disciplinary Core Idea (DCI)

- **ESS2.A Earth's materials and systems**
 - All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycle produce chemical and physical changes in Earth's materials and living organisms.
- **ESS2.D Weather and Climate**
 - Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms and living things. These interactions vary with latitude, altitude and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.

Science and Engineering Practice (SEP)

- **Engaging in Argument from Evidence**
 - Construct, use, and/or present a written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon.

Crosscutting Concepts (CCC)

- **Cause and Effect**
 - Cause and effect relationships may be used to predict phenomena in natural or designed systems.
- **Stability & Change**
 - Stability might be disturbed either by sudden events or by gradual changes that accumulate over time.
- **Systems and System models**
 - Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.

Performance Expectations (PE) to which the task is correlated

- **MS-ESS2-1**
 - Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
- **MS-ESS2-6**
 - Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric oceanic circulation that determine regional climates.

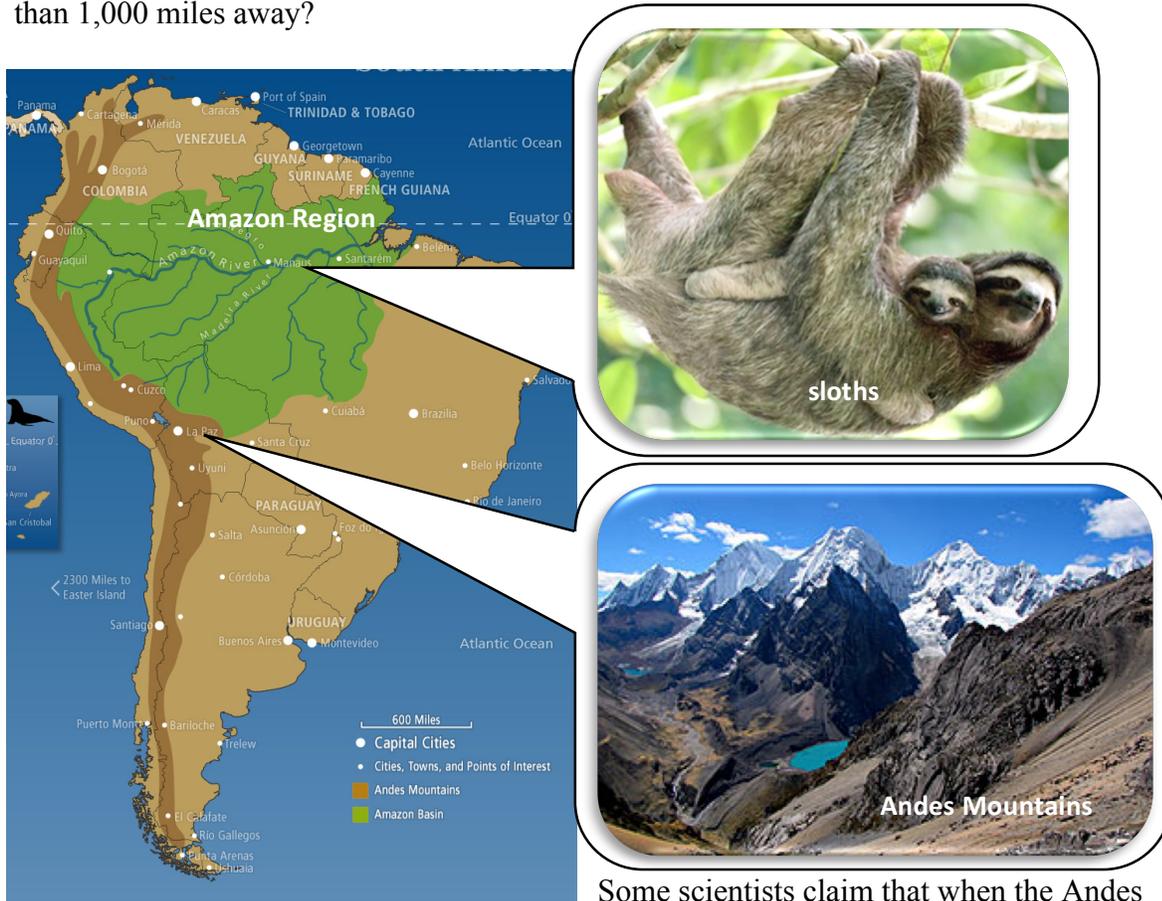
Evolution of the Andes

The original version of this
Earth/Space Science middle
school task may be found at:
[https://snapgse.stanford.edu/
snap-assessments/
instructionally-embedded-
assessments](https://snapgse.stanford.edu/snap-assessments/instructionally-embedded-assessments)

Student Instructions
Evolution of the Andes

INTRODUCTION

What does a sloth living in the Amazon rainforest have to do with the Andes Mountains more than 1,000 miles away?



Some scientists claim that when the Andes Mountains began growing they caused huge changes across South America, including changing the cycling of the water and atmosphere, which then influenced the ecosystems across the continent. They describe these interactions in terms of the movement of matter through the different systems.

This idea has caused a lot of controversy. Some people think that the mountains could not have caused so many changes to distant parts of the continent. Others agree, believing the mountains formed much earlier or later than these changes, so they could not have caused them. Some even argue that the climate helped the mountains to grow, not the reverse.

A museum in Chile, *El Museo Nacional de Historia Natural*, is gathering all kinds of experts to discuss their evidence for each of these claims in a series of presentations. You are part of The Amazonia Research Group that has been studying how the development of the mountains could affect life in the Amazon. You have been asked to present an argument describing the relationship between the mountains and the sloths using evidence collected by your research group.



Sloths are mammals that live in tropical climates of Central and South America. They spend nearly all their time on tree branches, hanging on with their long claws. Sloths need the warm temperatures and the trees found in tropical rain and cloud forests to survive. Before the Amazon region had the warm, wet climate that allowed the rainforests to grow, sloths did not live in this region at all.

Construct an argument to support a claim about one way that the Andes Mountains influenced the sloths living in the Amazon rainforest. This argument should use evidence from your model to support your claim. You may wish to include a model to help in the development of your argument.

The presentation should:

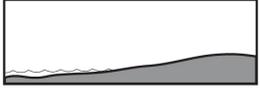
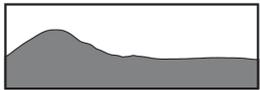
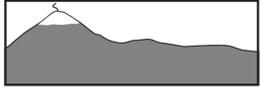
1. Include claim, evidence, and reasoning that together communicate an argument for how you think movement of matter in the Andes Mountains influenced the sloths in the Amazon.
 - The argument should describe each step of the relationship beginning with the developing of the Andes Mountains.
2. Your reasoning should describe **how** specific rock-changing processes and any other processes support your claim.
3. You are communicating an argument to an audience *at El Museo Nacional de Historia Natural* that includes people who have very different ideas about the relationship between the Andes Mountains and its environment. Be clear and convincing to your audience.

Evidence Table
 Evolution of the Andes IEA

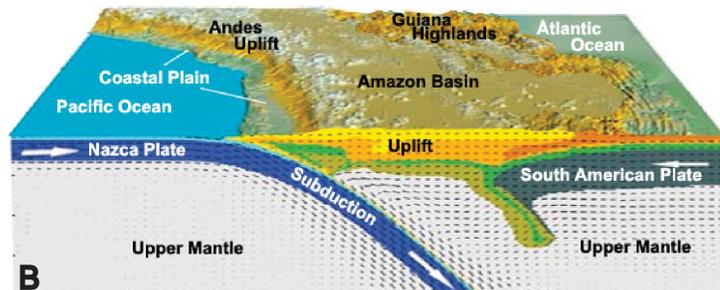
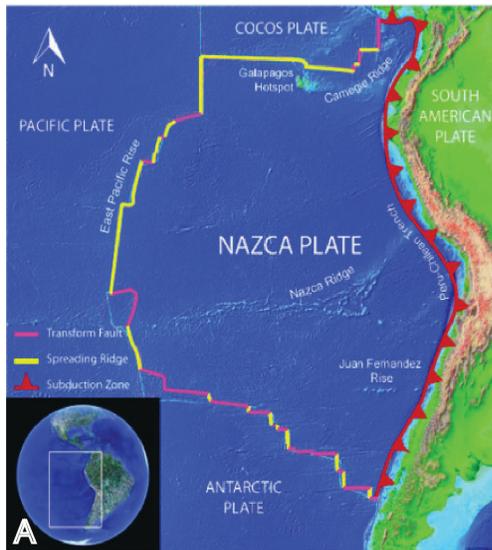
Evidence Table			
Evidence of changes in the earth system (short description)	Describe the processes that could cause the changes.	Where & when did the changes occur?	Order
<i>Sedimentary rock formed on the western edge of South America</i>	<i>Erosion and deposition: Water eroded rock in South America and the broken rocks were deposited and compacted until they formed new sedimentary rock.</i>	<i>65-80 million years ago</i>	1

Evidence card 1

The History of the formation of the Andes Mountains

65-80 Million Years Ago		<p>Water from the Pacific Ocean covered part of the west coast of South America. Sand that was carried in the water fell to the ground, was buried, and became sedimentary rock at the western edge of South America.</p>
34-65 Million Years Ago		<p>The Nazca Plate under the Pacific Ocean pushed into the South American Plate (see pictures at the bottom of the page). As the plates pushed together, the sedimentary rock at the edge of South America was compressed, deformed, faulted, folded, and a mountain range formed along the coastline.</p>
10-34 Million Years Ago		<p>The Nazca Plate continued pushing into the South American Plate and it eventually caused volcanoes to form and erupt. The volcanoes and the continued compression from the plates pushing together built enormous mountains.</p>
10 Million Years Ago to the present		<p>The two plates continue pushing together, now faster, forming another set of huge mountains and volcanoes. Snow collected in the mountains and melted, carving rivers down the sides of the mountains and breaking and moving sediments away from the mountains.</p>

Based on Gregory-Wodziki (2000) and Hoorn (2010)



The Nazca Plate under the Pacific Ocean pushes into the South American Plate, which includes South America. The Andes form along the coastline where the two plates push together. A: A map of the Nazca Plate pushing into South America. B: A view beneath the surface of the earth of the Nazca Plate pushing under (subducting) the South American Plate.

<http://4.bp.blogspot.com/-S1MrqBh1bCM/UGcsa-8Vvwh/AAAAAAAAAF5k/ir25x-MikEw/s1600/229B-Image+Andes+Uplift.jpg>
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Evidence Card 2

Evidence from rocks that are 5-12 million years old

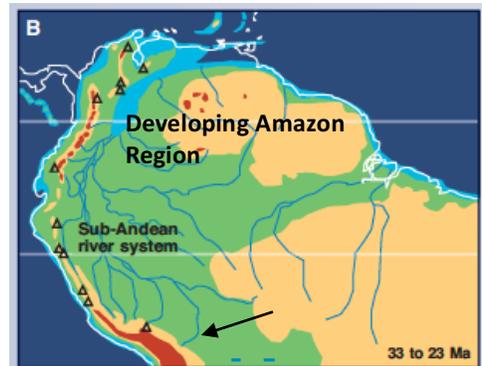
1. There are large amounts of new metamorphic and volcanic rock that formed from 12 million years ago to 5 million years ago in the developing Andes Region.
2. Fossils of tropical plants and insects, soil, and rock formations in the Amazon region show evidence of increased temperature and rainfall (a change in climate) beginning 5 million years ago.
3. Computer models of the atmosphere show that the warm, humid (wet) air that comes from the Atlantic Ocean started being blocked from moving across South America by growing mountains. By 5 million years ago this warm, wet air stayed in the Amazon Region.
4. Soil, sedimentary rocks, and fossils of plants and animals that live in wet environments show that shallow lakes and swamps formed in the Amazon region in this period.

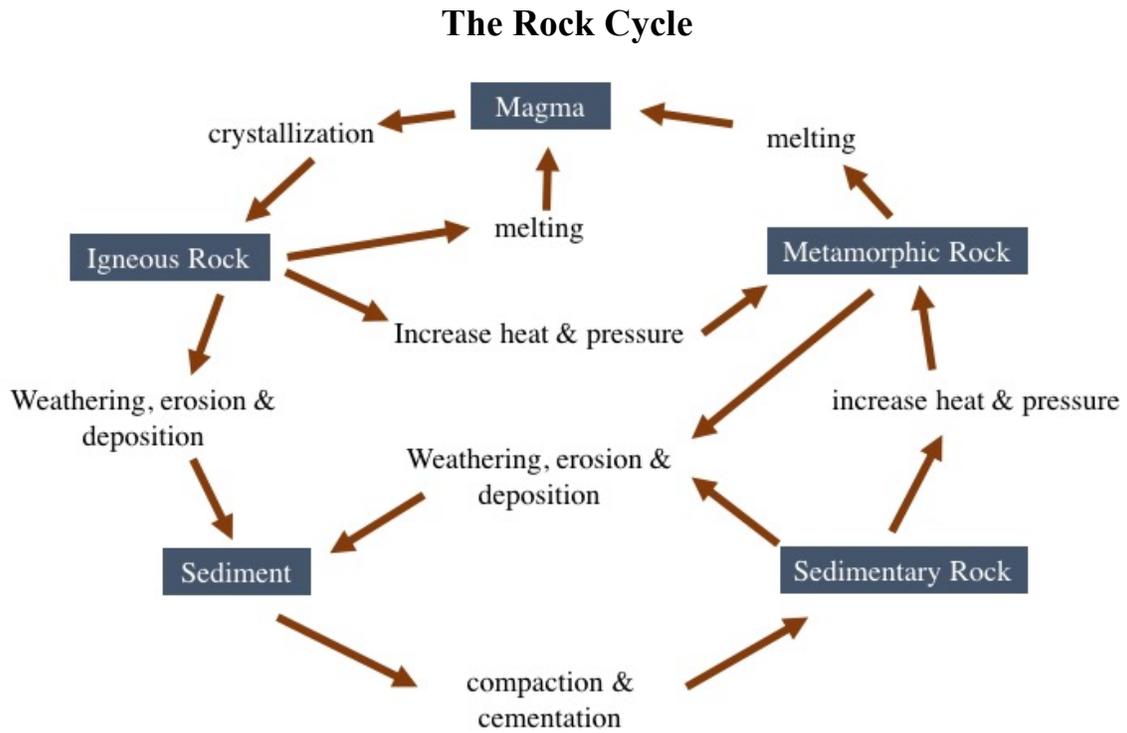


Evidence card 3

Evidence from rocks that are 5 million years old – now (rocks forming today)

1. Fossil plants and animals show changes to cooler climates around the world starting 10 million years ago.
2. Many fossils of plants and animals found in tropical rainforests are found across the Amazon region (including jaguars, toucans, poison dart frogs, cocoa trees, passion fruit trees, orchids, and thousands of kinds of butterflies). Fewer fossils of trees and animals from swamps and wetlands are found in the region.
3. The oldest fossil sloths in the Amazon region are about 10 million years old and in rocks that are 5 million years old and younger there are many species of sloths in the region.





Annotated Task

Students will **construct an argument** to support a claim about one way that the **Andes Mountains** **have influenced** the sloths living in the Amazon rainforest. This argument should use evidence from the model to support your claim

The presentation should:

1. Include claim, evidence, and reasoning that together communicate an argument for how you think movement of matter in the Andes Mountains influenced the sloths in the Amazon.
 - The argument should describe each step of the relationship beginning with the developing of the Andes Mountains.
2. Your reasoning should describe how specific rock-changing processes and any other processes support your claim.
3. You are communicating an argument to an audience at *El Museo Nacional de Historia Natural* that includes people who have very different ideas about the relationship between the Andes Mountains and its environment. Be clear and convincing to your audience.

Dimension		Student is asked to...
SEP Engaging in Argument from Evidence:	Construct, use, and/or present a <u>written argument</u> supported by <u>empirical evidence</u> and <u>scientific reasoning</u> to <u>support or refute an explanation or a model for a phenomenon</u> .	Write a claim, evidence, and reasoning to communicate an argument using evidence to support their claim. The argument should be clear and convincing to their audience.
CCC * Cause and effect:	<u>Cause and effect relationships</u> may be <u>used to predict phenomena</u> in natural systems.	Describe how specific rock-changing processes and other processes influenced the sloths
CCC * Stability and change:	<u>Stability</u> might be disturbed by <u>gradual changes</u> that accumulate over time.	Describe each step of the relationship beginning with the developing of the Andes Mountains.

<p>CCC *</p> <p>Systems and System Models</p>	<p><u>Systems may interact with other systems;</u> they may have sub-systems and be a part of larger complex systems.</p>	<p>Describe how the development of the mountain system influenced the local weather systems.</p>
<p>DCI</p> <p>ESS2.A</p>	<p>All <u>Earth processes</u> are the result of <u>energy flowing and matter cycling within and among the planet's systems.</u> <u>This energy is derived from the sun and Earth's hot interior.</u> The energy that <u>flows and matter that cycle produce chemical and physical changes in Earth's materials</u> and living organisms</p>	<p>Describe the development of the Andes Mountains.</p>
<p>DCI</p> <p>ESS2.D</p>	<p><u>Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms</u> and living things. These interactions vary with latitude, <u>altitude and local and regional geography,</u> all of which can <u>affect oceanic and atmospheric flow patterns.</u></p>	<p>Describe how the development of the mountain system influenced the local weather systems.</p>

*You may not find all three CCC's in every response. At least one should be present.

Student annotations

Student 1: Synthesis & Understanding

The Andes have a lot to do with sloths living in the amazon because the Andes changed the climate, allowed the forest to grow, and sloths appeared around the time the Andes did. **The text states** “some scientists claim that when the Andes mountains began growing they caused huge changes across South America, including changing the cycling of the water and atmosphere,” **the text also states** “Before the amazon was a warm, wet climate that allowed the rainforest to grow, sloths did not live in that region at all.”(page 1-2) **This means that** when the Andes changed the climate, sloths could live in the rainforests it caused. They were unable to live there before. **The text states** that “10 Million Years Ago to the present the two plates continue pushing together, now faster forming another set of huge mountains and volcanoes.” **The text also says that** “The oldest fossil sloths in the Amazon region are about 10 million years old.”(evidence card 1-3) **This means that** when the Andes were formed, the sloths showed up in the Amazon at the same time the mountains were being developed. **This suggests that** the sloths were not able to live in the Amazon area before the mountains formed. **The text states that** “Computer models of the atmosphere show that the warm, humid (wet) air that comes from the Atlantic Ocean started being blocked from moving across South America by growing mountains. By 5 million years ago this warm, wet air stayed in the Amazon Region (evidence card 2) **This means that** the mountains are the thing that caused the change to the climate, to where sloths can live there. **The evidence given shows** that the development of the Andes had a huge impact on sloth and their environment, even if the Andes are 1 thousand miles away.

Student 1 demonstrates **synthesis & understanding** by using relevant information from the text and evidence cards to **make sense of the phenomena**.

Student 2: Coherence & Connections to dimensions

The Andes Mountains influenced sloths by making the Amazon rainforest habitat for the sloths. “The Pacific Ocean sent waves on the sand and made sedimentary rock the Nazca Plate pushed into the South American Plate started to make a mountain range then it formed volcanoes and made them erupt that built enormous mountains then snow collected on the mountain and melted sending rivers down the mountains that moved sediment.” (Task card 1) This affected the Amazon rainforest by giving it a lot of water that made the ground good for plants to grow and drinking water for animals. “Fossils of tropical plants and insects, soil, and rock formations in the Amazon region show evidence of increased temperature and rainfall beginning 5 million years ago.” “Soil, sedimentary rocks, and fossils of plants and animals that live in wet environments show that shallow lakes and swamps formed in the Amazon region in this period.” This shows that the Andes mountains affected sloths in the rainforest by the Andes making the climate humid for the sloths, other animals, and plants to thrive and grow. “Fossil plants and animals show changes to cooler climates around the world starting 10 million years ago. Many fossils of plants and animals found in tropical rainforest are found across the Amazon region. Fewer fossils of trees and animals from swamps and wetlands are found in the region. The oldest fossil sloths in the Amazon region are about 10 million years old and in rocks that are 5 million years old and younger there are many species of sloths in the region.” This shows that most sloth fossils found in the Amazon go back 5 million years when the air started to become humid that animals and plants like. Over the last 5 million years, different species of sloths have evolved. This all shows that sloths in the Amazon rainforest have to do with the Andes Mountains more than 1000 miles away because without the Andes sloths would have never been able to live in the Amazon. The Amazon was created by the Andes trapping humid air in the forest and giving water to it that all helped make it habitable for animals, plants, and sloths thrive.

Science & Engineering Practices: Student 2 has Engaged in Argument using evidence (SEP) from the materials provided. Arguing that the development of the Andes made it possible for Sloths to live in the Amazon rainforests.

Cross Cutting Concepts: Student 2 has identified **cause and effect relationships** between the development of the Andes and the impact in climate providing the humid Amazon rainforest required for sloth habitats. This student also shows how the **mountain system interacts with climate systems.** “Without the Andes sloths would have never been able to live in the Amazon. The Amazon was created by the Andes trapping humid air in the forest” The student has also displayed understanding of **stability and change over time.** “This shows that most sloth fossils found in the Amazon go back 5 million years when the air started to become humid that animals and plants like. Over the last 5 million years, different species of sloths have evolved.”

Disciplinary core concepts: Student 2 has used a quote to explain the formation of the Andes
(ESS2A): *“The Pacific Ocean sent waves on the sand and made sedimentary rock the Nazca Plate pushed into the South American Plate started to make a mountain range then it formed volcanoes and made them erupt that built enormous mountains...”*

The student demonstrates understanding of the mountain range influencing the climate
(ESS2.D): *“The Amazon was created by the Andes trapping humid air in the forest and giving water to it that all helped make it habitable...”*

Overall, student 2 has written a cohesive argument with the different dimensions integrated into their response

Student 3. Connections to dimensions

The Andes Mountains changed where the sloths lived. According to the text it says, "...forming another set of huge mountains and volcanoes. Snow collected in the mountains and melted carving rivers down the sides of the mountains and breaking it, moving sediments away from the mountains." The Andes changed the sloths habitat because the mountains formed by a convergent boundary where two plates pushed together and the land moved up to form the Andes Mountain range. Since they are tall, the climate became snowy and the sloths love the warm environment so they had to migrate away from the Andes. The article states "computer models of the atmosphere show that the warm, humid, wet air that comes from the Atlantic Ocean started being blocked from moving across South America by the growing mountains. By 5 million years ago, this warm, wet air stayed in the Amazon region." This shows that the Andes changed where the sloths lived, because sloths like warm air. When the Andes formed, it made a rocky environment with no trees and less vegetation. So, it made them move. In the end, the Andes made a good habitat for sloths in the Amazon, because it is making it warm and humid. Just the way the sloths like it.

Science & Engineering Practices: Student 3 has Engaged in Argument using evidence (SEP) from the materials provided. They have used some evidence from the text "The article states, computer models of the atmosphere show that the warm, humid, wet air that comes from the Atlantic Ocean started being blocked from moving across South America by the growing mountains. By 5 million years ago, this warm, wet air stayed in the Amazon region." The student has written an argument that makes sense of the information supplied.

Cross Cutting Concepts: Student 3 has identified **cause and effect relationships** between the development of the Andes and the impact in climate providing the humid Amazon rainforest required for sloth habitats. This student also shows how the **mountain system interacts with climate systems**. "Since they are tall, the climate became snowy and the sloths love the warm environment so they had to migrate away from the Andes." The student has also displayed understanding of **stability and change over time**. "By 5 million years ago, this warm, wet air stayed in the Amazon region." Although all of these concepts should be developed further, the initial ideas are present.

Disciplinary core concepts: Student 3 has used a quote to explain the formation of the Andes (**ESS2A**): "...the mountains formed by a convergent boundary where two plates pushed together and the land moved up to form the Andes Mountain range."

The student demonstrates understanding of mountain range influencing the climate (**ESS2.D**): "the warm, humid, wet air that comes from the Atlantic Ocean started being blocked from moving across South America by the growing mountains."

Overall, Student 3 has demonstrated connections to the dimensions and synthesis of the information read. Could it be organized in a way that would make it more coherent? More evidence from the information from the provided would offer greater depth of the dimensions.

Student 4: Errors or Flaws in Logic

I believe that the Andes Mountains affect the sloth's life drastically. Certain things in life can change the earth and here are some things that can change the Andes Mountains, which in turn makes the sloth's habitat. Sedimentary rock can be changed with erosion and deposition. Water eroded rock in South America and the broken rocks were deposited and compacted until they formed new sedimentary rock. This happened 65 to 80 million years ago. Scientists believe that when the Andes mountains started growing they had a huge impact on South America's land and Wildlife. They say that the mountains created changes in the water cycle which also caused the change in the atmosphere. Which then influenced the ecosystems across the continent such as the sloths got less water and the air may have changed around them not to mention the fact that it is taking their habitat when it is growing this could have a huge impact on the sloths, not to mention all the other animals in South America's habitats. There were large amounts of metamorphic and volcanic rock that formed from 12 million years ago in the development of the Andes Mountains, which could have hurt the animals' environment very much. Fossils of tropical plants and insects, soil and rock in the Amazon region suggest that increased temperature and more rainfall could make the natural creatures here not be suited to live in this environment anymore. Computer models of the atmosphere show that the warm humid air comes from the Atlantic Ocean and the mountains are blocking the humid air and that means that it could take the Rain out of the rainforest and kill many species of animals. In conclusion the Andes can and will have a huge impact on the sloths unless something steps in.

Does the student think this is what happened in the Andes area or the Amazon area?

How does the metamorphic/volcanic rock hurt the environment?

Flaw in logic here, sloths like the wet, humid Amazon environment.

Error in understanding, the Andes create the rainfall for the rainforests, they are not taking it away.

Science & Engineering Practices: Student 3 has attempted to Engage in Argument using evidence (SEP) from the materials provided. They have used some evidence from the text, although their synthesis of the information may be lacking. *“Computer models of the atmosphere show warm humid air comes from the Atlantic Ocean and the mountains are blocking the humid air (and that means that it could take the Rain out of the rainforest and kill many species of animals).”*

Cross Cutting Concepts: Student 3 identified a **cause and effect relationship**; “the mountains created changes in the water cycle which also caused the change in the atmosphere.”

Student 3 does identify **mountain system interacts with climate systems**; “warm humid air comes from the Atlantic Ocean and the mountains are blocking the humid air”

Disciplinary core concepts: Student 3 has demonstrated very limited understanding of the formation of the Andes (**ESS2A**): *“Sedimentary rock can be changed with erosion and deposition. Water eroded rock in South America and the broken rocks were deposited and compacted until they formed new sedimentary rock.”* The student did not develop the full process of mountain formations.

The student demonstrates knowledge of the mountain range influencing the climate, but again lacks understanding/synthesis of the information. (**ESS2.D**): *“They say that the mountains created changes in the water cycle which also caused the change in the atmosphere. Which then influenced the ecosystems across the continent such as the sloths got less water and the air may have changed around them not to mention the fact that it is taking their habitat when it is growing this could have a huge impact on the sloths*

Overall, Student 4: while the student has shown some connections to the Cross Cutting Concepts and Disciplinary Core Ideas, they do not demonstrate coherence and synthesis of the evidence they have used. The logical connections made are flawed, errors in understanding are present.