Formative Assessment Exemplar - 7.2.1

Introduction:

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS A LESSON FOR STUDENTS.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

Of note: All formative assessment clusters were revised based on feedback from educators after being utilized in the classroom. During the revision process, each cluster was specifically checked to make sure the phenomena was authentic to the DCI, supporting information was provided for the phenomena, the SEPs, CCCs, and DCIs were appropriate for the learning progressions, the cluster supported student sensemaking through the Gather, Reason, and Communicate instructional model, and the final communication prompt aligned with the cluster phenomena. As inconsistencies were found, revisions were made to support student sensemaking. If other inconsistencies exist that need to be addressed, please email the current Utah State Science Education Specialists with feedback.

General Format:

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

Accommodation Considerations:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

Feedback:

If you have comments or suggestions for this document, please use the Online Feedback Form

References:

Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

Utah State Board of Education | Teaching and Learning

Teacher Facing Information

Standard: 7.2.1

Develop a model of the rock cycle to describe the relationship between energy flow and matter cycling that create igneous, sedimentary, and metamorphic rocks. Emphasize the processes of melting, crystallization, weathering, deposition, sedimentation, and deformation, which act together to form minerals and rocks. (ESS2.A)

Assessment Format: Printable or Online Format (Does not require students to have online access, if printable version is used videos will need to be shown to students as a class)

<table>
<tr><th colspan="2">Phenomenon</th></tr>
<tr>
<td>The sand of Reynisfjara beach looks different than the sand from the Great Salt Lake.

Figure 1: Sand from the beach of the Great Salt Lake.

https://www.usu.edu/today/story/utah-with-no-great-salt-lake-report-warns-of-lakes-ultimate-demise-without-action

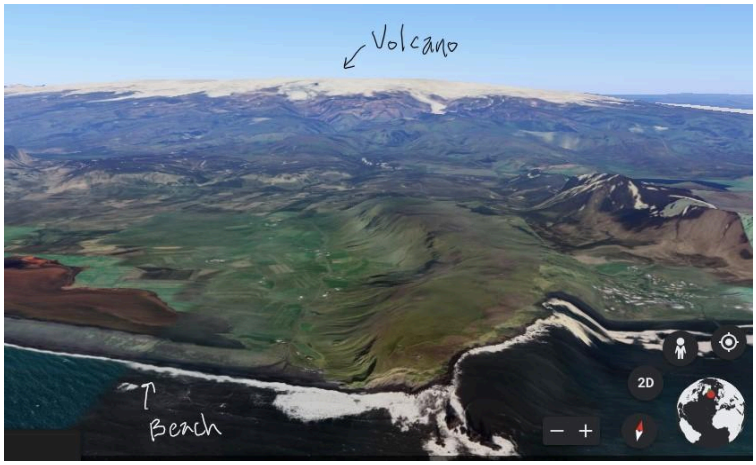

Figure 2: Sand from the Reynisfjara beach.</td>
<td>Proficient Student Explanation of Phenomenon:

Students should be able to model the processes that form black sand in Iceland. Iceland is a volcanic island. When the volcanoes erupt (driven by energy from the core), lava hardens to form black basalt. The coastlines have very strong wave action (driven by energy from the sun) that weathers the basalt into smaller fragments, forming black sand beaches. Sand that is other colors are caused by the original rock that was weathered. Different processes made the different source materials.</td>
</tr>
<tr><th colspan="2">Cluster Task Statement</th></tr>
<tr><td colspan="2">(Represents the ultimate way the phenomenon will be explained or the design problem will be addressed)

In the questions that follow, you will develop and use a model to describe the role of energy flow and matter cycling in relation to the formation of sand like the black sands in Iceland on Reynisfjara Beach.</td></tr>
<tr><th colspan="2">Supporting Information</th></tr>
</table>

Iceland is an island with many volcanoes made of black basalt rock. Fagradalsfjall is an active volcano in Iceland (see **Figure 2**) that is located near Reynisfjara Beach. Reynisfjara is shown in **Figure 3**, and is famous for its basalt cliffs and black sand. Reynisfjara Beach also has heavy wave action.

Figure 2 - Fagradalsfjall beach and Fagradalsfjall Volcano in Iceland



This image shows Fagradalsfjal Beach and the Fagradalsfjall Volcano.

Figure 3 - Reynisfjara Beach in Iceland



These images show Reynisfjara Beach in Iceland, which has black sand and is next to Basalt rocks and cliffs.

Figure 4 - Wave Action at Reynisfjara beach



The image shows Reynisfjara beach has heavy wave action at Reynisfjara beach Video 1(also, see this video Reynisfjara Beach Video)

Figure 5 - Lava flow from the Katla Volcano



This image shows a six-month lava flow from the Fagradalsfjall Volcano in Iceland during the March 2021 eruption. Video 2 - [Fagradalsfjall Volcano Eruption]

Cluster Questions

Gather:
Cluster Question #___1___
Question Type: Table Grid
Addresses:
____ DCI
_x___ SEP ((Obtaining, evaluating, and communicating information)
__x__ CCC (Systems)
Answer:

Parts of the System	Item Descriptions Based on Observations
Fagradalsfjall Volcano and Lava (Figure 2, 5, and video)	Volcano is really big, close to the beach, it's active.
Basalt rock (Figure 3)	black, it's right on the beach, it's large

Question 1:
Make observations about the parts of the system in Iceland shown in figures 2-5 in the table below. Consider how these dynamic processes might influence the rock features in the surrounding area. Think about the forces, matter, and energy in the system.

Parts of the System:	Observations that can be used as evidence of how processes create change in the rock features in this area.
Fagradalsfjall Volcano and Lava (Figure 2, 5, and video)	
Basalt rock (Figure 3)	
Black Sand (Figure 3,4)	
Ocean Waves (Figure 3, 4, and video)	

Black Sand (Figure 3,4)	it's black like the rock, it's on the beach next to the water
Ocean Waves (Figure 3, 4, and video)	they are really big and powerful, they hit beach the hard

Gather:
Cluster Question #___2___
Question Type: Table Grid
Addresses:
__x__ DCI (ESS2.A)
__x__ SEP (Obtaining, evaluating, and communicating information)
__x__ CCC (Systems)
Answer:

Parts of the system	**Inferences about changes to the item**
Fagradalsfjall Volcano and Lava (Figure 2, 5, and video)	The lava erupted and cools
Basalt rock (Figure 3)	Gets hit by waves, gets rained on. breaks
Black Sand (Figure 3,4)	Gets hit by waves, gets rained on. breaks, dragged around, breaks down larger to smaller

Question 2:
In the table below explain how each part of the system is affected by the flow of energy and cycling of matter based on the different processes in the rock cycle that shape the surface of the earth.

Parts of the System	**Inferences about changes to the item**
Fagradalsfjall Volcano and Lava (Figure 2, 5, and video)	
Basalt rock (Figure 3)	
Black Sand (Figure 3,4)	
Ocean Waves (Figure 3, 4, and video)	

Ocean Waves (Figure 3, 4, and video)	crash on beach- blown by wind.

Gather:
Cluster Question #___3___
Question Type: Table Match
Addresses:
__x__ DCI (**ESS2.A)**
__x__ SEP (Obtaining, evaluating, and communicating information)
__x__ CCC (Cause and Effect)
Answer: Correct answers are marked with an 'x' in the table

	Weathering and Erosion	Melting	Cooling and Hardening	Deposition	Heat and pressure without melting
Basalt			x		
Lava		x			
Black Sand	x			x	

Question 3:

Identify which processes are involved in the formation of the Basalt rock, lava from the Katla Volcano, and the black sand from Reynisfjara Beach, Iceland by selecting the boxes below. Select only the boxes that show the processes of the most recent phase of creating each one. You may mark more than one process each time.

	Weathering and Erosion	**Melting**	**Cooling and Hardening**	**Deposition**	**Heat and pressure without melting**
Basalt					
Lava					
Black Sand					

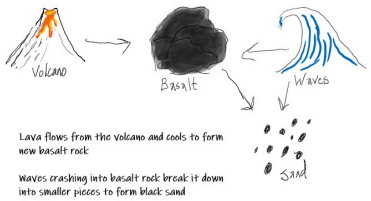
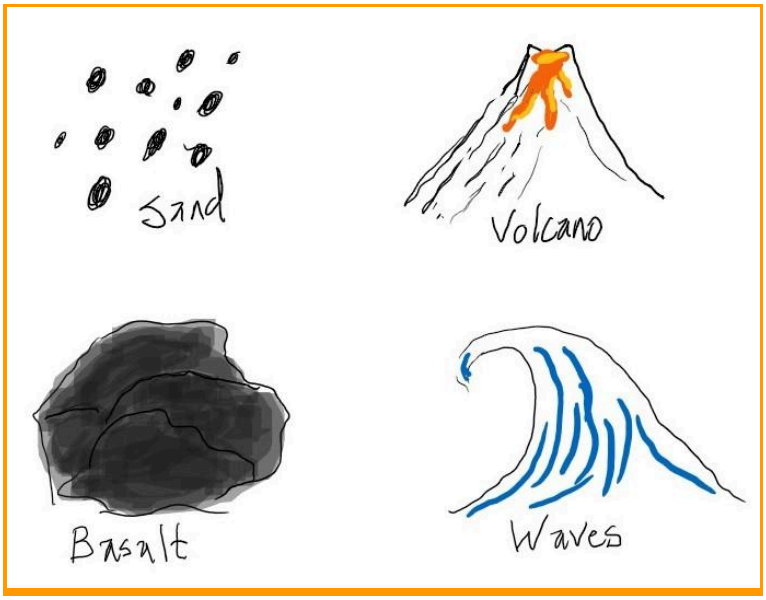
Reason:
Cluster Question #___4___
Question Type: Short answer
Addresses:
__x__ DCI (ESS2.A)
__x__ SEP (Obtaining, evaluating, and communicating information)
__x__ CCC (Cause and Effect)
Answer:
Earth's interior. Building up. Basalt. Igneous rock
the Sun. weather. breaking down. Sand. sediment

Question 4:

Select the best answer from each set of parentheses for each of the questions below.

Heat energy from (Earth's interior/the Sun) causes rocks to melt. As melted rock reaches the surface, it cools (building up/breaking down) rock. This process forms (basalt/sand) which is (sedimentary rock/igneous rock/metamorphic rock/sediment).

Heat energy from (Earth's interior/ the Sun) warms air and water to cause storminess and intense wave patterns in this area. The waves (melt/weather) the rocks (building up/ breaking down) rock. This process forms (basalt/sand) which is (sedimentary rock/igneous rock/metamorphic rock/sediment).

Reason: Cluster Question #_5_____ Question Type: Long Answer Addresses: __x__ DCI (**ESS2.A)** __x__ SEP(Modeling) __x__ CCC (Cause and affect) Answer:  	Question 5: Part A: Create a model to show the cycling of matter ad transfer of energy needed to make the black sand. • First, arrange the pictures in order to demonstrate the flow of energy and cycling of matter in the system. • Then, describe the cycling of matter and the transfer of energy in each section of the cycle. Include the processes. 
Reason: Cluster Question #__6____ Question Type: Long Answer Addresses: __x__ DCI (**ESS2.A)** __x__ SEP(Obtaining, evaluating, and communicating information) __x__ CCC (Cause and affect) Answer: Lava flows from the volcano and is cooled to form basalt rock. Waves crashing into basalt rock break into smaller pieces to form black sand. Increasing wave action will change how much the basalt breaks apart- more wave action would break it more. Increasing volcanic activity	Question 6: Please answer the following questions in 1-2 complete sentences. How does volcanic activity drive the cycling of matter between lava and basalt? How does wave action drive the cycling of matter between basalt and black sand? How would increasing wave action affect the cycling of matter in this system? How would increasing volcanic activity affect the cycling of matter in this system?

would increase eruptions, and produce more basalt from the volcano.	
Communicate: Cluster Question #__8____ Question Type: Modeling, Long Answer Addresses: ___X_ DCI (ESS2.A) __x__ SEP: (Modeling) __x__ CCC: (Energy flowing matter cycling) Answer: The black sand is made from the black basalt. The basalt is formed from hot lava, which is melted from the heat coming from the earth's core. The lava is cooled rapidly as it exits the volcano. Heat energy is transferred during this process. Energy from the sun is transferred to air and water, resulting in heavy wave action. Once basalt has formed, waves weather and erode the basalt, breaking down the basalt into smaller pieces and carrying the sediment to be deposited on the beach.	Question 8: Use the model and evidence from above to describe how the energy from the Sun and Earth's interior are driving the matter cycling processes that occur between the volcano, basalt rock, and ocean waves to form black sand. Part A Use your model and evidence from previous questions to identify the rock type of the basalt. Part B Predict the type of rock the sand would become if it was

Proficiency Scale

Proficient Student Explanation:

The parent rock would be something other than basalt- the black sand is black because basalt is black. So for white sand or purple sand, the parent rock would have to be white or purple.

Level 1 - Emerging	Level 2 - Partially Proficient	Level 3 - Proficient	Level 4 - Extending

SEP: Does not meet the minimum standard to receive a 2.	**SEP:** Develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. Develop and/or use models to describe and/or predict phenomena. Develop a diagram to convey a process.	**SEP:** Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed. Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.	**SEP:** Extends beyond proficient in any way.
CCC: Does not meet the minimum standard to receive a 2.	**CCC:** Understands matter is transported into, out of, and within systems. Can track matter flows and cycles before and after a process occurs. Identifies energy can be transferred in various ways and between objects.	**CCC:** Can track the transfer of energy drives the motion and/or cycling of matter, within a natural system. Recognizes energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). Understands that the transfer of energy can be tracked as energy flows through a natural system.	**CCC:** Extends beyond proficient in any way.
DCI: Does not meet the minimum standard to receive a 2.	**DCI:** Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.	**DCI:** All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is	**DCI:** Extends beyond proficient in any way.

		derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.	

(Student Facing Format on following page)

Name: _____ Date: _____

Stimulus

The sand of Reynisfjara beach looks different than the sand from the Great Salt Lake.

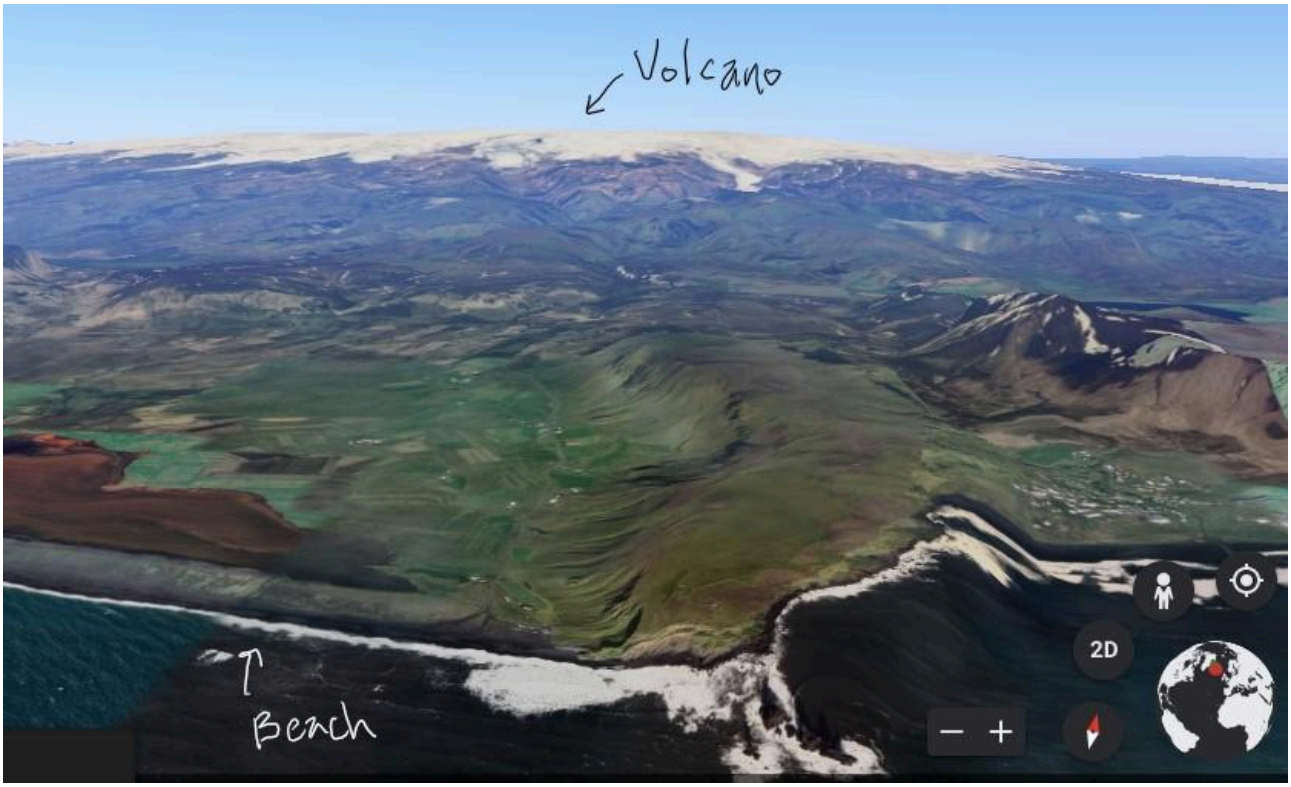
Figure 1: Sand from the beach of the Great Salt Lake (left) and Reynisfjara (right).



These images show sand from two different beaches.

Iceland is an island with many volcanoes made of basalt rock. Fagradalsfjall, the largest active volcano in Iceland (see **Figure 2**) is located near Reynisfjara Beach. Reynisfjara is shown in **Figure 2**, and is famous for its basalt cliffs and black sand, and heavy wave action.

Figure 2 - Reynisfjara beach and Katla Volcano in Iceland



This image shows Reynisfjara Beach and the Katla Volcano.

Figure 3 - Reynisfjara Beach in Iceland



These images show Reynisfjara Beach in Iceland that has black sand and is next to Basalt rocks and cliffs.

Figure 4 - Wave Action at Reynisfjara Beach and Video 1



The image shows Reynisfjara beach has heavy wave action at Reynisfjara Beach.
Video 1: Reynisfjara Beach Video

Figure 5 - Lava flow from the Katla Volcano and Video 1



This image shows a six-month lava flow from the Fagradalsfjall Volcano in Iceland during the March 2021 eruption.
Video 2 - **Fagradalsfjall Volcano Eruption**

Your Task

In the questions that follow, you will develop and use a model to describe the role of energy flow and matter cycling in relation to the formation of sand like the black sands in Iceland on Reynisfjara Beach and identify the rock types involved.

Question 1

Make and list observations about the parts of the system in Iceland shown in figures 2-5 in the table below. Consider how these dynamic processes might influence the rock features in the surrounding area. Think about the forces, matter, and energy in the system.

Parts of the System	**Observations to be used as evidence of how processes create change in the rock features in this area.**
Fagradalsfjall Volcano and Lava (Figure 2, 5, and video)	_____ _____ _____ _____
Basalt rock (Figure 3)	_____ _____ _____ _____
Black Sand (Figure 3,4)	_____ _____ _____ _____
Ocean Waves (Figure 3, 4, and video)	_____ _____ _____ _____

Question 2

In the table below explain how each part of the system is affected by the flow of energy and cycling of matter based on the different processes in the rock cycle that shape the surface of the earth.

Parts of the System	**Changes that Occur Based on the Flow of Energy and the Cycling of Matter.**
Fagradalsfjall Volcano and Lava (Figure 2, 5, and video)	
Basalt rock (Figure 3)	
Black Sand (Figure 3,4)	
Ocean Waves (Figure 3, 4, and video)	

Question 3

Identify which processes are involved in the formation of the Basalt rock, lava from the Katla Volcano, and the black sand from Reynisfjara Beach, Iceland by selecting the boxes below. Select only the boxes that show the processes of the most recent phase of creating each one. You may mark more than one process each time.

	Weathering and Erosion	**Melting**	**Cooling and Hardening**	**Deposition**	**Heat and pressure without melting**
Basalt					
Lava					
Black Sand					

Question 4

Select the best answer from each set of parentheses for each of the questions below.

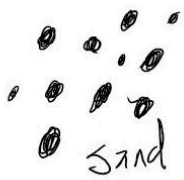
Heat energy from (Earth's interior/the Sun) causes rocks to melt. As melted rock reaches the surface, it cools (building up/breaking down) rock. This process forms (basalt/sand) which is (sedimentary rock/igneous rock/metamorphic rock/sediment).

Heat energy from (Earth's interior/ the Sun) warms air and water to cause storminess and intense wave patterns in this area. The waves (melt/weather) the rocks (building up/ breaking down) rock. This process forms (basalt/sand) which is (sedimentary rock/igneous rock/metamorphic rock/sediment).

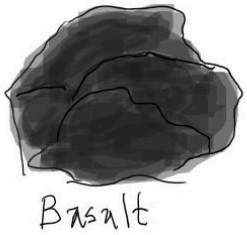
Question 5

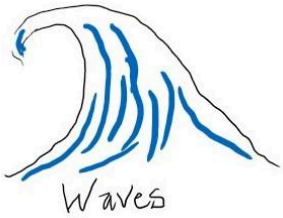
Part A: Create a model to show the cycling of matter and transfer of energy needed to make the black sand.

- First, arrange the pictures in order to demonstrate the flow of energy and cycling of matter in the system.
- Then, describe the cycling of matter and the transfer of energy in each section of the cycle. Include the processes.









First: _____

Second: _____

Third: _____

Fourth: _____

Part B: Draw a model using the information, including information about the transfer of energy and cycling of matter.

Question 6

Please answer the following questions in 1-2 complete sentences.

How does volcanic activity drive the cycling of matter between lava and basalt?

_____

_____

How would increasing volcanic activity affect the cycling of matter in this system?

_____

_____

How does wave action drive the cycling of matter between basalt and black sand?

_____

_____

How would increasing wave action affect the cycling of matter in this system?

_____

_____

Question 7

Use the model and evidence from above to describe how the energy from the Sun and Earth's interior are driving the matter cycling processes that occur between the volcano, basalt rock, and ocean waves to form black sand.

_____

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