Sea Level and Climate Change – Tutorial Script

You'll remember from the lesson on Earth's formation, seafloor sediments are extremely important records of Earth's past climate. How? The species of diatoms, coccolithophores, radiolarian, and foraminifera will change as seawater temperatures change. In addition, the type of sediment that is deposited will change. Increased glacial activity on land during an ice age will bring more sediment to the margins, and in areas closer to the poles, these sediments will consist of large angular immature material carried by glaciers and then sea ice. In the mid latitudes, where glacial ice was present only in the mountains, rivers have a higher amount of water and sediment. Sea level drops, as water is trapped on land in glaciers. The new coastline moves out towards the edge of the continental shelf, or break. The area exposed can be covered by huge amounts of delta sediments and sands. What's the deepest part of the oceans that can be exposed during an ice age? The continental break. Do you remember how deep the depth is at the break (mentioned in previous lectures)? 125 meters or about 375 feet. That's the deepest sea level will drop during an Ice Age. What's the average depth of the oceans? 4000 meters. So most of the ocean is still covered! Since the earth has experienced multiple episodes of ice ages and interglacials during the past 1.6 million years of the Pleistocene, what story do our shelf sediments record? Let's imagine we take a research cruise to the outer shelf, near the break, and drill through the layers of sediment that have collected. What will we find? What kind of sediment is collecting there today? Assuming it's a wide shelf, we would expect mostly muds that far offshore – maybe some fine sands. What's under them? The sediment that collected during the last ice age, when that spot was the beach. What kinds of sediments collect along a beach? Gravels and sands! So we should see alternating sequences of sediment representing different levels of the ocean. In fact, if we wanted to study fishing villages of earlier cultures that lived 15,000 years ago during the last ice age, we would have to go to the edge of the shelf and drill through many layers of sediment that have deposited since, burying those records. What's the highest sea level could be if we melted all the current glaciers, a direction the planet is currently heading, as it has many times in the past 1.6 million years of glacials and interglacials? 70 meters above current sea level.

Are there other ways to cause sea level to change besides an ice age? What happens if we simply cool water, without producing glaciers? What happens to water as we cool it? Or the reverse: what happens to water as we warm it? To answer that, let's watch what happens to a marshmallow in a microwave. This peep is cold – compact and well preserved. Want to see what it looks like after we heat it? What would we expect? The molecules of marshmallow will pick up energy, moving faster and spreading themselves further and further apart – expanding. The marshmallow should grow. And here's the result. So warming up water should cause it to expand, much like what happens during convection – the expanded warmer water rises up because it's less dense, while the colder denser material sinks to get heated up itself. In this case, we warm up all the oceans, so all of it expands. Sea level would rise. And if the water then cools, it would contract. Sea level would drop.

One more way to change sea level is to change the size of the ocean basins. If we make the bathtub bigger, so to speak, the water that fills it will have more room – sea level will drop. The reverse, shrinking the bathtub, would make sea level rise. As seafloor spreading rates change in the world's oceans, so too will the size of the oceans change and correspondingly, sea level. What's the lowest sea level has been in the past few million years of earth's history as a result of cooling oceans, ice ages, or larger ocean basins? About 130 m below its present position. What's the highest sea level has been? About 170 m (and that was during the Cretaceous, over 100 million years ago, when average surface temperatures were 10 degrees Celsius warmer than they are today).

Remember that the average elevation of the land is 800 m, so 170 m wouldn't cover much – however, it would cover about 85% of the world's population, as that's where the majority of our population centers and associated infrastructure are located. This fact is probably one of the most important you will learn in this class this semester – sea level is rising and will have a huge financial impact on the future of human civilization. An intelligent and sustainable plan for future development should include a good understanding of this regular and natural process of sea level fluctuation. Temporary and transportable structures are logical for building within 100 m of sea level. Permanent structures will require constant financial input to maintain in the face of rising sea level.

Pause now.

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Produced by Katryn Wiese
City College of San Francisco

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