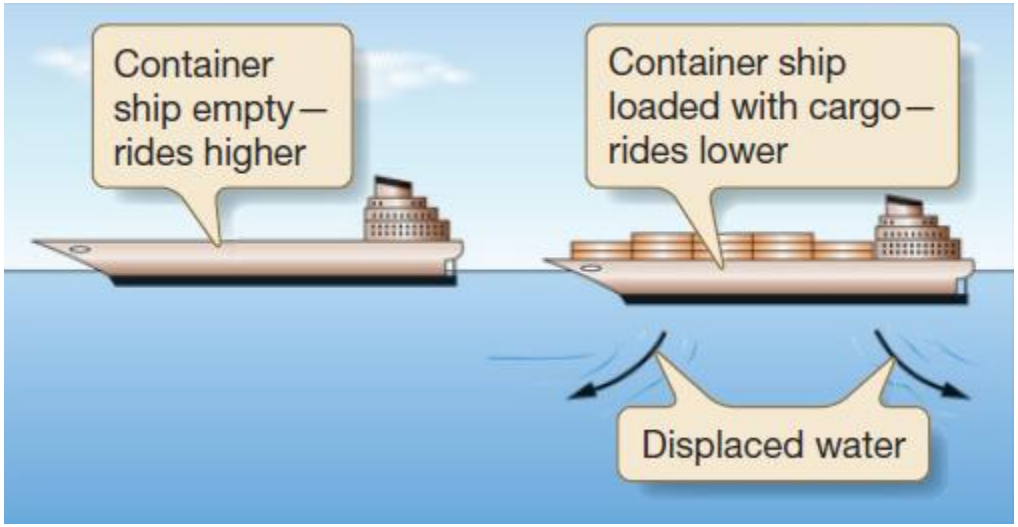
Pearson Science Geoscience Animation Project
Trujillo and Thurman, *Essentials of Oceanography* 11E
Animation Author: Al Trujillo
Associate Media Producer: Tod Regan
Senior Instructional Designer: Sarah Young-Dualan

Animation Storyboard Manuscript

Isostatic Adjustment

Summary: This animation shows how a container ship experiences isostatic adjustment as cargo is loaded on/loaded off. It also shows how isostatic adjustment causes landmasses to exist at different elevations during and after continental glaciation.

Base Art: Trujillo and Thurman, *Essentials of Oceanography* 11E, Figure 1.19 (A container ship experiences isostatic adjustment). A similar figure exists as EO10E, Figure 1.17 (lacks the new balloons shown in the EO11 figure). Also include ancillary images: (1) maps of the Northern Hemisphere during/after the Pleistocene Ice Age and (2) a cross-section of Earth's outer structure (EO11 Figure 1.18: Internal structure of Earth), enlargement only.

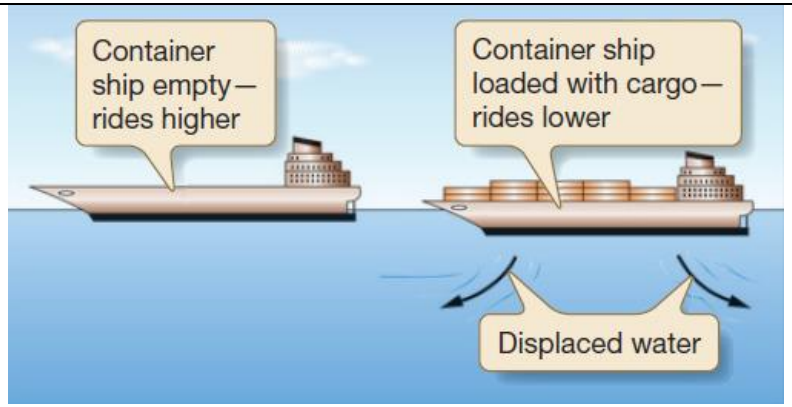


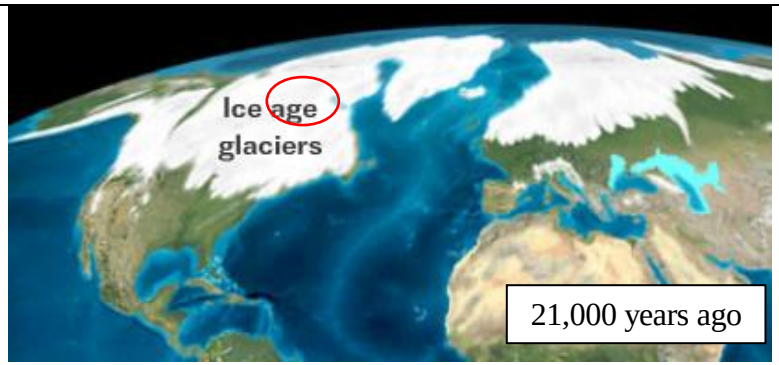
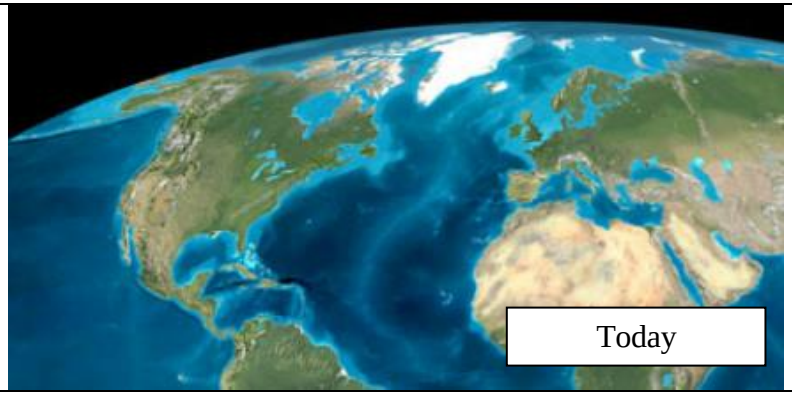
Labels: The labels on the image are the same as shown in the reference figure.

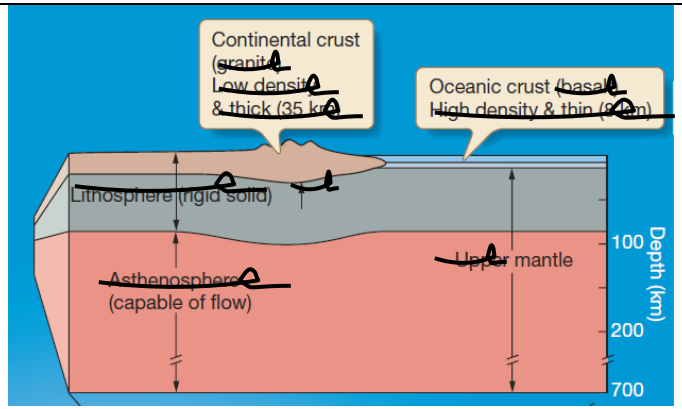
Length: The animation should take about 40-45 seconds.

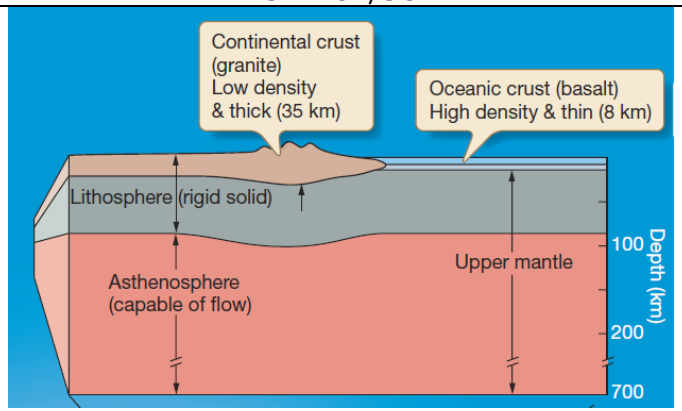
Storyboard

SCENE	NARRATION	SKETCH/SCRAP ART	INSTRUCTIONS
1	Did you know that Earth's crust moves vertically because of the addition or removal of weight? This movement is called *isostatic adjustment*, where the term *isostatic* means "equal standing."		Al is also sending 2 new images that shows glaciers better. Use one of the new images instead.
2	A container ship floating on water provides a good example of how isostatic adjustment works. Notice the empty container ship is floating high in the water near a dock. Press on the "Load containers" button a few times to see how the ship adjusts to the addition of weight and floats lower in the water. Press on the "Unload containers" button to see how the ship readjusts and floats higher in the water with the removal of weight.	 This image was found on Google and is not a Pearson image. It serves to give an idea of what we are looking for. Change out the dark blue stripe above red to white. This can help students see when the ship descends and ascends in simulation.Keep the containers random and multi-colored. We would like to see the ship underwater as well. The red line above gives an idea for depth.	At the beginning of the animation, have the tug boat to the left move in front in front of the container ship and disappear out of the frame to the right. It would be good to show the tug boat's hull below water as well. After the narration completes, activate the "Load containers" button and the "Continue application" button. The ship begins empty. The crane can have 7 containers preloaded horizontally in a row similar to the illustration. When the student clicks on the "Load containers" button, the containers will load onto the ship and another 7 will preload on the

SCENE	NARRATION	SKETCH/SCRAP ART	INSTRUCTIONS
	When you have finished loading and unloading containers, press the "Continue application" button.	Change the color of the container ship color from blue to red. See the image below for an example.  Ref: http://www.shipspotting.com/gallery/photo.php?lid=1690683	crane. In addition, the ship lowers down in the water (needs to be obvious, but not too much). The student can only load up to three rows of containers similar to the illustration. After the third row, the "Load containers" button is disabled. The "Unload containers" button is enabled when there are containers on the ship. It is disabled when the ship is empty. Whenever the containers are unloaded, the ship will rise higher in the water, which needs to be enough to make it obvious. The up and down movement of the container ship will help students understand the concept of isostatic adjustment.
3	As you have loaded and unloaded cargo onto a container ship, you have seen that the ship rides higher in the water when it is empty. You have also seen that the ship rides lower in the water when it is loaded with heavy cargo. To accommodate the additional weight of a fully loaded ship, water is displaced below. A container ship riding higher or lower in the water depending on its	 Have labels come on to match the narration.	Highlight empty boat when the narration states "higher" and then highlight the boat with cargo when the narration states "lower."

SCENE	NARRATION	SKETCH/SCRAP ART	INSTRUCTIONS
	weight illustrates the principle of isostatic adjustment.		
4	Landmasses also experience isostatic adjustment as weight is added or removed. For example, about 21,000 years ago during the last Ice Age, northern landmasses were covered by thick continental glaciers that made the continents ride lower because of the additional weight of the ice.	 Change "age" to "Age" in label. Add label "21,000 years ago." Image comes from previous animation: http://media.pearsoncmg.com/bc/bc_0media_geo/interactiveanimations/039_GlobalGeogTime_SP_GL_Stu.html?tru10#/Geography-Through-Geologic-Time the above image comes on around 3:48 Tod – not sure if we have source images? Or, if B360/P202 can repurpose existing globe images we have been using	Switch to map view, showing glacial extent during the past Ice Age.
5	At the end of the Ice Age, the ice melted and the landmasses began to slowly rise back up, adjusting to the removal of weight. This process occurs slowly and continues in some northern areas even today.		Fade transition to this image to give an impression of the ice melting or disappearing over time.

SCENE	NARRATION	SKETCH/SCRAP ART	INSTRUCTIONS
		Add label "Today" Image comes from previous animation: http://media.pearsoncmg.com/bc/bc_0media_geo/interactiveanimations/039_GlobalGeogTime_SP_GL_Stu.html?tru10#/Geography-Through-Geologic-Time the above image comes on around 4:32 Tod – not sure if we have source images? Or, if B360/P202 can repurpose existing globe images we have been using.	
6	Both the continental and oceanic crust float on the mantle in a similar fashion to the way the container ship floats on water. Notice how the high-density oceanic crust ride lower on the mantle, even though it is thin. Also notice that the thicker, lower density continental crust rides higher above the mantle. Interestingly, what makes tall mountain ranges on land so high is that they have a thick root of continental crust below that keeps them buoyed up.	 EO11 Figure 1.16 The image has three labels only: • Continental crust: Low density • Oceanic crust: High density • Mantle Keep the Depth scale. Make the mantle all one color (not 2 colors).	Highlight both the Continental crust and Oceanic crust in first sentence. Highlight the Oceanic crust only in second sentence. Highlight the Continental crust only in third sentence.

SCENE	NARRATION	SKETCH/SCRAP ART	INSTRUCTIONS
	Since continents slowly move up and down because of isostatic adjustment, it would make sense that they are also able to slowly drift *horizontally* from place to place across the globe. This is exactly what is happening on Earth today: the slow movement of Earth's plates across the globe, thanks to the processes of plate tectonics.	 Keep labels from previous scene.	Show up and down arrows when narration states "Since continents move up and down by isostatic adjustment" Then show left and right arrows slowly stretching back and forth when narration states, "it would make sense that they are also able to slowly drift horizontally from place to place across the globe"