ES322 Geomorphology In-Class Exercise: Density, Buoyance and Isostasy

Examine the demonstration set up with a Styrofoam block, box of sediment, and fish tank with water. The box of sediment is resting on top of the Styrofoam block, and floating in the fish tank. The key concepts and questions to think about: (1) how does the density of the Styrofoam compare to that of the water and sediment? (2) what forces are acting to float the box of sediment? (3) what happens to the immersion depth of the Styrofoam block as sediment is unloaded from the plastic box? (4) How does density related to buoyancy, in turn to isostatic uplift of the Earth's crust as erosion occurs over geologic time?

Preliminary Thought Experiment 1: what is the density of water in the following units:

_____ g / cu. cm
_____ kg / L
_____ g / ml

Preliminary Thought Experiment 2: if an object has a density greater than water, will it sink or float? Why?

Step 1. Calculate the density of the Styrofoam block in grams per cubic centimeter (show all math work)

Density = mass / volume

Area of Styrofoam block surface =	_____	sq. cm
Thickness of Styrofoam block =	_____	cm
Mass of Styrofoam block =	_____	grams
Density of Styrofoam block =	_____	g/cu. cm

Step 2. Calculate the density of the plastic box of sediment in grams per cubic centimeter (show all math work)

Density = mass / volume

Area of sediment box =	_____	sq. cm
Thickness of sediment box =	_____	cm
Mass of sediment box =	_____	grams
Density of sediment box =	_____	g/cu. cm

Step 3. Calculate the combined density of the Styrofoam block + box of sediment (show all math work)

Total Density = $\frac{\text{Mass Styrofoam + Mass Sediment}}{\text{Vol. Styrofoam + Volume Sediment}}$ = _____grams / cu. cm

Step 4. While the syrofoam and sediment are floating in the fish tank, use a scoop to incrementally remove masses of sediment from the plastic box.

Thinking Questions: What happens to the immersion depth of the Styrofoam block as the "boat" is unloaded? As the mass of sediment is removed, and the void space is filled with air, what is happening to the overall bulk density that you calculated in Step 3 above? Increasing, decreasing or staying the same? Explain your observations.

Erosion Rate Problem:

The total relief of Mt. Everest in the Himalayan Mountains is ~8800 m above the surrounding landscape. Through geomorphic observation, the erosion rate of the region ranges from 2-12 mm/yr; with an average of ~6 mm/yr. The uplift rate of the mountain is ~10 mm/yr. Assuming that buoyant isostatic uplift forces of Mt. Everest are zero, and given the average erosion rate, how many years would it take to erode the mountain to base level? Draw a sketch and show your math work.

Given that uplift of the Mt. Everest region is estimated to have began ~50 Ma ago, explain why the mountains stand tall and have not been eroded to base level given your calculations above. What processes are responsible for uplift and maintenance of topography associated with Mt. Everest?