Why are there trillions of sea shells in the Colorado River Delta?

***Essential Questions:***

* *Why are there trillions of shells in the Colorado River delta?*
* *Why does the Colorado River delta look the way it does?*

***Objectives specific to the Colorado River VFE:***

* *Explain generally the influence of moving water in a variety of environments upon the deposition of sedimentary particles;*
  + *Describe how changes in moving water over short and long time scales can influence erosion, deposition, and environments;*
  + *Define chenier and explain specifically how cheniers form, including description of how the processes of erosion and deposition contribute to chenier formation;*
* *Describe several ways human activities have changed the Colorado River Delta over the last century.*
* *Propose policy initiatives to appropriately protect, restore, or, if appropriate, leave be, the Colorado River Delta ecosystem and explain the rationale for these initiatives drawing from the available evidence.*

***Background:***

The Colorado River delta covers more than 65 km2and is situated just south of the US-Mexico border at the head of the Gulf of California. The delta environment can be harsh due to the hot, dry climate, but life nonetheless thrives in a variety of habitats, from cottonwood groves to saltmarshes and tidal flats. Here in this virtual field experience (we’ll abbreviate it “VFE”) we will take a closer look at one of the most prominent features in the delta, accumulations of trillions of sea shells in formations called cheniers, and you will explore how they formed. These cheniers are unique and such formations only occur in a few places around the world. It took experts several decades to understand the mystery of how they formed, and now it’s your turn to solve the mystery of chenier formation in the Colorado River delta. Just like a scientist conducting research, you may not be able to answer all of your questions on your first pass and you may need to change your answers as you learn more about the Colorado River delta.

1. To begin, go through the introductory slides to familiarize yourself with where the Colorado River delta is located and how it looks today.

**Question Set 1: How does a typical river delta form?**

1. The different colored sediments, which in this video are plastic beads of different sizes, represent different sediment grain sizes. Why do you think the sediments end up sorted by color even though they didn’t start that way?
2. What happens to the sediments as the video progresses?
3. What do you think would happen if a dam were built halfway up the stream in the video?
4. **The grand challenge: Make a prediction about how you think these cheniers formed?**
5. Go through the VFE and answer the questions in it to help you solve the mystery of the formation of the shell accumulations.

**Question Set 2:** **Geology in the Colorado River delta: The big picture**

1. How do you think the mountains near the Colorado River delta formed?
2. What role did the tectonic history of the Gulf of California play in the development of the Colorado River delta?
3. Do you think tectonic history of this area has influenced chenier formation? Why?

**Question Set 3: Digging Deeper: Human Impact**

1. How has the delta ecosystem changed in the last several decades?
2. In what ways are people responsible for the changing ecosystem?
3. What actions have been taken to restore the Colorado River delta ecosystem?
4. What do you think happened to the delta after the water was released?
5. Do you think the release of water influenced chenier formation in the delta?

**Question Set 4: A history of diversions**

1. How do you think diversion of the Colorado River to the Salton Sea may have influenced life in the Colorado River delta?
2. In the time lapse, how did the color of the delta change?
3. What human activities does this correspond to?
4. What is similar about these past diversions and conditions in the Colorado River basin today?

1. How do the two sets of conditions differ?
2. How might these diversions of the river have affected the formation of cheniers in the delta?

**Question Set 5: How does water shape a delta?**

1. What factors determine how far a river will transport any given sediment particle?
2. In the video the Colorado River delta is identified as an “outie.” Based on what you have learned so far, do you agree with this assessment?
3. What might lead to changes in the shape of the Colorado River delta?

1. Do you think the water is currently depositing sediments, eroding sediments, or both?
2. How have dams changed the impact of water in the downstream delta? Would this affect chenier formation?

**Question Set 6: Geology at a finer scale**

1. What is the grain size of the clasts on the tidal flat?
2. How do the clasts in the chenier differ?
3. What types of processes might lead to this difference?

1. **Reconsidering the grand challenge: Revisit your prediction about chenier formation. Revise your prediction to incorporate the new information you learned.**
2. Now that you have written an answer based on the contents of the VFE, compare your answer to the information on chenier formation in the “Chenier Formation” section and answer the following questions.

**Question Set 7: Chenier formation**

1. Which set of conditions (progradation or reworking) is currently dominant in the Colorado River delta?

1. What processes in the Colorado River delta have led to the development of cheniers?

1. How have humans influenced chenier formation in the Colorado River delta?

**Question Set 8: A final thought: Water in the future**

1. Keeping the potential drought in mind, what do you think the cheniers will look like in 50 years? 100 years?

1. Return to the graphic organizer and reflect on what information was useful for solving the mystery of the chenier formation. Provide three examples of information that helped you solve the mystery. Be specific.
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